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"SHAPING DIGITAL SERVITIZATION USING I4.0 TECHNOLOGIES: TWO EXEMPLARY CASES IN BTOB MANUFACTURING"

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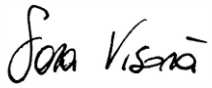

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Introduction

This research aims to analyse the concept of servitization, a business model that originated in the 1980s, but that recently is offering many opportunities for growth especially to manufacturing companies. The world of industry has changed over time and today companies are experiencing a new digital era in which technology, combined with servitization strategies, is becoming a driver of economic growth. Aim of this research is to find out exemplary cases in which Italian producers exploit digital technologies to implement a profitable business model based on services.
In order to reach this objective the thesis is structured as follow:

- The first chapter focuses on Industry 4.0 concept. Following a brief historical view, we are going to present the academic literature regards characteristics, tools and applications of Industry 4.0. In this chapter, we will analyse in detail concepts as Big data, Internet of things and Cloud computing given their importance in the analysis of case studies.

- The second chapter is about the phenomenon of servitization and the impact that digitalization has on it. We will analyse the concept from many points of view following the existing bibliography trough the presentation of the different models. We will also highlight the difficulties to be faced in undertaking the transition from a vision dominated by the product to one dominated by the service.

- The third chapter is then dedicated to the presentation of the two case studies. Thanks to the interviews with the energy manager and the managing director of the two companies, respectively, it was possible to trace the contours of the two entrepreneurial stories, analysing their past, present and future development.

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1. Industry 4.0: new technologies and new possibilities

Humanity faced many changes in his history, the more relevant ones are related to the use of new technologies and techniques. The evolution of the industrial system is not a static event, but a perpetual motion, which causes a continuous change in the way that things are conceived and developed.

To be able to understand Industry 4.0 phenomena, it is relevant to go through the previous phases that had characterized the last centuries of our history.

Since the XIX century, the industrial economy showed an exponential improvement of techniques and organizations, defining some distinguishing features of the modern era.

1.1 Concept and definitions

The first industrial revolution in the middle of the XVIII century put the basis of the industrial system. In those years, the economy was based on agriculture ad craft. In that scenario the main innovation was the invention of the steam engine in 1775, which gave a new source of energy different from the human labour: coal. That technology was first applied to transportation and industrial production system. That transition led to huge changes mainly in the cotton and iron industry. The productivity of work increased, allowing the first "mass production", which meant an increase of quality and pieces produced and, at the same time, a cost reduction compared to the craft production. (McAfee, 2014). This first revolution opened the engine era and, compared to the past, was the most radical innovation of human history: productivity raised by 90%.

This first revolution took place mostly in England and only after 1870 it widespread through Europe. The diffusion of this new industrial transition throughout Europe had proven to be different from the one in England. This last transition was characterized by unprecedent technological improvements and took a different name: The "Second Industrial Revolution". The world industrial production increased by 378% in 1913 respect to 1875 after this transition. In addition to coal, the steam engine was used on water, allowing the process of electrification through hydroelectric power. This kind of energy could be stored, transmitted, distributed and utilized to warm up, illuminate and for transportation. Those years were also signed by the innovation of the internal combustion engine and the replacement of coal as the main energy source in favour of oil.

This context occurred simultaneously with the birth of the telegraph, which allowed people to easily exchange information worldwide for the first time in history.

That period was characterized by the so-called "industrial giantism: factories increased in dimension; division of the labour was implemented; firms started to cooperate in larger groups.

Regarding the division of labour, Taylor Ford wrote "*The principles of scientific management",* which explains how to use the workers rationally and scientifically inside big productive plants, in order to reduce the cost of labour increasing productivity. (Crowther & Ford, 1922)

The division of labour and the introduction of the assembly line allow the reduction of time and cost per unit produced, ensuring an increase of workers productivity and pieces produced, essential factors to gain economies of scale.

The second industrial revolution is considered the era of standard production. It was characterized by mass consumption, which saw the rise of Germany and the US, even if the UK maintained a key role.

Moving towards the third industrial revolution, the core innovation moved from the industrial world to the digital one. Electronic and informatic are the sectors that mainly have been touch by that revolution. Thanks to the development of microprocessors the process of digitalization has been made possible, discovering a new and more efficient way to transfer information and then, in 1970, with the invention of the personal computer. These are the first steps toward a new and fast technological development, which determined deep mutations both at the economic and social levels. Computers allowed the public to access another technology: the Internet. This innovation gave definitely birth to the digitalization of information. The third industrial revolution was the beginning of the so-called "information age", a period marked by the free transferability of information and its immediate accessibility. This innovation is strictly related to the Globalization phenomenon, through which countries promoted a free market all over the world. A new industrial power was born: China.

Digitalization had exponential development, as described through Moore's law. Regarding the industrial sectors, there were increasing difficulties linking mass production and saturated markets: demand had strong fluctuations and preferences of consumers moved from standardization towards quality (Battilossi, 2002). Firms were obliged to move from the standard assembly line to a new and more flexible production, which must be able to adapt its volumes and production characteristics in a way to follow demand without increasing too much costs.

The idea of the importance of data arises, opening the way to a huge variety of services, moving from an industrial society to a new way to conceive resources: information, knowledge, and creativity became the key elements to serve consumers that became more and more demanding and knowledgeable.

The facts expressed so far can be considered the prologue to the Fourth Industrial Revolution in place nowadays. This last one, generally known as Industry 4.0, has the aim to increase the competitiveness of the productive sectors of the future by the integration of "cyber-physical systems" (CPS) into industrial processes. CPS integration could effectively be achieved through the inclusion of intelligent machines connected to the internet. (Fiandese, 2015) Innovations, nowadays, allow integrating classical manufacture firms with digital technologies, which can increase the quality of the goods produced, minimizing errors and costs. New technologies allow also to modify the production scheme in real-time based on external inputs guaranteeing efficiency and efficacy.

Industry 4.0 is also called "digital revolution". It concerns all those digital technologies which allow interconnection and cooperation of resources (physical workers or IT systems). The industrial sector is witnessing the introduction of many radical changes, with the production of goods and services. *These innovations allow fundamental improvements in industrial processes regarding production, engineering, use of materials, the supply chain and in general product life management. Advantages range goes from increased flexibility, mass customization to product quality and delivery speed.* (Hermann, Pentek, & Otto, 2016)

Industry 4.0 represents an "open chapter" for the manufacturing industry. The name itself contains a number typical of the IT world, revealing the strong technological push. The term "Industry 4.0" was born in 2011 at the Hannover Messe from the working group led by Siegfried Dais (Robert Bosch GmbH) and Henning Kagermanss (Acatech). The initiative 4 is part of the "High-tech Strategy 2020", a plan to support 6,000 companies for industrial development and to increase the country's competitiveness in the manufacturing industry. As it was presented, every-one recognised the importance that I4.0 for the future of the industry. Many parallel initiatives began to pursue similar aims in by other countries. Some examples are mentioned hereinafter: Smart manufacturing Leadership Coalition and US Advanced Manufacturing Initiative in the USA, Cyber-Physical Systems Innovation Hub in India, e-F@ctory in Japan and the Horizon 2020 framework program including the entire European Union.

As previously mentioned, the data assumes a primary role in 4.0 Industry, since it is the basis of any operation: it has become a tool to create value. In past data has been considered a simple piece of information, only useful in a small local system. The information coming from data had a start and an end in a definite time range. Nowadays, instead, data determine the calculation power of machines and are fundamental for the economy of the next future. For the previously explained reasons, data can be considered one of the four cornerstones of Industry 4.0 revolution. The three other most important factors are the following:

• Analytics: all the analysis operations performed after data collection.

• Human-machine relationship-interaction: easy interfaces between men and machines (e.g. high-level programming languages, tools, displays, and HMI)

• Manufacturing: tools to produce the goods; the final step which connects the digital world to the real industrial production world.

The common aspect between these factors is the interconnection between many multiple elements of a bigger system (CPS). Optimal development of the factors presented above together with a pervasive implementation of sensors, a high level of communication via network and an upgrade calculation power, are basilar aspects to achieve in order to get into the 4^{th} revolution.

The vision for the new industrial revolution is of a future in which business activities will create a global network that connects production machinery, storage systems and production plant activities under a single cyber-physical system that connects the real and virtual world. The CPS, Cyber-Physical System, will extend to every part of the production system, making it able to implement decentralized decisions, to exchange information autonomously and to implement a mutual control between systems.

1.2 Industry 4.0 tools

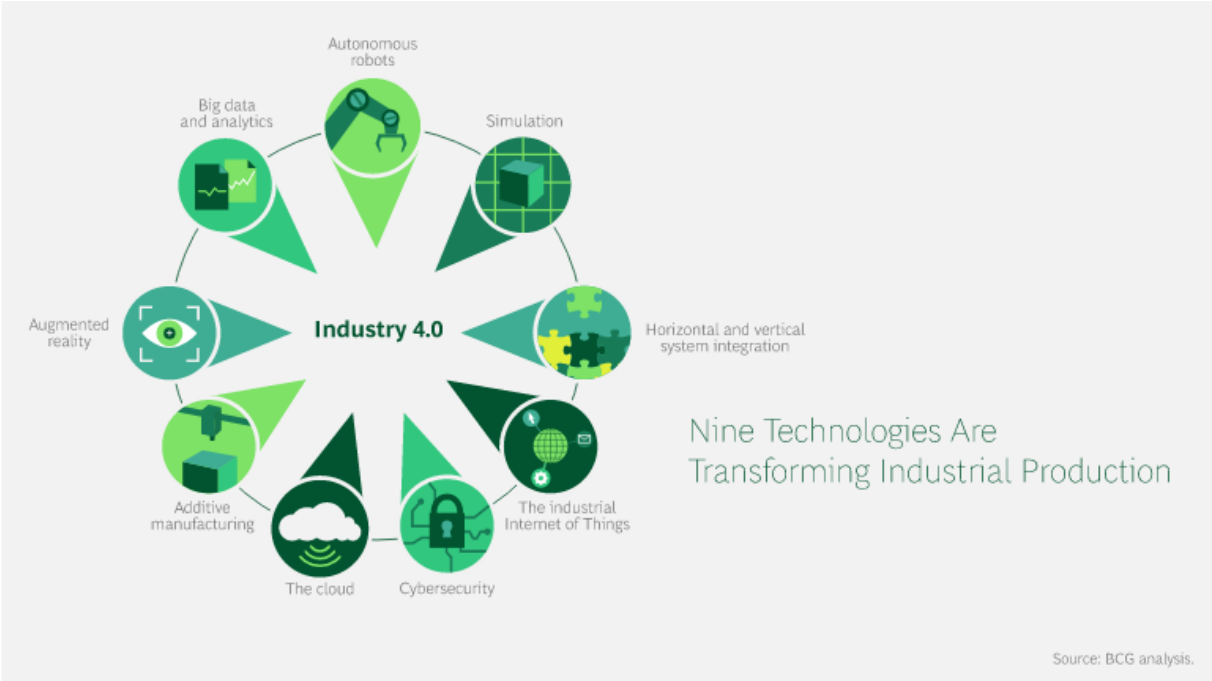
To better analyse what Industry 4.0 is, it is necessary to focus on the 9 main technologies concerning this process. These are also named the Industry 4.0 “Tools”.
The 9 technologies in which Industry 4.0 can be identified are actually well-known technologies in the nowadays industrial world. The big value given by Industry 4.0 revolution is the usage of these “tools” no more in a specific and embedded way, but simultaneously in an extremely wider aspect. In other words, Industry 4.0 starts when the 9 optimized but

isolated technologies start coexisting together in a fully integrated, automated and optimized production flow, leading to greater efficiencies and changing traditional product relationships among suppliers, producers, and customers as well as between human and machines. (BCG, 2017)

According to the most recent classification executed by leading institutions in the economic world (BCG, 2017) the nine enabling technologies of Industry 4.0 are so identified:

1. Big Data and Analytics,
2. Autonomous Robots,
3. Simulation,
4. System Integration (both Horizontal and Vertical),
5. Industrial Internet of Things,
6. Cybersecurity,
7. Cloud,
8. Additive Manufacturing (3D printing),
9. Augmented Reality.

Figure 1 - Nine Technologies are transforming Industrial Production (Scalabre, 2016)



1. Big Data and Analytics

Each second firms collect a huge amount of data not only externally from customers but also internally from many different sources (production equipment and systems as well as enterprise); this explains the importance of their collection and comprehensive evaluation. The analysis of that data will be the main factor for decision making.

2. Autonomous robots

Most advanced technologies develop a new era of robots that are able to interact with one another, but the real innovation is the cooperation with humans and the ability to learn by doing.

3. Simulation

Models are not something new in manufacturing firms. What is new, instead, is the possibility to test the final product in advance, virtually, so that once the machine has to be built, or to be set up, the probability that an inconvenience occurs is far lower. These possibilities of simulation come from Cyber-Physical Systems and Internet of Things.

4. Enterprise Integration

In the past information flow slowly through firms and inside them but now, progressively, the availability and the exchange of them are becoming more immediate both inside the firm that in the context. This evolution is reducing the barriers and the “silos mentality” between the different functions of the firm and is also clarifying the dynamics inside the value chain. For this reason, the concepts of vertical and horizontal integration come into action. 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, instead, is the external integration, it deals with collaborations of partners along a supply chain. Big Data and Industrial Internet of Things will permit a strong degree of collaboration among the firms of a value chain, leading to the concept of value network.

5. Industrial Internet of Things (IIoT)

Industrial Internet of Things is the fact that sensors and machines of manufacture are networked and make use of embedded computing. Modern processors, smaller and cheaper, allow a generalised use of them not only in the main product and this gives a new world of

possibilities and way to use them. IoT will permit to decentralise decision-making, making it an instantaneous process.

6. Cybersecurity

As explain before he huge amount of connections and data flowing through devices and firms will lead to threads about securities. Due to the fact that connected devices are exponentially growing it is important to invest heavily in encrypting the data when are transmitted, protect them

while being stored in servers, have high-level identification systems, have an enterprise policy about the diffusion of internal information.

7. Additive manufacturing

3D printing is not a new technology. It was first invented by Hideo Kodama, in 1981, for many years that technology does not succeed due to lots of imperfections but, with the beginning of the new millennium, a lot of progress has been made, even in biological 3D printing, to create human organs ex Novo. Only at the beginning of the decade after 2010 that these machines became affordable. Now they are widespread and used especially for prototyping. However, in a not so distant future, they will become the means through which entire components of final products will be made. In the aerospace industry, actually, the deployment of this technology, now possible, has already led to a considerable decrease in costs, complexity and lead time. In the future, where, conceivably, almost everything will be 3D-printable, additive manufacturing, through the elaboration of huge quantities of big data.

8. Augmented reality

Augmented reality id strictly linked to the technology of simulation. It will permit to completely merge the real and the digital world, creating representations of digital data and analytics over the real world. This will permit to test real data information for decision making, working procedures, and virtual training.

9. The Cloud

The term cloud is a vivid expression for a network of servers that provides layered services in the form of Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). The great improvements in technology, connectivity and capacity storage will permit an increased deployment of this technology in smart production systems.

Cloud technologies, as IIoT and Big data, will be explained in detail in the next chapter regarding digital servitization.

1.3 Opportunities and applications

Huge potential for value creation is available nowadays with I4.0. With the use of “big data analysis”, it’s easy to extract useful information from data. Many conclusions concerning product life management and about the production system efficiency can be drawn from data analysis (Manyika, et al., 2015).

Thanks to this new way of making decisions based on a huge quantity of data analysis and processing ability, the industrial overall productivity can improve up to 30%. A target like this could be reached by improving the following parameters (Heng, 2014):

- More flexibility: Business organizational processes are more dynamic thanks to the network. Production processes can react dynamically following changes or problems in the value chain. The creation of production lines able to operate with autonomous choices facilitates demand management and reorganization.
- Manage time reduction: data collection and easy access to data without space or time limitations make easier the taking of important short-term decisions. The innovation developed by the company can reach the market in more limited time.

- Customer requests with small batches: the production criteria are based on the needs of the customer who can specify the design, configuration, order, and production methods even with short notice. The goal of working with unitary batches is achievable thanks to cutting-edge technologies.

- Workplace: in a changing labour market, is essential to motivate staff with an attractive work environment.

- Economic efficiency of production: an optimized use of available capital, with continuous supervision of the company's value chain. Particular attention is paid to the cost of capital, energy costs, and personnel costs.

To give a better understanding of the coming empirical investigations we are going to analyse in detail applications and tools that we will meet later in the case studies. Starting from Big Data, there is not a clear definition of that but usually it indicates a set of rapidly growing data collected by a database software (De Mauro, Greco, & Grimaldim, 2015). A distinction between Big Data and traditional datasets is that Big Data mainly includes data from heterogeneous sources; therefore they are not only made up of structured data, such as databases but also unstructured, such as images, emails or GPS.

In the early 2000s, Doug Laney formulates the theory of the three Vs whereby describe the dimensions though which can be examined Big data (Laney, (2001):

- Volume: these dimensions regard the quantity of data that a system is able to collect. New technologies facilitate the storage of these data coming from many different sources.

- Velocity: Velocity is referred to the speed in which these data can be processed. Technologies have made this process faster giving also a real-time output.

- Variety: Data usually come from different sources and for this reason has also different formats that have to be comprehended.

At this three characteristics can be added other dimensions as variability, regarding the cadence in which data are collected; and complexity that, connected to the concept of variety, regards difficulties in which firm run into when data coming from different sources has to communicate

De Mauro (2015) proposes a definition of Big Data on the basis of this model: “Big data …represents the Information assets characterized by such a High Volume, Velocity, and Variety to require specific Technology and Analytical Methods for its transformation into Value”.
Big data could be applied in many different areas to create value. According to Elgendy and Elragal (2014) Big data can be exploited in fields as:

- Customer management: Big data allow a more easy and punctual collection of data that can give to organizations information to profile customers. Firms acquire the ability to segment clients by different characteristics that could be socioeconomics or could regard the level of satisfaction. These opportunities turn into marketing

strategies more focused and differentiate by segments. Purchase patterns and customer behaviour can be predicted through models in order to develop in advance promotions and campaigns.

- Performance Management: As we see in the previous point big data can intercept demand changes allowing firms to adapt their supply to that needed. With big data is also possible to automatize replenishment through analysis of stock utilization and projections of deliveries that results in a reduction of lead times, minimizing costs and delay.

- Quality management: it is referred to the act of improving the quality of goods increasing profitability and reducing costs. This is true especially for manufacturing where though predictive analysis breakdown can be prevented by providing early alerts. Big data allow a real-time check of network demand and strategic and productive decisions can be modifies based on these data analysis

Apart from potentialities, Big data bring out also some challenges that regard the use of data, technological and structural limits (Wamba, Akter, Edwards, & Chopin, 2015).
About the use of data, there could be problems with the treatment of personal data, for example regarding health, or questions about intellectual property that is not totally regulated by law. In respect to data there is also the question linked to the operational field, not all the sectors are able to take advantages from big data technologies, sectors in which possibilities are greater are the ones both in term of technological possibilities (storage and analytical abilities) that regarding the characteristics of the field (e.g. high versus low competition).
Summarizing, big data are gaining importance in the decision's process of firms given the huge amount of information that can be collected. Data is not useful itself, but when it is properly analysed in order to find valuable insights. Due to that firms are focusing on the analysis part of internal data combined with external ones that can increase the significance of information (Elgendy & Elragal, 2016).
Usually, the decision-making process is marked by different phases; initially data has to be collected (both from internal and external sources) and stored with a logical pattern. These data can be processed following algorithms only at a later time. At the end comes the design phase in which decisions that place; the different models are analysed and the ones that fit better with the situation is chosen. Solutions are examined studying final impacts and the process ends with the implementation of the best solution found (Elgendy & Elragal, 2016)

After having described the features of big data we can move to the definition of Industrial Internet of things (IIoT).

Internet of things is defined as a network of objects, that could be sensors, machines, buildings, that allows the creation of interactions and synergies between them with the aim of reaching a common goal. Each object produces data that can be collect and combine inside the network thanks to big data analytics giving at the decision-maker the ability and the knowledge to take appropriate actions (Abdmeziem, Tandjaoui, & Romdhani, 2016).

There are different interpretations of IoT, Abdmeziem (2016) divide it into three layers based on the architectural point of view:

- Perception layer. Perception, or sensing layer, is the step in which data are collected. At this point, the aim is to perceive and collect the physical properties of components inside the network trough sensing technologies like GPS or NFC. After having collected information these have to be converted into digital signals useful for transmission. In this layer have great importance nanotechnologies that allow building microchips small enough to be implanted into objects to give them sensing and processing abilities.

- Network layer. After the collection process, there is a layer dedicated to the process and transmission of these rough data. Transmission is carried forward through network technologies such as Local Area Networks (LAN) or Wireless networks. In this layer, the core technology is represented by cloud computing that offers reliable and dynamic support to store and process data.

- Application layer. Processed data are then analysed to develop the IoT strategy. This layer is the ending point of the IoT architecture in which all the potentiality will be exploited. The output of the process opens to a range of different application's possibilities (Xu, 2011).

Up to now we a classical IoT process that can have applications on smart homes, healthcare, transportation o industrial environments; in this latter case, researchers have coined the term Industrial Internet of Things. IIoT differs from the concept of Industry 4.0 mainly because IIoT regard technologies while I4.0 is associated with the economic impact (Wang, Torngren, & Onori, 2015). Industrial internet of things offers many opportunities for any industry, but the main advantages are in manufacturing. IIoT can help in trace and handle the entire firm

starting from materials, parts, machines, tools, inventory and logistics, allowing inter-communication and storing data. IIoT has the potential to improve connectivity, increase efficiency and push scalability inside the industrial organization. In Manufacturing IIoT can be the driver for the transition to Operational technologies from Information's one. Industrial internet of things technologies provide a new way to conduct preventive maintenance though wireless connection, the analytics given by big data and sensors (now cheaper and easier to insert); Only with preventive maintenance firm can save up to 12 per cent over scheduled repairs reducing the overall cost of maintenance by 30 per cent and eliminating breakdowns up to 70 per cent. (Scalabre, 2016)

However, these technologies face critical challenges in securities topics. An online network with many devices connected opens to vulnerabilities also given by the decentralization. At the industrial level, an intrusion could lead to service unavailability or physical damages that will have consequences in terms of profits. Due to that, it is necessary to protect the systems and users from external access that might compromise the integrity of the system (Sadeghi, Wachsmann, & Waidner, 2015). So, it is possible to say that IoT is the most general concept, whilst IIoT is the same concept applied in the manufacturing context. Another concept closer to IIoT is the Cyber-Physical System (CPS). The latter put the emphasis on the interaction between objects and cyber parts or humans while the first concept of regard, as mentioned before, technologies and information. However, these definitions are often used as synonyms given their relationship with networked software-intensity systems. (Lee, Kao, & Yang, 2014)
The functionalities of IIoT are linked to Cloud technologies, through it is possible to manage and share data between different entities that could be inside the same organization or outside in the environment. The concept of cloud computing is present from many years but there is not a clear definition of it. Cloud could be described as the model that enables on-demand network access to shared computing resources that are released to people with minimal interaction and management effort (Mell & Grance, 2011).
This cloud model could be summarized into seven essential characteristics, three service models and four deployment models.
Starting from characteristics, Cloud technology should present the following specifics (Jula, Sundararajan, & Othman, 2014):

- On-demand self-service. Cloud is a service that is directly usable by customers; they can by themselves, through a connection, exploit the potentialities of the cloud.

- Broad network access. Each resource located inside the cloud can be available from remote locations. This characteristic is also called “global reach capability” or Easy to access standardized mechanism”.

- Resource pooling. The same computing resources are aggregated to create a diffuse service for multiple consumers. Users do not have the perception or the necessity to know the location of the provided resources. Example of pooling includes storage, memory and processing services (Mell & Grance, 2011).

- Rapid elasticity. Elasticity is used here as the scalability concept; it is the ability to scale up or down resources when it is necessary. This characteristic is important because users do not have always the same necessities and might request different services at any time.

- Measured service. Cloud has the characteristic of being automatically controlled and optimized from both side providers and customers.

- Multi-tenacity. Inside the cloud, there should be different segmentation based on customer’s categories

- Auditability and certifiability. As previously mentioned, policies become increasingly important in digital services and cloud has to prepare logs and trails to allow the evaluation of the degree of adherence on regulations and policies.

After understanding the characteristics of cloud computing is important to define the different relationship that could be implemented between the provider and the user. Cloud computing deployment models could be summarized as follow (Jula, Sundararajan, & Othman, 2014):

- Public cloud. This approach is the most common, it consists of a cloud owner that provide public services on an internet based. Here there are predefined rules and policies to follow in addition to pricing models. The provider here owns many different widespread world resources.

- Private cloud. This solution is designed for an organization or institute using the same concept of a public cloud. In this case, the organization face high costs of design and for the setup of the system. Advantages are in the security field since this type of cloud is usually created to build a corporate firewall.

- Community cloud. The different organization can establish a community in which they share the cloud computing technology in order to reduce costs and increase the security of the system with respect to a public cloud.

- Hybrid cloud. There should be combinations of the previous types for example when a private cloud of an organization is putting in communication with a public one.

Finally, it is important to understand how this technology is used to create value analysing the cloud computing service models. Models differ one by each other based on the degree of importance that cloud has in the system. They should be divided into (Xu, 2011):

- Infrastructure as a service (IaaS). This model represents the lower level network in which cloud computing is represented by processing and storage abilities. This is like the classical hosting service with the difference that cloud infrastructure is rented on a virtual base (via internet) and the offer could be modified instantly according to customers' needs thanks to the scalability of the system. In this model users have only the control on the operating systems or storage.

- Platform as a service (PaaS). Growing the cloud experience, PaaS provide to users an environment for programming and executing activities. In this framework final user can create programs (using languages and application programming interfaces) that then can be deployed inside the cloud infrastructure. In this case users have the control only on the deployment application with no interest in the infrastructure of the cloud. This model could help developers in reducing administrative efforts in favour of a concentration in production issues.

- Software as a service (SaaS). SaaS could offer a complete and complex service on an internet base such as CRM or ERP. In this framework software are hosted in the cloud freeing local computers from space and application problems. The software is available online and delivered via browsers to subscribers. SaaS is expected to reduce

costs of maintenance and acquisition of proprietary software. The cost is competitive able because SaaS is structured with a single code though which user come in connection with the service and users' data are separated in a second moment trough Authentication and Authorization policies.

This chapter and technologies presentation is an introduction to the analysis of the cases. In chapter 4 we are going to explore two different organizational realities in which these concepts are applied to business model.

2. Servitization and digital servitization

After understanding the different technologies that turn around Industry 4.0 concept, in this chapter we will focus on how firms can use them in combination with servitization strategies in order to make profits. Here we are going to describe the methodology and definition behind servitization, ins and outs of these strategies, analysing how technology innovation impact on it.

2.1 The State of the Art of the servitization phenomenon

Servitization could have many different interpretations, one of the most recognized by the literature (Baines T. S., Lightfoot, Benedettini, & Kay, 2009) is the Vandermerwe and Rada (1988) e that define servitization as following: " *"Modern corporations are offering fuller market packages or 'bundles' of customer-focussed combination of goods, services, support, self-service, and knowledge. Services are beginning to dominate"*
From this reading is possible to understand that servitization goes far beyond the simple maintenance of spare parts as many thinks. Services usually start as a value added of the product but, over time, their importance in the generation of the value-added increase (Baines T. S., Lightfoot, Benedettini, & Kay, 2009). In this process the relationship between firm and customer change, becoming more complex and closer in respect to a product selling process.

Along this thesis we will refer to "Servitization process" meaning the phenomenon of firms that shift towards services. Entering this field require some knowledge about concepts as services and value proposition. The word "service" plays a central role in the definition of servitization. As explained before services are different from products; four characteristics have been attributed to services: intangibility, heterogeneity, inseparability and perishability. (Baines T. S., Lightfoot, Benedettini, & Kay, 2009) (Lovelock & Gummesson, 2004)
Now, we are going to analyse them in detail:

- Intangibility: Services are represented by performance, deed or effort, at the country products are a tangible object (Moeller, 2010). Tangible and intangible seem to be easy to differentiate but the boundary line is not so certain. Every company contains a part of intangibility because every product has a slice of it. What is clear is that

services have a degree of intangibility that is always much higher than the one for products.

- Heterogeneity: Services are never performed in the same way: time, place, context always change. This variability makes the service output heterogeneous, the more labour intensive the service is, the harder is to uniform it (Lovelock & Gummesson, 2004). Services usually are tailor-made on the customer's necessities and, consequently, cannot be standardized.

- Perishability: Characteristic of services is that once it is performed it vanishes.

- Inseparability: Strictly related to perishability, service is performed by the provider in a certain moment or linked to a certain product.

These features are always under evaluation, technology makes them less stringent: Automation or quality control services could increase the percentage of homogeneity into services, making them replicable through modules, communication technologies also have improved the characteristics of separability and perishability of services (Lovelock & Gummesson, 2004).

Moving to the second concept, Value Proposition, is important to underline that any product or service, to be sold, has to resolve a need and costumers has to willing to pay for it. In other words, both for companies and customers, product or service are profitable when the cost needed to create or buy them is lower than the exchange value. Where "exchange value" refers to the price that customers are willing to pay (Lepak, Smith, & Taylor, 2007).

More recently the IHIP paradigm describe above was criticised by many scholars to be too far from reality; the insights given by that was too simplistic and it was no credible that only four characteristics, however weak respect to technology as explained before, differentiate goods from services (Lovelock & Gummesson, 2004). In contract with that paradigm came to light the so called "service-dominant logic", in which the focus was not on the output offered by firms nether on the concept of ownership, but on the process of creation. For Vargo & Lusch (2004) services are: "*…the applications of specialised competences, obtained through deeds, processes, and performances, for the benefit of another entity or the entity itself".* The real difference between product and service lies in the process: service differs from product

because it is a result of a work of co-creation. With these premises it is easy to understand that customers acquire a totally new role in the firm; from being only the final user they become an “operand resource”, meaning a resource useful for taking actions resulting in effects (Vargo & Lusch, 2004).
In this perspective the process of value creation goes outside the company’s boundaries being given partially to customers in the so call co-creation model.

It is clear from that introduction that servitization is not a new discovery but is becoming important due to the fact that companies, especially in the manufacturing sector, need to find an alternative to products because, many times, firms are struggling the competition with low cost producers (Neely, 2006). That one is not the only reason behind the decision to moving to services, explanations can be found both inside and outside the organization.
Taking into account external factors, namely servitization reasoning coming from the market, is possible to point out (Lee, Kao, & Yang, 2014):

- Commodization: nowadays products lost their distinguishable attributes ending to be perceived as mere commodities for the final user. This cause price war and margins collapse. A way to avoid that is offering hybrid products with an important part of service, less easy to replicate.

- Customer demand: Services allows the company to be closer to their end-users; end users that continuously desire to have customized products faster and at a cheap price. Services can help in fulfilling that desire.

- Technology capabilities: technologies are present inside many products for years but that type of technologies is easily replicable and do not allow to keep a competitive advantage for too long. The value added can be given by technologies assisting products: information technologies, data management and so on. These technologies increase the intangible value of a product giving also a new perspective in the development of new business models.

After having explored how external drivers push firms towards servitization, it is time to investigate internal drivers. Arguments coming from companies are usually focused on strategic objectives; it is possible to summarize them in the following categories (Oliva & Kallenberg, 2003):

- New opportunities: In mature sectors firms are looking for new opportunities for growth. Opportunities can come from new markets but also from new value proposition. Services became a way to explore deeply the customer base redefining income.

- Increase margins: Services are, by definition, higher margins respect to products. This is not the only impact of services on profits; Products are sold in only one transaction and that value can change among time, at the contrary services generate a recurring stream of revenues that stabilize cyclical variations.

- Knowledge of customer: manufacturing firms have already deep knowledge of its market and its community. The transaction to services allows them to use better that understanding resolving users' needs without costs in customer acquisition.

- Competitive advantages: Servitization is for sure a competitive tool useful both for innovation and differentiation. Services are difficult to replicate due to the labour-intensive components; this allows companies to compete no more on cost but on value added.

Internal and external are close one to each other. Regarding customer, for example, servitization push companies to consider customers' needs, in this way the two entities come close. This new kind of relationships require that companies adapt fastly to the environment; if it is able to do that firm acquire advantage on its competitors that could play a key role in creating loyalty and dependence with its customer, that can turn into a competitive advantage. (Oliva & Kallenberg, 2003)

2.2 The servitization transition's pathway

Starting from the insights saw in the previous chapter we are now ready to explore the different servitization routes.

Initially service was seen by the manufacture as a necessary evil: in that time the main percentage of revenue was given by physical products and services were only an add-on to these. Then things changed for many reasons, competition and crisis forced companies to shift strategy: service becomes an element of differentiation in a world of integrated product. Price was no more an important variable and source of advantages, service put the focus on the

customer, listening to their needs and creating a relationship. In that situation customer centricity became one of the key features of any servitization strategy. (Oliva & Kallenberg, 2003)

Oliva and Kallenberg (2003) defined that this orientation to customer has two different components:

- A shift from product-oriented services to user-oriented services. Basically, a change of paradigm from providing a working product to ensure functionality and effectiveness in the process of using it

- A shift in the nature of interaction from transactional to relational. Selling products became secondary to creating a long last relationship with the customer

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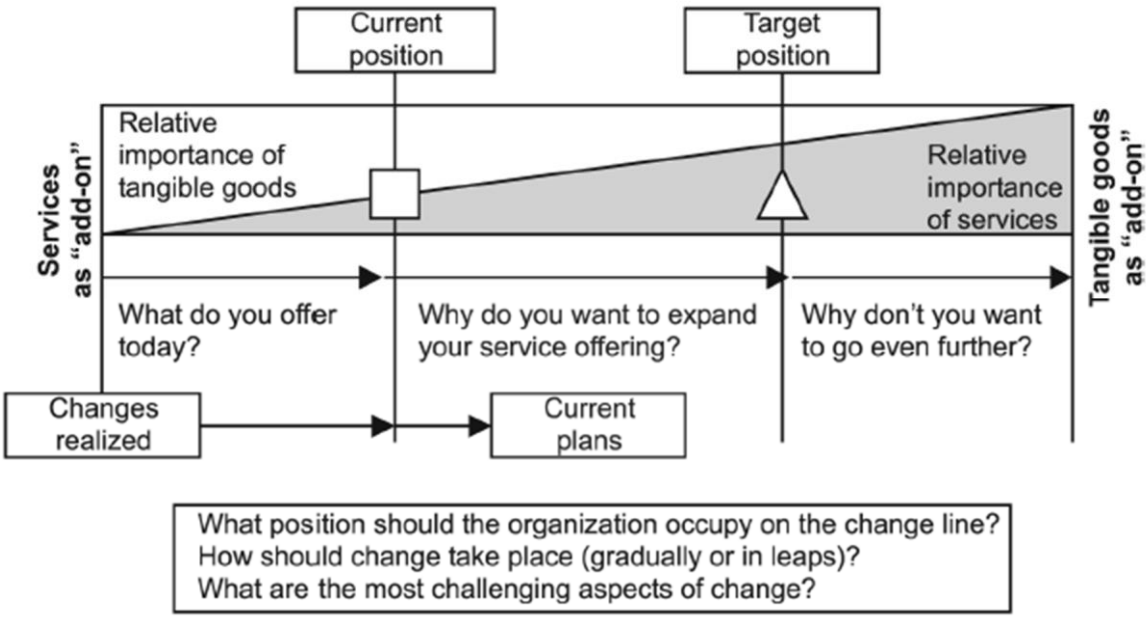
Figure 2 - The product-service continuum (Oliva & Kallenberg, 2003)



In any case servitization define a huge amount of strategy and roads to follow for servitize.

Inside the so-called product-service continuum represented in fig. 3.2 Oliva and Kallenberg (2003) identifies different potential applications that go from the pure product extreme, defined as the service as an add-on to the pure service configuration on which is the product

that takes the part of the add-on. Any firm move along this line, the position can vary depending on the culture, the seniority and the external environment of the firm.

The model in figure 3.2 is accepted also by the research community of PSS. Servitization is actually treated by two research communities, servitization and PSS but to better explain similarities is useful to present this second world. PSS stands for Product-Service-System and, according to (Baines T. S., Lightfoot, Benedettini, & Kay, 2009) this term is often used as a synonym od servitization due to the fact that the principles under them are pretty identical; differences come from the country of origins, PSS is a Scandinavian concept while Servitization is linked to Anglo-Saxon's dimension. There is not accordance on the definition of PSS, two of the most recognized are the following of Baines et al. (2009):

- *"PSS consists of tangible products and intangible services, designed and combined so that they are jointly capable of fulfilling specific customer needs. Additionally PSS tries to reach the goals of sustainable development*"

- "*PSS is an integrated product and service offering that delivers value in use. A PSS offers the opportunity to decouple economic success from material consumption and hence reduce the environmental impact of economic activity*".

Additional element respect to the concept of servitization is environmental sustainability that can be reached by de-materializing the offering. Gaiardelli et al. (2014) add three other key characteristics of PSS: The value proposition that is focus on offering a bundle of products and services able to resolve customers' needs for which they are willing to pay; The infrastructure, such as capabilities and resources inside and outside the organization; the relationship between the parties that determine how the product will be delivered.
Neely (2008) states that PSS is "*an integrated product and service offering that delivers value in use*" while servitization "*involves the innovation of an organization's capabilities and processes so that it can better create mutual value through a shift from selling product to selling PSS*". Generalizing these definition states that servitization is related to the process while PSS is related to the final object. Baines et al. (2013) also said that PSS is a special type of servitization that provide value to customer through the integration between products and services.

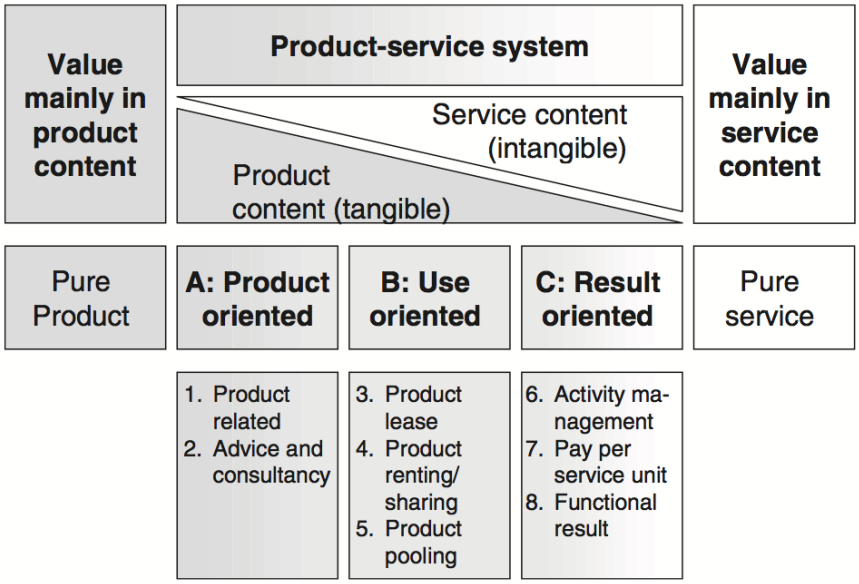
Taking back the previous “product-service continuum” is possible to observe how this is integrated with the model of Tukker (2004) representing the different categories of PSS (Figure 3.3).
Tukker (2004) divides PSS into:

- Product-oriented: The property of the product is given to customers adding some services related mostly to monitoring and maintenance of the physical product.

- Use-oriented: The property of the product is kept by firm and the customer pays for its usage and the services related.

- Results-oriented: In this case company and customer agree on a specific result even without specifying the product.

Figure 3 - PSS typology (Tukker, 2004)



Neely (2008) Suggest an enlargement of Tukker’s typologies adding two PSS types:

- Integration-oriented: The property is transfer to customer but here the topic is moving downstream, adding services to the product through vertical integration

- Service-oriented: relates to incorporate service inside products being able to sell a system that resolves customers need.

Given this continuum it is important to underline that servitization do not occur in one time only but is a step by step process (Oliva & Kallenberg, 2003) due to the fact that servitization has deep impact on the day by day operations starting from competencies, contracts, pricing, rinks and companies has to adapt slowly. (Gaiardelli, 2014)
Oliva and Kallenberg (2003) propose a three-step evolution through which service could become dominant (fig 3.4):

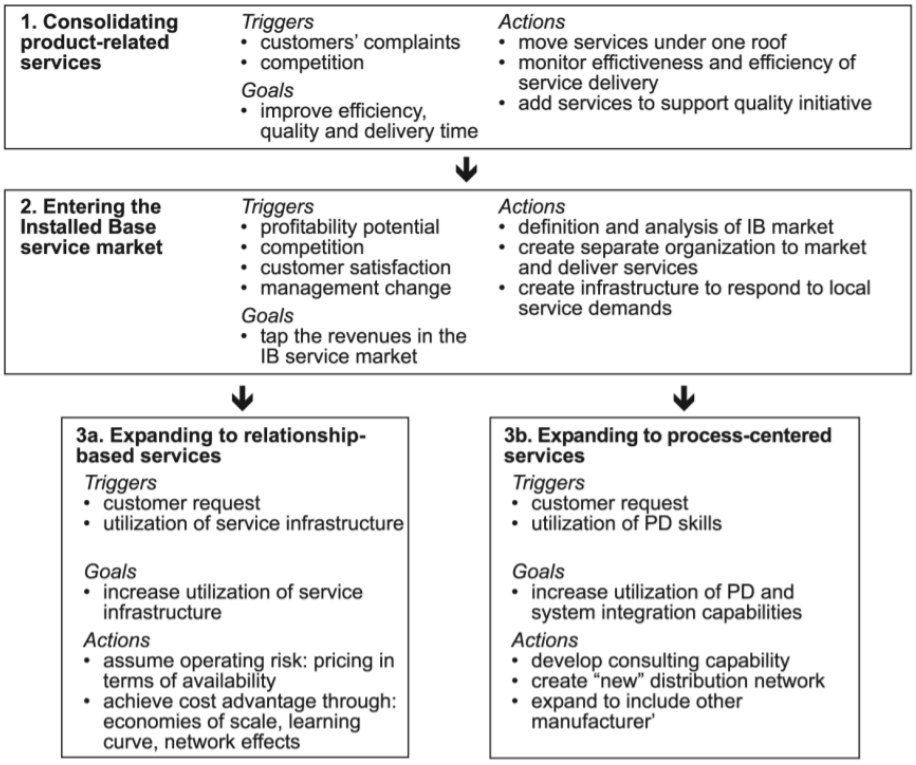
- Consolidating Product related services: Initially many manufacturing firms was unconsciously approaching the market of product-related services offering services as an add-on to products. In this position service is a necessary evil that has the only aim to increase product's sales. This first step of consolidation is usually driven by the fact that hybrid product increases customer's satisfaction and this push firms to invest in that. When firm start to consolidate services under a unit with a clear objective normally there is an improvement of sales, efficiency and quality, not to mention the monitoring system that allow to discover the great possibilities under services.

- Entering the installed base service market: Trough the first stage companies realize the potential margins of services and start exploring the different opportunities to exploit them. Could happen that this process of realization does not come from internal monitoring activities but come from the observation of competitors. In this step firm reinforce the current services' offer modelling the organization to give inside credibility to the process and establishing itself outside as a proactive player to which trust. Oliva and Kallenberg (2003) highlight two challenges in this step; a cultural change is needed in order to perform the transaction, dynamics behind service are different from the product ones and the entire organization has to adapt. We are going to treat these concepts later. The second difficulties regard the need to have a global infrastructure to be able to respond locally to requirements of the installed base. Operationally this requires investments that probably will not be immediately profitable in addition to capabilities that have to be spread across a network.

- Expanding the services offer: The expansion into services take place once the core functionality has been set and this development could be done through two different dimensions: the first concern the transition from transaction to relationship-base focus while the second is about the value position from product efficacy to product

efficiency. Moving along the first dimension, the shift regards the way the service is priced from a mark-up for every single piece to a fixed price covering all services in a given period. This has an impact on firm's risk because the service provider assumes the risk of an equipment failure. In this situation the organization has to develop organizational abilities since the organization became a fixed cost and profitability lies on the capacity utilization. However, manufacturers have the advantages of experience that allow them to perfect the organization with practice. The second transition is about services that became the centre on value creation respect to being only a part of an offer. In this case challenges are being able to provide services over the entire life cycle of the installed base. To be able to that firm should establish a network of distributors and set long-lasting contracts with the final users. This requires capabilities on replication of infrastructures and capabilities in addition to marketing challenges.

Figure 4 - Process model for developing IB service capabilities (Oliva & Kallenberg, 2003)



After the presentation of the different steps of servitization is the time of the Ulaga and Reinartz's model (2011) that is about the different type of hybrid offerings implementable in the BtoB market (fig 3.5). This model identifies four typologies of services identifying them using two dimensions. The first dimension is about the aim of services: if it is directed at the

supplier's good or if it is directed to the customer's process. The second dimension regards the value proposition that could be input-based if promise to perform a deed, or output-based if focused on achieving performance. (Ulaga & Reinartz, 2011).

Figure 5 - Classification scheme of industrial services for Hybrid Offerings (Ulaga & Reinartz, 2011)

Classification Scheme of Industrial Services for Hybrid Offerings

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

Starting from the first type, Product Life Cycle services (PLS). With PLS are represented the basic set of services that firms propose even without considering them services, an example of PLS is maintenance and spare parts, necessary in every manufacturer company. Therefore, PLS services are focus on facilitating the use of its product ensuring the proper functions during its life cycle. It is easy to understand that this type of service is strictly related and attach to the physical goods, for this reason many times customer perceive PLS as a must have and are not willing to pay for that. To overcome these problems of missed income, firms have to standardize these services in order to make them cheap. Despite this PLS are

important for creating a reputation and start a process of fidelization with customers, in that way PSL became a "trojan horse" for expanding to other services with a higher value-added.

Asset Efficiency Services (AES) are the second typology of services, a step forward PLS in which firm start to differentiate with value-added services in addition to products. AES is defined by Ulaga and Reinartz (2011) as: "…the range of services suppliers provide to achieve productivity gains from assets invested by customers". Services included in this category are for example pre-emptive maintenance or customised applications. As for PLS also Asset efficiency services are linked to the product but the shift is on value proposition; with AES the commitment is related to asset productivity. This type of service is no more consider as a must have by customers because of its degree of differentiation respect to competitors; therefore, customers show a higher willingness to pay that allows the firm to sustain a non-standard output.

The third category is Process support services (PSS), here is possible to observe firms that start to propose services directly linked to customers' processes. PSS is defined as the range of services provided to assist customer in achieving its aim optimizing one or more elements of their process without taking any responsibilities on that. To be able to carry on this strategy, manufacturers have to deeply know the needs and problems of its customers in order to assist them as well as possible guaranteeing them a high differentiation gap in the market. Furthermore, PSS requires to change approach in respect to pricing; Customer is willing to pay a lot for this type of service, but firm has to grow in its hybrid offering sales capabilities to gain that margins.

Finally, Process Delegation Services (PDS) is the fourth category of hybrid offer. PDS is defined as: "…the range of services a manufacturer provides when it performs processes on behalf of customers" (Ulaga & Reinartz, 2011). In this framework providers built a service in order to achieve the process performance guaranteed directing the customer process. This type is considered as the most complex representation of services and, due to that, there are only few firms that can offer this. Providing PDS is particularly difficult because it is totally customized based on customer needs, this requires having a close relationship with clients and a direct involvement both in implementation and in information sharing among the contract. In PDS risk is transferred to company and consequently the interest of both parts has to be aligned otherwise there would not be advantages.

It is useful to remember that each of these categories has behind a different set of resources and capabilities that allow gaining a competitive advantage that could express in the form of

differentiation or cost leadership (Kowalkowsky & Ulaga, 2017). Resources refer to the productive assets needed for servitization. These assets could be already internalized by the company or could be acquired from outside building a valuable network. Resources can be split up into:

- Installed base product usage and process data. The most important asset for a firm is its installed base, though them the provider can collect useful data as the usage, location and so on. These data became the main advantages again competitors.
- Product Development and manufacturing assets. Manufacturer firm has the intrinsic advantage to have a deep understanding of the design and development phase of creation that gives them a competitive advantage in case of competition with pure-service providers that lack in such assets.
- Product sales force and distribution network. Competing in services requires a deep knowledge of the final user, that usually is given by direct contact. However, having a sales organization link to customers is not enough, sales force has to be aligned with the service strategy rethinking the way they present the firm on the market.

- Field service organization. For many manufacturing firms the main percentage of revenues in services regards spare parts and field services that could be seen as a strategic asset. These essential services allow firm to provide, from one side, a continuous stream of profit along the lifecycle of the product; from the other side could be an opportunity to propose to clients different types of services regarding efficiency or consulting activities.

Resources are an important piece to be able to achieve competitive advantages but they are not enough, these assets have to be translated into capabilities in order to be effective.

Capabilities could be summarized following the Kowalkowski and Ulaga (2017) model:

- Service-related data processing and interpretation capability. The access to customer's data on the installed base is for sure an element of advantage but these data has to be translated into information though which companies can identify new opportunities or resolve actual problems. The interpretation of such data is a key capability to be able to find useful insights that can lead to a cost reduction or an increase in productivity.

- Execution risk assessment and mitigation capability. Entering into service contract could be risky both for what concern the expectation on profit and the expectation on

outcomes. The ability to face these risks and manage them can be an important source of differentiation from competitors.

- Design to service capability. Design service is not a process that goes by its own. Inside companies, products and services innovation processes have to dialogue synergistically to be able to gain a competitive advantage. The cooperation between product and services allow company to identify not trivial opportunities that could generate innovative hybrid solutions through which it gains a competitive advantage.

- Service sales capability. The selling process of services is different from one required for product. For this reason, to be able to develop a service-oriented strategy sales force has to develop the right skills. In services the relation with customers is closer and more complex than the mere purchasing process, in addition the duration is usually longer as in consultant relations.

- Service deployment capability. In offering hybrid products there should be a balance between satisfying customer's request and keep cost low in order to make profits. In this framework companies have to learn to bring the production approach into services in order to standardize as much as possible internal process to be able to focus on customer's needs. Company has to exploit repeatability, economies of scale and modularity.

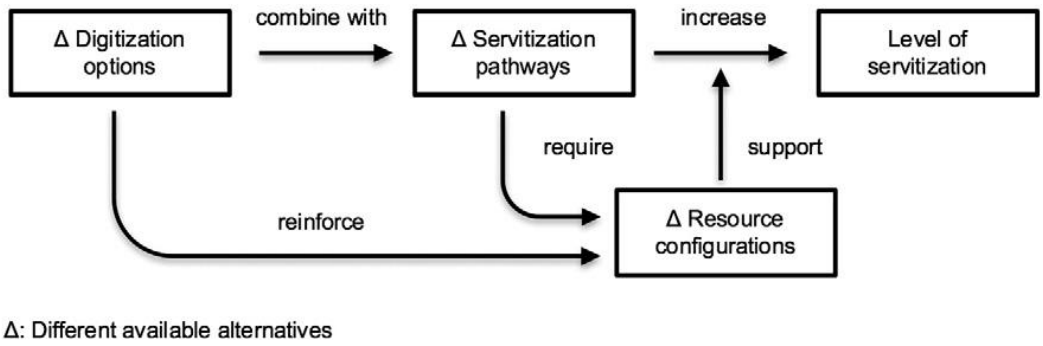
2.3 Digitalization driver of servitization

Up to this point we discuss about servitization and drivers for servitize but it is time to define also if, why and how digital technologies can help that process.
Vendrell-Herrero et al (2017) said that companies are able to understand the potentialities of services only if technological shocks disrupt the way in which they were used to produce and sell their products. In this framework digitalization can increase the servitization possibilities of firms.

Digitalization, or digitization, is a different concept respect to servitization, it refers to the introduction of services driven by new technologies, while servitization could be used to describe also the simple introduction of services even without digital capabilities inside.

In this chapter we will explore the concept of digital servitization going further on how these technologies impact on supply chain and business models.

Figure 6 - Boosting servitization through digitization (Coreynen, Matthyssens, & Van Bockhaven, 2017)



The effect of servitization could be exponentially increased by technologies (fig 3.1). According to Porter and Heppelmann (2014) technology can be translated into two different features inside products: the characteristic of being smart and the characteristic of being connected; these functionalities raise the value of product allowing firm to increase possibilities expanding the product boundaries improving reliability. The amount of smart product is constantly increasing thanks to the technological advancement from the capacity and performance to dimension (miniaturization) and price.

With these components smart products are now able to communicate information about their status and history but also regarding processes also proposing forward actions. Technological advancement allows product to store huge amount of data that permit to compute them into useful information. All these characteristics have earned them the classification as "smart and connected products (Porter & Heppelmann, 2014). Smart and connected products should combine processing capabilities together with the ability to exchange information with external providers. Porter and Heppelmann (2014) had categorized in three macro-categories the components needed to build a smart and connected product:

- Physical: any product, for being such, has some mechanical or electrical components that define its tangible characteristics.

- Smart: Smart components refer to processors, sensors, software and data storage that define the operating system on which is built the user interface

- Connected: To be able to communicate the product has to contain antennae and ports that ensure a wireless connection. There could be different form of connection; one to one, product that is connected to one user; one to many, a system that is connected to many products simultaneously; and finally many to many, products that are connected to many other products.

Regarding these three components the main role, according to Porter and Heppelmann (2014) is covered by connectivity. The ability to communicate raise the product from being only a tangible output bringing it in the so called "product cloud", to be able to exploit all the benefits given by this opportunity firm has to develop appropriate infrastructure in which the connectivity potential of the product shall appear.

After having discussed the features of Smart Product is possible to analyse the applications that these types of product can have, Porter and Heppelmann (2014) categorized them into:

- Monitoring capabilities: alert in case of modifications of environment or product use
- Control capabilities: check the product functionality through data analysis
- Optimization capabilities: adjust remotely the features of the product
- Autonomy capabilities: allow reactions to self-diagnosis

In all these categories we can derive that data coming from the smart product have a huge potential in analysing circumstances. These information generates analytics that can be summarized in four groups. The first one regard the ability to describe in detail the characteristics of the product and the environment in which it is immersed, this ability is linked to monitoring the state of the product.
The second type of analytics are of diagnostic type, so analyse reasons behind any failure or decrease in performances. Moving to the third group, this is about the Predictive analytics that allows the product to collect and trace patterns with the aim of predict and then resolve negative situation before the actual manifestation. Last categories of analytics are about prescription, analysing data in order to build automatic actions that smart product can use in case of inefficiency or problems.

Literature uses many different names when describing this phenomenon, remote services, smart technology, smart services and so on but it is important to underline that they are all the

same concept: a new product's feature innovated through digital technologies (Grubic & Jennions, 2017).
Another interesting research is the one of Vendrell-Herrero et al (2017) that give three characteristics to be able to define digitalization in respect to the simple servitization. Following this theory digital servitization is identified by:

- A marginal cost of services near to zero. This could be an opportunity for many firms that, with the simple servitization, incur in the so called servitization paradox because of services that are labour-intensive. From the other side there could be the risk that customer does not perceive the value of that resulting in low willingness to pay.

- A degree of replacement of traditional products. Many services are complementary to a product but through digitalization they could be substitute for traditional services, especially in the BtoC market.

- The presence of digital technologies. As the name present, new technologies play an active role in opening opportunities for many innovative firms that would approach the market

However, is relevant to remember that these technologies are not convenient in any situation, they become useful if are applied to capital intensive products which are the result of a complex process of engineering. This products usually have to has a long life cycle that requires continuous maintenance to avoid severe breakdown that will cost a lot in terms of profit losses (Grubic & Jennions, 2018). Despite all, this technology offers many benefits to the final user starting from the optimization of downtime to a reduction of breakdowns; any eventual error can be detected in advance remotely allowing the provider to repair ahead the problem. Another point if favour of remote technologies regards the use of data, manufacturer has direct access to operational data and can provide the customer with a more precise and punctual solution compare to when information goes through other people' understanding. Usually customer demonstrates a high willingness to pay for services that are able to reduce the risk of breakdown.

Smart products do not change only the relationship between firm and customers but modify also dynamics inside the value chain, where value chain is the collection of all the activities related to a product starting from the design to the post-sales phase. Inside this concept is

enclosed a source of competitive advantage depending on the firm's strategy and position along the chain. According to Porter, the value of a product is given by a summing linear process in which value is added at any step and customer is the final point. Many authors opposed this theory in favour of a more customer centric, here we found the concept of "value constellation" in which different actors work together in order to produce value (Normann & Ramirez, 1993).

Riasanow, et al (2017) took this concept calling it value network, defining it as a process in which each actor contribute to increase the value of the network concentrating only its core competencies. This model results in a competitive advantage that is created by the overall network and does not come from a single firm. Firms are interdependent one from each other because each of them contribute for with a specific component, in this setting relationship are both collaborative and competitive and results in the so called "coopetition structure" (Clarysse, Wright, Bruneel, & Mahajan, 2014) where is the ecosystem and not the single firm that bust innovation. The ecosystem that is generated, called also with the adjective "digital" is usually characterized by three concepts: self-organization, scalability and dynamism. This entity emerges spontaneously in a global form going outside the local boundaries and usually it is able to enlarge itself when the market demand increase; last but not least entities that come in contact with the network change frequently guaranteeing a flow of innovations and ideas (Li, et al., 2012).

The strategy of adding services into present offering does not represent a competitive advantage by itself at the contrary firm has to develop a way to offer services with an advance technology attach. These services can emerge inside companies on the operational level for example regarding automation and optimization in the allocation of resources (Coreynen, Matthyssens, & Van Bockhaven, 2017). Firms can exploit this internal knowledge inside customers' processes providing training or operational index. At the contrary there could be also the commercial perspective in which firm undertakes to understand customers' needs with the aim of resolving them through new digital platforms.

With digital servitization the installed base acquires strong importance respect to traditional services. For manufacturers having already an installed base can simplify the process of acquisition of clients even if products are not recent; with simple adjustment is possible to renovate them making possible the collection and exchange of data. This could be an investment that allows firm to add new revenues stream on existing products. (Oliva & Kallenberg, 2003)

According to Oliva and Kallenberg (2003) firms has to enlarge their view thinking not only on their own installed base but on the entire catchment area. This concept is particularly clear if we think that services are no more fixed inside bundles, their scope is to cover all customers' needs along the entire lifecycle and for this reason firms should be able to treat also competitors' product in a perspective of being a end-users' maintenance units or, more, a system integrator.

The installed base market is, for these reasons, a very competitive market that can generate huge competitive advantages; Firm competing on them usually know in detail its audience and it is able to acquire easily possible new needs. In addition, the requirement in terms of capital is lower because of firms already hold technologies required to offer services. In the previous chapter we have presented the road map of Oliva and Kallenberg (2003) for entering the installed base market.

In their research, Coreynen, Matthyssens and Van Bockhaven (2017) highlight that there can be different ways of offering services depending on whether digitalization is applied in the front-end or back-end. From the combination of these two components the authors define three models of practicable servitization: Industrial servitization, commercial servitization and value servitization.

Industrial servitization means to translate the knowledge and skills of optimisation of internal processes into added value for the end customer. Visual control of advanced workflows and management systems is needed to develop this system; the output can then affect the optimization of customer processes up to customization services. Companies that take this path are giving value to intangible knowledge through the use of digital technologies, this just described is a factor of advantage that protects companies from the risk of being copied by the competition. This pattern could be also defined as inside-out servitization due to the fact that data are collected internally through knowledge and skills, and then took outside in customer processes.

The second strategy is defined as commercial servitization, in which the company and the customer align their processes in a new form of collaboration. Digital servitization allows the company to support customers in the control of their processes by the way of a digital solution configured according to their needs. As before this strategy could be defined as Outside-in because information come inside the firm from the installed base. This model is favoured by the technological and problem-solving capabilities of the company combined with the ability to mediate between front-office customization and back-office production process. The key element is given by the scalability and flexibility of digital platforms that allow the addition

of functionality and personalised aspects with minimal economic expenses. Another characteristic of this business model is the so-called interpretation capability, that is the ability to capture the needs of customers by interpreting them in order to create new product ideas.
Finally, we have the value servitization, defined as: "…a fundamental renewal of the current value chain through the creation of new digital products that impact customer processes and provide a more disruptive impact on provider-customer relations" (Coreynen, Matthyssens, & Van Bockhaven, 2017). As for the commercial path, in these model companies create a different and more connected relationship with customers as these are involved in the design and testing of products. However, in this area innovation tends to be more drastic and disruptive than other forms of servitization linked to an existing product.
The use that companies make of data, their internal or external provenance and the object on which such data are collected are key elements to define the strategic direction that the company should follow for a good realization of the project

2.4 Impact of service transition on business processes

From learning the pathway through which services could be delivered we move to understand the different implication that they have on the business. Throughout this chapter we will analyse how service impact on different parts of the company and environment. To better understand could be useful to start from the steps needed to develop a service culture.

Product centric firms typically pass through four stages in moving toward services (Kowalkowsky & Ulaga, 2017) . The first step is defined as "Service Desert", at this point firms do not realize how profitable could be services even if they are actually selling them on a basic form. As explained before, firm perceives services as an obligation useful only to sell product. This phase finish when firm starts to try approaching services, here there could be the so called "Dark Tunnel" in which companies start investing in services but results are lazy to come. The service infusion over time is slow and require a critical mass to become profitable, due to this, firms with high initial rush could feel frustrated and stop here the transaction. Overcoming this dark phase there is the "Promising light" in which firms start to see some victories, these are a little preview of service potential stream of revenue that could spur firms to continue in that path. At this moment commitment is high and companies usually start to launch some new services. Finally, it is time for the "Bright Landscape", companies deeply understand the potentiality of services and start to invest significant resources on that. At his

point service become a profit centre responsible for profits and losses (Oliva & Kallenberg, 2003).

However, the road is not so clear and defined, the transaction from a product-centric view to a service-centric one is putting the company in a new and complex role within its environment. The company face different challenges in many fields that can be summarized as the following: (Neely, 2008):

- Shifting mindsets: All the aspects related to the sales force has to change. The Marketing strategy first move from transactional to relational; revenues stream come from service contracts and internal capabilities; the relation with the customer that lasts longer after the purchase giving importance at the after sales activities

- Timescale: The firm has to manage multi-year partnerships. That long-term relations bring out challenges regarding the control of the risk and the exposure

- Business Model and customer offer: the entire company culture has to move in a service direction starting from developing the capabilities to design services rather than products, understanding the value of the customer as an active player of the process.

From now on we will concentrate on the mindset aspects and business model innovation. The transition towards more services in the company impacts first the corporate culture. Corporate culture is define by Schein (2010) as: *"A pattern of basic assumptions - invented, discovered or developed by a given group as it learns to cope with its problems of external adaptation and internal integration – that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think and feel in relation to those problems".* In detail corporate culture is built around three pillars: artefacts (buildings, dress code, founders), values put forward in mission, behaviour and assumptions in ways of working and handling. Any shift in corporate culture is slow and difficult to realize due to the refusal of chances, characteristic of the human being. In this respect Dubruc et al. (2014) state that firm must focus on making service tangible as a product, for example through written contracts, to reduce the mental gap. Another useful technique to approach the transformation is to make things growing internally from a single business unit to the entire firm (Oliva & Kallenberg, 2003). Service culture grows slowly and has to be trained and empowered; the

transition needs the support of all the components of the organization. In particular "…*thus servitization requires a shift in people's mindsets and this shift has to be encouraged by the managers"* (Dubruc, Peillon, & Farah, 2014)

Figure 7 - Shareholder positions toward service growth (Kowalkowsky & Ulaga, 2017)

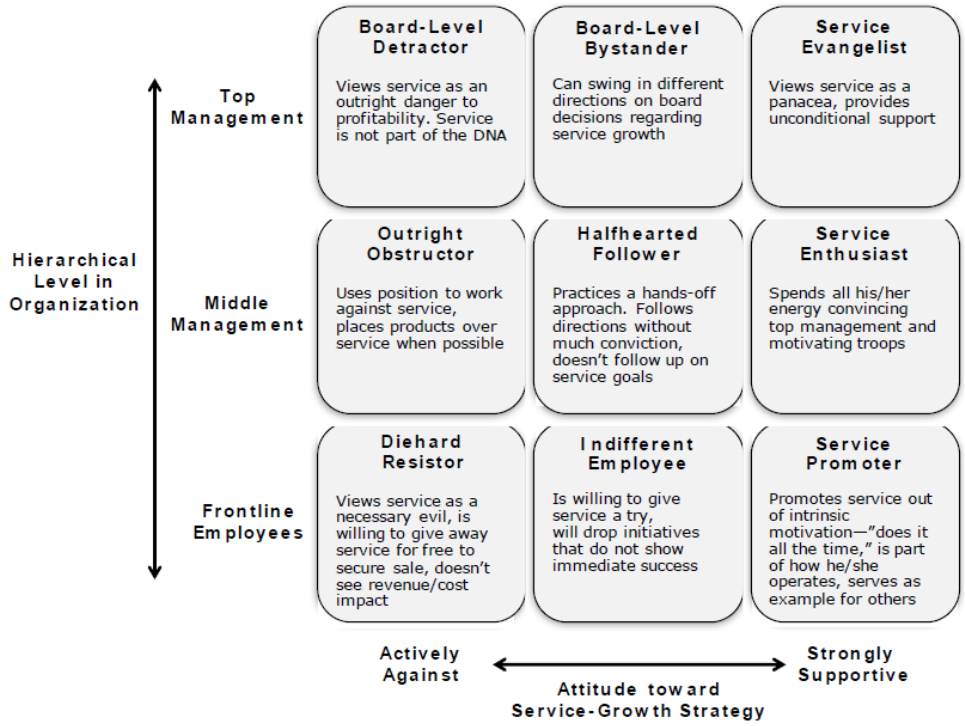


Figure 3.6 gives a representation of stakeholders into firm taking in consideration two variables:

The hierarchical level and the attitude respect the adoption of a service strategy. Hierarchically stakeholders are divided among three levels: Top Manager, Middle Manager and Frontline Employees; while regarding the positive attitude towards services we found: actively against, neutral and strongly supportive (Kowalkowsky & Ulaga, 2017). The support of the top management is needed in any cultural transformation. The so-called Service Evangelist is typically executives that strongly support the transition. This figure could cause many damages in the case of unconditional and blind brace that could push the firm into a non-sustainable situation. Many times, the Board-level bystander is a good compromise that allows the company to experience a new way of thinking without sparing himself from making questions regarding times, choices and feasibility (Ulaga & Reinartz, 2011).

Moving down along the hierarchical level we found the middle management. This figure is extremely important due to the fact that can directly dialogue both with its superiors and its employees; this is the definition of Service enthusiast. The other main group is Half-hearted

Follower; They are not totally devoted to services but is just a piece of their role. This latter is not indicated for the role of service manager. Both in Middle and top management there are obstractors and detractors. These two categories are strongly against the transition to services; it goes without saying that any service initiative is intended to fail if is pursued in that situation. At the bottom of the hierarchical pyramid there are often the main promoters of the cultural shift. It is not uncommon that people of the field perceive new opportunities and needs that could be profitable for the firm. Here too, as in previous categories, there are resistors; employees that do not support services due to past experience and the belief that services are out of the company culture (Kowalkowsky & Ulaga, 2017). In summary, company needs support from any hierarchical level to succeed. Managers need to believe in the economic viability and have a thoughtful strategy to integrate services, these challenges tend to make the transition careful and slow (Oliva & Kallenberg, 2003); frontline employees have not to focus on the past victories but have to move towards finding new spaces and opportunities.

Implementing new services is perceived as risky and will influence the managers' ability to assess opportunities and services are thought to be not in the competencies of product manufacturers (Gebauer, Fleisch, & Friedli, 2005) (Oliva & Kallenberg, 2003). This negative mindset is enhanced by the wrong expectation regarding the speed of adoption and the pathway explained before. Service infusion follows an s-curve pattern: the expected growth rate is higher than the actual service infusion. This, link with the idea of the dark funnel, could bring Service evangelist or Service enthusiastic to abandon rapidly their belief. In the case of no other support in that path the project is intended to fail due to wrong time expectation (Kowalkowsky & Ulaga, 2017). Furthermore, selling services is profoundly different from selling products therefore companies have to acquire new selling capabilities (Kindstrom, Kowalkowski, & Alajandro, 2015). Sales force is required to have a strong connection and comprehension of its customers as well as a new approach to them in reference to pricing.

Moving from internal stakeholder to external ones, this section will focus on customers.
Customers too have to adapt to the new value proposition that moves from a product that "do things" to a product that is relevant for the end-user within a solution. As seen in the previous chapter, Oliva and Kallenberg (2003) define this concept as product efficacy and product efficiency, where efficiency represents the capabilities of the product to fulfil the customer needs at the contrary of the efficacy, capabilities that work independently from the final user needs.

Finally, there are also problems in pricing and financing services. In many cases the cost structure change from variable to fixed, from direct to indirect (Mathieu, 2001). An example of this is the creation of a cloud system: costs are linked to the software that is then replicated and utilized into each product. Services are traditionally linked to a bundle of things valuable for customers or a model based on subscription and no more on a single transaction; this makes more difficult to establish the price. As explained before the price is also under the pressure of customers that do not perceive the value added by the service and, therefore, they will not retrieve the same amount of value for the same amount paid. For the above reason, services do not have a positive impact on the revenues in the first phase of life. This could create also an irrational fair on shareholders considering that many of the ratios commonly used could be negative (Oliva & Kallenberg, 2003). Products and services require the enforcement of different metrics for profit. Old metrics as the market share, quality levels and cycle time are calibrated on product but an organisation approaching services have to move towards new indicators as installed unit and total customer return over the product life cycle (Wise & Baumgartner, 1999). These metrics are usually away from volume due to the fact that is no more a fight on small profit margin as it was with products. Services allow to achieve higher margins especially in capital intensive goods. Cashflows change radically: it will be spread over a long period of time unlike when the ownership is transferred to customer at the time of the product purchase. In that case the total expenditure throughout the entire life of the good is much larger than the cost of the product itself due to the impact of maintenance and spare parts. (Wise & Baumgartner, 1999).

However, Gebauer et al. (2005) found that service development is often expected to happen at an unsustainable rate; this can have a negative impact on the employees. Therefore, targets should be decided with employees, improving their involvement, making goals achievable.

Given that, the process of making services profitable and self-sustaining is not immediate; these activities became profitable after passing some thresholds in terms of volume and organization. As explained before, the creation of a separate business unit dedicated to services can help that process of profitability (Oliva & Kallenberg, 2003).

3. Empirical investigation: two exemplary cases

In recent years many firms have tried to expand their offering through services but not all these attempts have been successful, many times it is due to the service paradox. Given the literature about industry 4.0 and servitization in this last chapter we are going to analyse exemplary empirical cases. The following research has the aim to characterize two different types of strategy explained in chapter 2.3: inside-out and outside-in servitization; as explained before the differences between these two model regarding the provenance of data and the final use of them. In case of inside-out strategy data are collected inside the company and used outside; at the contrary data are collected outside and used inside in case of outside-in servitization path.

Firms analysed both come from Padua province, one from Fontaniva and the other from Marsango (Campo San Martino), and both belong to the manufacturing sectors. These organizations have been chosen to highlight the different, but equally profitable, digital strategy that affirms can choose based on its own characteristics, capabilities, resources and output. Other criteria for selection was logistic proximity and the availability of the firms to participate in the survey through an interview.

To do that we organized an interview with the people responsible for services inside each firm; in the first case, Sariv, we took a two hours meeting with the managing director Nicola Sartore, while in Arneg we had a conference with the energy manager Marco Foralosso. Then we use the data collected there to make assumptions about their strategy following the literature concepts (Baines T. S., Lightfoot, Benedettini, & Kay, 2009). In addition to interviews, that were transcribed and coded, this thesis follows the so called triangulation method (Voss, Tsikriktsis, & Frohlich, 2002) that support the codified interview with researches through companies' websites, company presentations and general information coming from internet or AIDA database. The table below summarizes the main characteristics of the two cases:

Table 1 - Characteristics of analysed companies

Company	Industry	Revenues	Employees	Interviewed	Interview duration
Sariv	Manufacturing firm of metal items and metal small ware	252 million	37 (Italy)	Nicola Sartore – Managing director	2 hours
Arneg	Manufacturing firm of apparatus and equipment for cooling systems, refrigerators, etc.	8 million	696 (Italy)	Marco Foralosso – Energy manager	2 hours and 35 minutes

3.1 Sariv

Sariv was founded in 1989 in Fontaniva as a business development of a family-owned group, already operating in other industries in the mechanical sector as a result of the deep knowledge that Sartore family has on the sector.

3.1.1 Early times

Sariv is a company specialized in the production of blind rivets, an extremely poor and simple product that was mostly sold in hardware stores or used in the industry for the construction of objects of moderate value.

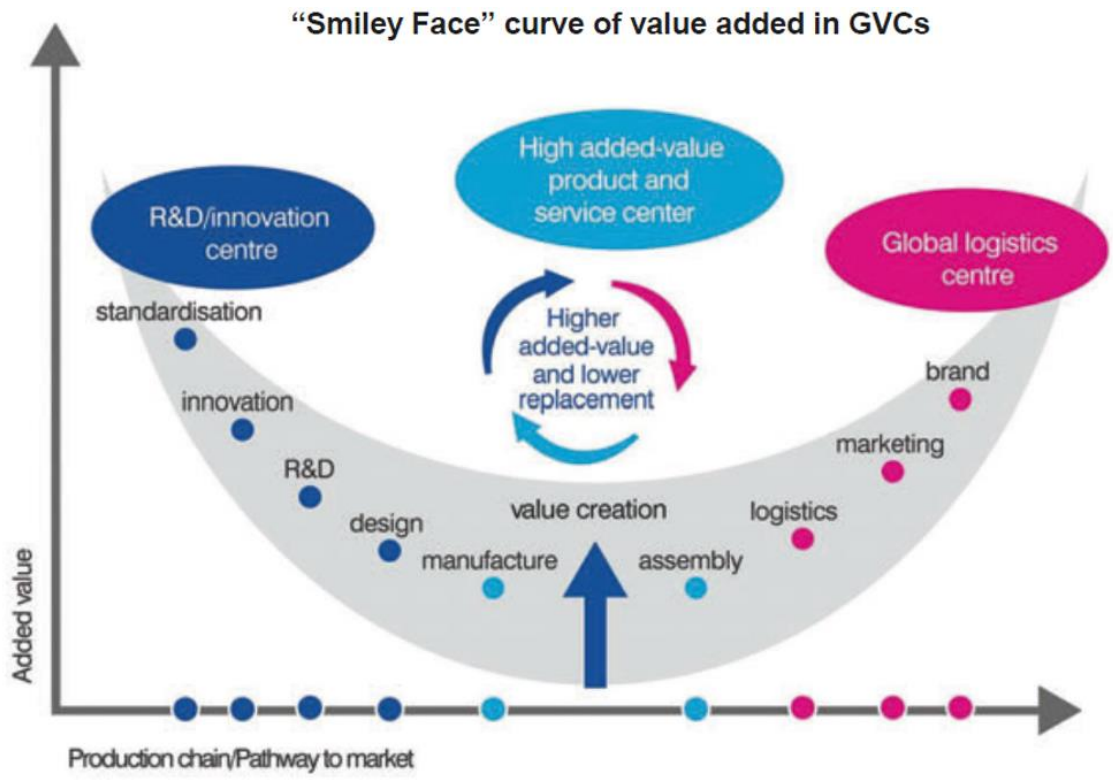
The company has had a strong foreign footprint since the beginning thanks to the experience gained by Oddone Sartore, one of the founding partners, in South Africa. Deep knowledge of the French language led him to attract customers around Europe; right from the start this strategy proved to be effective by generating an important percentage of production for the foreign markets.

This foreign propensity led Sariv to open five productive branches with foreign companies; these groups produced about fifty percent of their turnover on their own, producing especially for the B2C market but, being third parties, they caused a slow loss of focus compared to the initial project.

Nicola Sartore, managing director, tells how in that period, we are around the years of the financial crisis, although Sariv had positive margins due to his internal efficiency, was at the mercy of the market. The company strategy focused on the sole sale of the product thus remaining in the area of perfectly substitutable products in which the main determinant of

differentiation is the price. Quoting the work of the McGill University in figure 4.1 we can affirm that Sariv was positioned in the centre zone of the curve of creation of the value; There the added value from the company was minimal and Sariv distinguished only as a manufacturing company of production and assembly. To aggravate this situation was added the heavy financial crisis of 2008 and the beginning of the shadow of cheap Chinese products in Europe.

Figure 8 - The smiling Curve of Stan Shih by the McGill University and the Conference Board of Canada

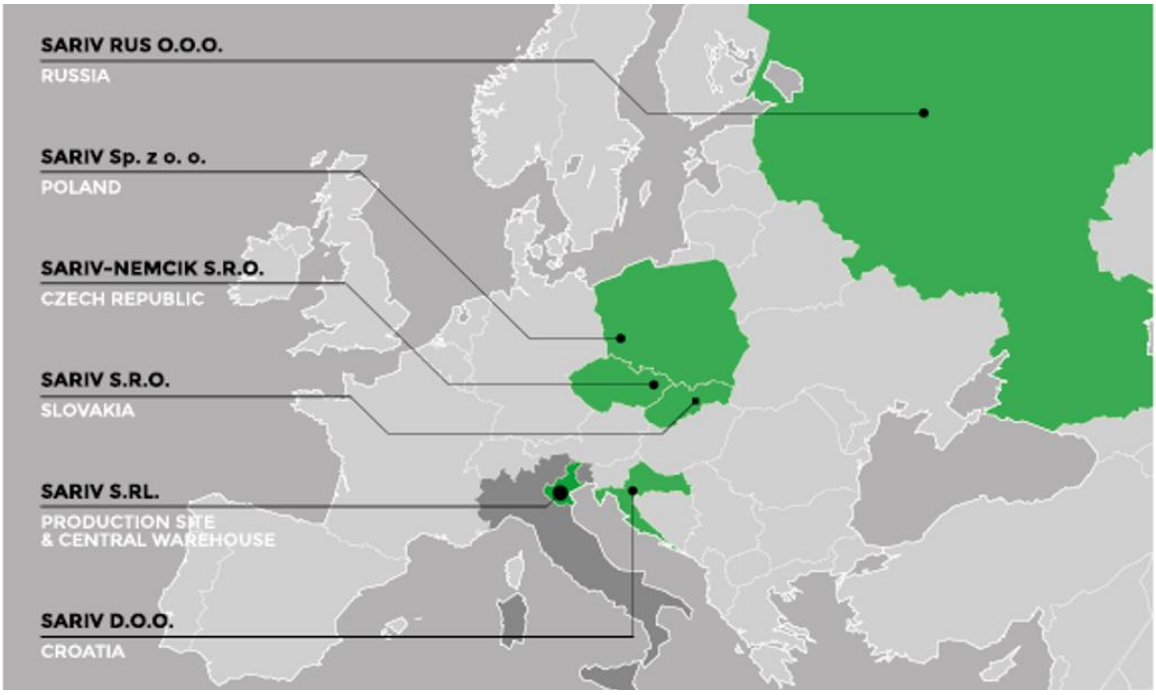


2008 was also the year of the turn at managerial level: the Sartore family decides to divide the companies and entrust Sariv, with the plants in Russia and Croatia, to Nicola Sartore, son of one of the founding partners. September 1, 2008, says Sartore, is a day that still today everyone remembers very well. Sariv has gone from 100% to 50% of sales today to tomorrow. The company was composed of 15 people, the plants were stopped for lack of orders; The impact of the crisis had been so heavy that the price of steel (Sariv's only raw material) was reduced from €1200 per tonne to €800. Sariv had an extreme need to produce and sell.

In this situation of emergency the 4.0 revolution of *Sariv begins, which today is proposed to: "Become the* reference competence centre for all companies that have to use blind rivets,

aiming to be market leader in services related to the product, from design, production and supply of data on the product itself". Thanks to the technological renewal Sariv can now count on 5 warehouses at European level, in Poland, Czech Republic, Croatia, Slovakia and Russia; an automatic warehouse with a capacity of 5000 pallet places and a headquarters of approximately 9000 square meters.

Figure 9 - Sariv in the world (Sariv, 2020)



The strong technological commitment, combined with the ability to innovate, allowed Sariv to move along the value curve to occupy strategic roles to a higher added value in innovation and research and development.

We will now go to understand in detail what were the steps that allowed Sariv to establish itself as a leader in the design of fixative solutions.

3.1.2 Sariv's servitization strategy

The evolutionary process of Sariv from a mere producer of components to company design services has been long and not without problems. The company has always wanted to deal with the automotive market but in order to approach it was necessary to equip itself with certifications that guarantee quality and traceability of the product. The automotive sector is a very complex and risky sector which places great pressure on efficiency; Suffice it to say that the concept of risk management was born in this market. The aim of Sariv was to enter this

complex market with the proposal to become a centre of expertise; thus, making the rivet, poor product, would take on a much higher economic value generating an important return. The most recent data indicate that a simple components company has on average an EBIT of 8% while Sariv, succeeding in this business change, is now able to reach an EBIT of about 30%. To achieve these results and obtain the required certifications Sariv had to act in the optics of risk reduction by setting up a system of total traceability of every single piece. At the beginning of this journey the documents were all on the paper and this was in the first place uncomfortable and also took up too much space for storage.

In 2010 the company started the process of introducing the MES system (Manufacturing Execution System) by digitizing the documents produced by the newly installed machinery. Sartore is still surprised at how at the time were only three companies in Italy to adopt that kind of system so useful and effective. A possible explanation could be linked to the fact that incentives for Calenda's reform had not yet been activated and, consequently the process required a strong economic commitment. Only in 2012 the system succeeds in producing the first tracking data of the product from the raw material, passing through the machinery used for its creation. In the same year Sariv approached for the first time the automotive market with Renault and later with Jaguar.

Then, in 2013 Sariv continued its strategy of offline expansion by acquiring the machinery of an Israeli company producing structural rivets; with this expansion of fastening solutions Sariv continued even more firmly its path in the automotive.

The success of Sariv as a knowledge centre was only defined later: "…one Saturday afternoon…" says Sartore, "we receive a call from Germany... I answer and it was the Jaguar who told me that they had stopped the productions of the model XS". A problem of this calibre would have caused Sariv to leave the market, the team did not lose heart and I start the search, among the various documents, of what could have gone wrong. Among the documents analysed it was found that Jaguar had not specified the function, and therefore the physical characteristics, that should have had the rivet chosen. After a quick session, Jaguar gives to Sariv the freedom to resolve the problem as they prefer at Jaguar expenses. So, three long days of development experimentation gave life to a personalized rivet. At that moment both Sariv and the market understood that the real company's value stood in its knowledge of the product. From here Sariv still grew digitally by integrating the MES system to quality control, ensuring even more control to the end customer.

Returning to the representation of the models of servitization of Ulaga and Reinartz (2011) Sariv occupies a place among the PLS, products life-cycle services, and AES, asset efficiency services; Sariv has in fact structured its business around the customer and the satisfaction of

his needs ensuring a high-performance product built specifically to carry out specific activities within the production line of destination.

In the next section we will talk in detail about how the information is managed and which figures Sariv has surrounded to reach the goal. The technical and technological factor was, according to Sartore, the key element that allowed the transition from a production company to a solution company but the transition was not easy. The change was initially opposed by employees accustomed to the paper system and Sariv had to proceed slowly through a system "quick wins" to avoid breaking the project.

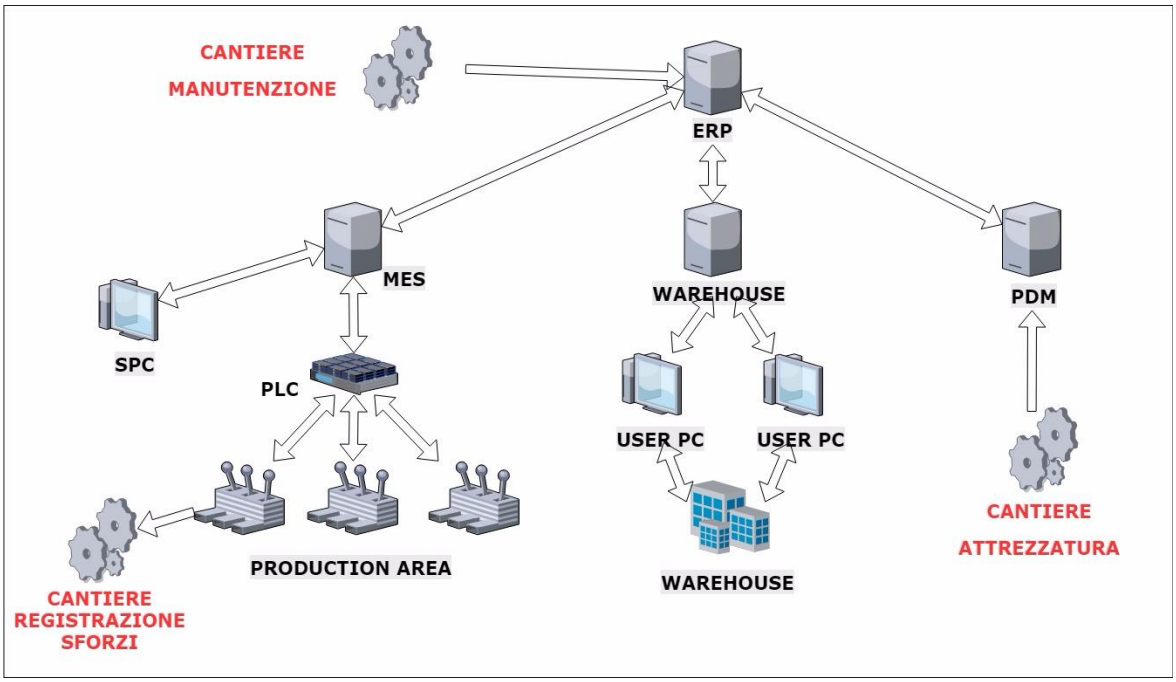
As explained in the previous chapter in figure 3.1, the digitization of the processes has accelerated the process of servitization; According to Coreynen et al (2017), the key point for companies has been from tangible product to intangible values of knowledge, specialization and skills in production processes. This client-centric perspective presupposes the ability to be adaptive and dynamic in proposing solutions; The relationship that follows will be very close and the competitive advantage created here will be given by the integration of the business reality in the processes of the customer. In Sariv we are faced with the case of industrial servitization Coreynen et al (2017) where the focus is on the efficiency of the customer's operations.

Today Sariv: is equipped with the best certifications to operate in the automotive market (ISO and IATF); produces about three million pieces per day, 60% dedicated to special products and cars; it has an in-house R&D laboratory for the development of new products; have complete digital processes for product traceability; It has automated the quality control through SPC (Statistical Process Control) and finally, as the last project, it has codified also the equipment and the components of every machinery in order to guarantee a predictive maintenance and therefore the productive efficiency.

3.1.3 Technologies and capabilities

Let us now focus on Sariv's technological structure. In figure 4.3 is represented the computer system of the company that manages every type of information from the purchase, to the planning, up to the sale.

Figure 10 - Sariv's digital infrastructure (Sariv, 2019)



At the level of Enterprise Resource Planning (ERP) Sariv has chosen to adopt the Dynamic NAV system offered by Microsoft, a modular and flexible solution for the integration of business processes. At this level all the information regarding the production data and the handling of the material are stored, divided by article codes. This information is then used for the planning of purchases and production orders and for administration.

To manage the data related to the product there is then a program of Product data management; The latter is responsible for document management, coding the articles and managing the equipment necessary for the creation of the articles.

The warehouse is managed by another system, System logistics, which automatically, reading an identification code, moves the material and checks the weight of every outgoing product.

In the management of the actual production, Sariv has entrusted to the MES Master Factory of Arpa technologies; This system allows to schedule production and quality control based on production orders.

These four systems work together to ensure complete traceability and consistent quality to the end customer. We are now going to review the production process of a hypothetical product.

The request generally starts from the needs of a customer, the first step therefore regards the R&D area in which the application is studied and the materials are tested. Once the final solution has been reached, the project is inserted into PDR, the physical and qualitative characteristics are defined and in addition the production process is defined (material to be

used, processing cycles and necessary equipment). In the meantime, the raw material purchased is inserted in ERP identifying it with a label representing lot, supplier and certificate raw material. Also, the incoming gear undergoes the same traceability process with the addition of a QR code identifier for each component. In production, orders are simultaneously programmed by the MES; from these interfaces it will be possible to see in real time the progress of the processing, the material requirements and the deterioration of the components of the machinery. At the start of the production order the product card will indicate to the worker the equipment and the necessary material, these objects will be scanned to verify their correctness and then proceed to the processing. The whole process is traced by the systems by recording the machine parameters and any stops. Quality control shall always be carried out through the MES; at regular frequencies given by the machine/product combination, the system alarms the operator to carry out the quality control. All output data is then saved in the central database.

Sariv managed to digitize its processes thanks to the technological partners with whom it came into contact, without these technical figures the process would have been much longer and more complex to integrate.

In addition to the technological factor, the project has been successful thanks to the training and skills of the team. As far as management was concerned, the group was multidisciplinary and with an innovative spirit that, with a top-down approach, led the staff to accept the changes. With the arrival in the digital system at the work of the production workers, other relevant figures are added, who are on one side connected to the world of data, therefore data strategist and data security, and on the other side connected to the world of research. Today the development department counts on the work of experts in materials, big data experts, designers and technicians.

3.2. Arneg

Arneg is an international leader in the design, manufacture and installation of complete equipment for the retail sector. The firm was founded in Marsango, Campo San Pietro, near Padova following the moral value typical of Veneto culture: a belief in the effectiveness of production connected to important topics as the respect for people and community. These principles were then taken around the world to build the international Arneg Group present in all the fifth continents.

3.2.1 Beginnings

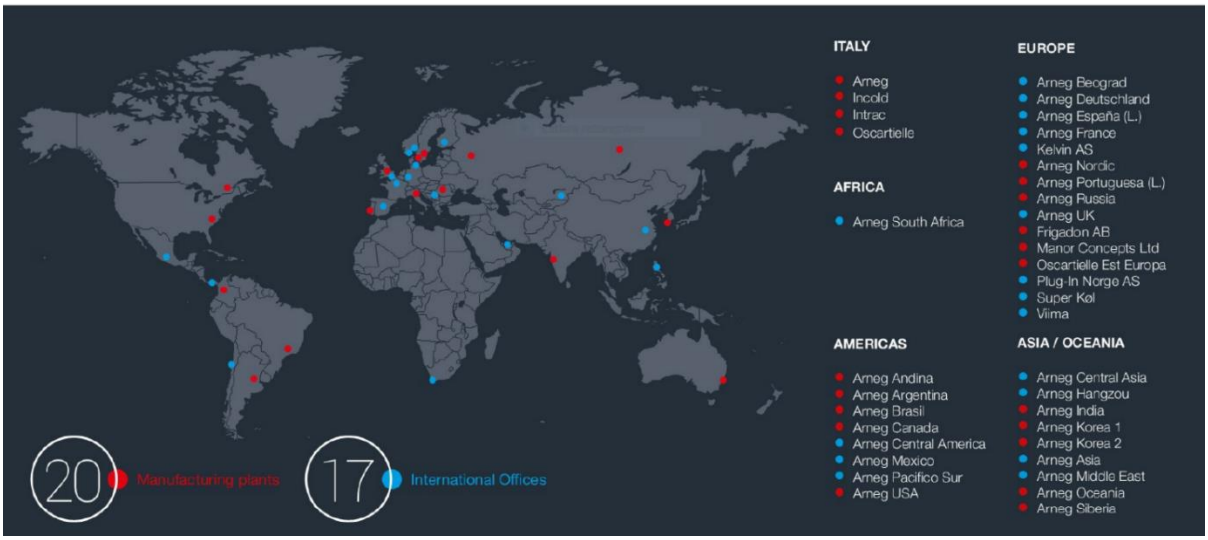
The history of Arneg starts with his two co-founders Luigi Finco and Roberto Marzaro. In the early sixties they both work in Officine Facco, a reality with 70 employees in Marsango, Campo San Pietro that produced cages for chickens. At that time the business had a drop due to a campaign against the poor feeding of chickens that cause a decline in sales of cages; to being able to survive at his crisis the company start to produce shop's shelving with the same material used before in cages. Through this differentiation strategy the company was able to face the crisis. The project of shelves was then developed in the idea of producing refrigerated counters.

Facco began to structure itself acquiring new technicians but it had no competencies regarding refrigeration systems. To be able to sell the first refrigerated counter Marzaro and Finco entered into agreements with a craftsman who made the system and a carpenter who build the isolated structure. Immediately they understood that it would be a success and, to be able to sustain the business, they create a new company separated from Facco entirely dedicated to refrigerator systems. It was the summer of 1963 when Arneg was born.

Arneg is now an industrial group that has been operating for almost sixty years in the commercial and industrial refrigeration sector. It is active in the design and production of equipment for the storage and display of food products and consumer goods in general. To date, the main products lines are counters and cold rooms, refrigeration systems, shelving and cash units. The production activity is accompanied by the provision of advanced technical services such as assembly, assistance, scheduled maintenance and remote monitoring of the points of sale; all these activities guarantee the operation of the equipment according to technical standards defined with customers.

In the '60s attention was mainly paid to the preservation of food with technologies that are certainly less advanced than the current and certainly not sustainable. Given the growing development of the sector in the 1980s, Arneg has had the opportunity to grow and create its current headquarters in Marsango, Campo San Martino (PD). Now it has become a multinational company reaching a global dimension that describes its great growth path with about twenty production sites located in Europe, America, Asia and Oceania, seventeen commercial offices and a widespread network of distributors.

Figure 11 - Arneg world (Arneg, 2019)



The group is strongly present in Europe distinguishing itself for the performance and innovation of its products, combined with an increasing demand for attention to environmental issues and energy optimization. A growing market since the 90s is the Korean one, where the company is now the leader. From there Arneg began his conquest of the Asian continent with factories in China, India and Russia, then moving to Oceania with the recent plant in Sydney. Arneg has a long history also in Latin America with offices in Colombia, Brazil and Argentina. As far as North America is concerned, this represented a major challenge for the whole group, which has recently succeeded in affirming the Italian style with two factories in Canada and the USA. Finally, a market in great increase is that African in which Arneg is strengthening the presence with operating units that can satisfy the requirements of the market.

Arneg enhances its Italian character, meaning made in Italy as something unique and inimitable. It stands out in the international market for the link it has emphasized between made in Italy, quality and design. Arneg S.p.A., the parent company, is a joint-stock company not listed on the stock exchange. The company has around 2960 employees worldwide, occupies a land area of 1.300.000 m2 and 400.000 m2 of structures all over the world.

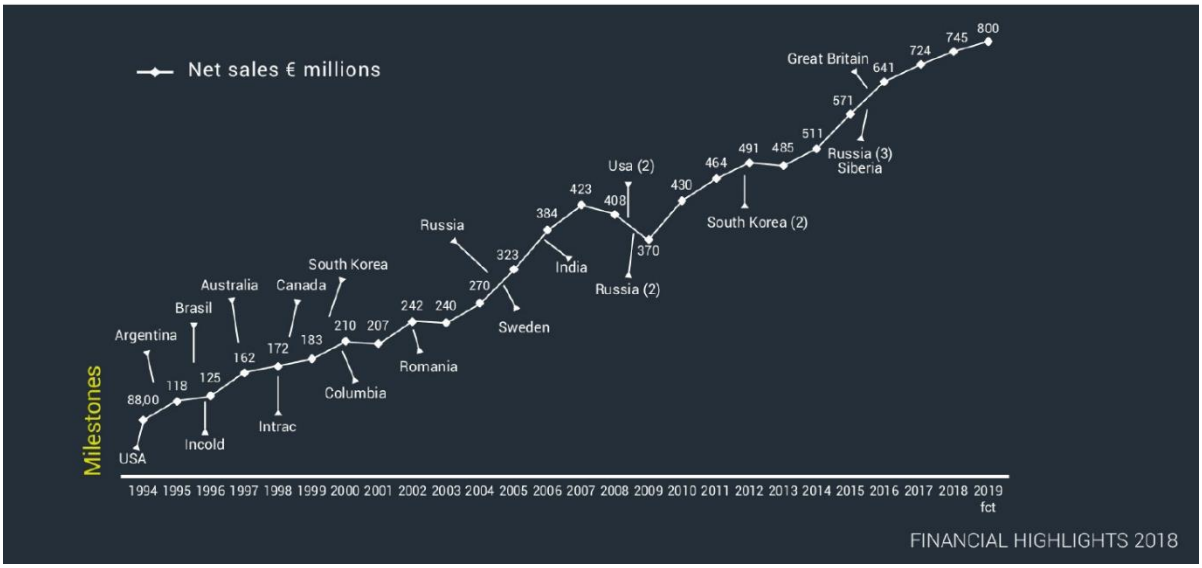
Figure 12 - Financial highlights 2018 (Arneg, 2019)

All the companies of the Arneg group are 100% owned by Finco and Marzaro families and, where there are foreign shareholders, the majority of the share package still belongs to Italian ownership. Regarding production, each factory produces different products; for example, in Italy, Incold produces panels, cells, doors and hardware for cells; Intrac produces shelves and crates; Oscartielle makes the so-called "plug" counters. All the other Group companies produce counters, or cells, or power plants or combinations of these products, for example in Russia, counters, shelves and insulated doors are currently produced. In general, Italian companies develop projects and products first. Subsequently, the subsidiaries select the most suitable products for their markets from the Italian catalogue. Some companies of the group could require particular models depending on the market's need; these specific models are not necessarily and entirely different from the Italian ones instead they can be reinterpretations or adaptations of those produced in Arneg Italia.

From the interview with Marco Foralosso (Energy Manager of Arneg Italia) it was clear how much the fact of being a world-wide company is a factor of extraordinary importance for the group. The internationalization process has allowed Arneg to discover new markets, to expand its commercial and productive penetration force and to become a point of reference in the global market. Internationalization allows also to expand cultural horizons and acquiring a more open, dynamic and evolved entrepreneurial mindset. Its leadership position in the commercial refrigeration sector stems from the enhancement of the synergies that are created between the various companies of the group and from a wealth of knowledge and ideas that circulate in a continuous flow of information through the production and distribution network in each continent. In fact, in Arneg's website we can find the following statement: "Share professionalism, experiences, talents, identity. Sharing knowledge and technology. Share

points of view and strategies. Share similarities and differences for the development of a common growth project. That's what group is. And this is the strength of Arneg Group". Figure 4.6 present the evolution of Arneg net sales considering the time of acquisition of new production plant or offices, this graph highlights the importance of the international strategy for Arneg success.

Figure 13 - Financial highlights 2018 (Arneg, 2019)



Arneg is an example of a company capable of competing in the global market thanks to continuous improvements of its products and expansion towards foreign markets. The company operates in multiple countries and demonstrates advantages in terms of research and development, logistics, production and marketing and finance. Internationalization allows Arneg to deeply understand customer's needs based on different habits and locations, but also allow the company to improve its services being able to solve potential problems fastly. Finally, through the different plants, they are able to face local competition that, otherwise, would not have been accessible due to important transportation costs (Foralosso)

3.2.2 From PLS to PDS

Going into detail, Arneg has in its portfolio solutions as refrigerated counters, cold rooms, roll-on furniture, hulls and backbenches to solve all the needs of a small, medium and large distributor of the GDO and not. Arneg not only offers the finished product but also meets every customer requirement from design to production to installation and certification. The company has in fact developed its handcrafted footprint with a strong preponderance for

customization and design with areas dedicated to design and research, prototype testing and construction laboratories as well as areas with high technological impact with state-of-the-art plants that allow ideas to become finished solutions. All this coupled with a growing interest in the world of services that we will now explore in detail.

Arneg begins its history as a purely productive company with a crafty soul, aimed at the made in Italy and the customization of its products. Until the early years of 2000 the company grows thanks to its constructive quality focusing on production; At that time, the budgets of large GDO groups were high, the premises were restructured with a frequency of about 8 years and the sector did not seem to have been affected by particular crises. Arneg began in 2005 to approach the world of services as a large customer required, in addition to the warranty, 5 years of contract for the maintenance of the plants. Until then, the revenue generated by the services was close to zero because the maintenance was not managed directly by Arneg but entrusted to external bodies. From 2005 instead the company takes charge of the direct relationships with the customer for the maintenance issues subcontracting but the execution of the same. The internal complexity of contract management is growing, but with this the post-sales revenues are also growing. Recognizing the theory, this is the phase in which services are perceived as a necessary evil (Oliva & Kallenberg, 2003) to accompany the product offered. The services are imposed by the final customers and the company is forced to adapt quickly to the new environment in order to maintain its business. In this context the company is experimenting with the PLS model, Product Life-cycle Services explained in the second chapter (Kowalkowsky & Ulaga, 2017)

As a result of the financial crisis of 2008, the growth of Arneg is slowing down and facing the need for renewal. Past the so-called service paradox, where the company's equipment to follow the needs of the customer but the growth does not reflect the expectations and investments made in the project, Arneg begins to differentiate itself from its competitors for the efficiency of the service thanks to the internalization and direct management of contracts, spare parts and all the complexity that was previously managed externally. Thus, making Arneg manages to attract more and more customers arriving at a point where, saturated the market and acquired the majority of the customers, the business returns to flatten. To overcome this stalemate the company proactively commits itself to increase the variety of services within every customer reached, born so slowly, from a need, the services that still today are the pride of Arneg: remote management, BEMS, and Extra-cold service. We will now analyse these services one by one by explaining the evolution from PLS to PDS.

The first service we will analyse is remote management, the first service adopted by Arneg to approach the market. With remote management is installed inside the supermarket a plc

(Program logic controller) that allows to analyse data from all devices connected to it. Inside the supermarket, the temperatures of refrigerating equipment must be constantly monitored in order to comply with the HACCP (Hazard Analysis and Critical Control Points) consumer protection legislation. Such norm previews that the perishable goods must always remain within a given range of degrees otherwise, in case of exceeding of the threshold for a prolonged time, the goods must be thrown. Arneg has used this delicate field to put into use all his knowledge of the cold sector. Through the PLC installed inside the supermarket Arneg monitors all the refrigerating equipment in such a way that it can verify in real time any problems. To do this Arneg uses the cloud platform offered by Amazon () through which the data passes to the central direction for analysis. The error resolution process starts with an anomaly that is reported to the central system via warnings, such warnings remain latent for a period of time suitable to verify whether it is an error or a passenger event. In the case of a real fault, the system moves from the warning mode to send a real alarm to the central operating unit that thus starts the process of resolution of the error. This can be defined in the literature as a service of the AES type, Arneg provides the customer with much more than a simple maintenance service, a service of constant and direct control of the equipment, no difference in brand, which allows the customer to maintain productivity at the expected levels. Here you can notice the first paradigm shift: the service is no longer passively linked to the company product but begins to take the form of a service more related to functionality and efficiency than to the product itself; This is demonstrated by the fact that products from other companies can also be controlled through these systems. Through the cloud it is also possible to offer a predictive maintenance service and assistance per product using controllers that communicate with the system via sim. This option is particularly favourable for small shops where the cost of a remote management contract is not sustainable. Doing so there's no more physical PLC inside the store but the whole thing is internalized on cloud and computer system.

To date, there are approximately 6000 stores connected; in Lombardy 1152 and Veneto 950 and on an average day arrived at the headquarters about 9000 alarms.

Inside what appears to be a simple after-sales process there are actually several issues that the company has had to overcome; We will analyse difficulties and technologies after giving a general overview of the different services offered.

After experimenting with remote assistance services Arneg wanted to use its knowledge of the market and its presence within the large chains to propose itself as general manager of all the equipment present inside and outside the structures of the GDO, This is how the Building Energy Management System (BEMS) program was born. Research carried out within the

company showed that the highest fixed costs for a supermarket are staff, a variable that is not easily aggregated; the advertisements and the electric cost. Arneg has been able, analysing in depth its customers and the connected needs, to propose a complete service that would allow to lower what everyone thought was a fixed cost without having negative impacts on safety regulations (HACCP regulation).

With the BEMS refrigeration, air conditioning and lighting are all managed with a view to saving energy to offer the best combination of efficiency and economic savings. With these services Arneg increases the interdependence with the customer, the latter takes away the weight of the management and maintenance of the plants but in doing so becomes in a certain sense dependent on collaboration with tools that allows it to keep such costs under control. The company becomes in a way a consultant of the supermarket in when it has all the useful data in order to verify the evolution of the cost of the energy, the maintenance and the connected expenses. This creates a relationship destined to continue over time generating new revenues when the equipment is renewed. With this service we are entering the world of Process Support Services or PSS in which the company supports the customer in improving its performance by offering technical support directly on consumer processes. Here we can observe the passage sale of the product within addition the service, to sale of the service with the hope to then sell the product.

The third and last service analysed is the Extra-Cold service. This service allows Arneg to exploit its internal structure to solve the most diverse problems of supermarkets. Through this system, the supermarket contacts tools for breaks, faults or problems ranging from refrigerators, bulbs, tiles; Arneg then takes the burden of contacting the appropriate maintainer to the problem to resolve it quickly.

3.2.3 Technologies and structure

In order to be able to propose the services explained above Arneg has had to develop over time a structure and capacities suitable to manage growing technical complexity. First, he had to rely on a cloud service to manage the important amount of daily data. The choice was made on the basis of the company’s needs and the algorithms that the platform made available, following such driver Arneg chose the service offered by Amazon AWS. It is important to note how Arneg uses the cloud as both data storage and predictive analysis and more. In the cloud there are no corporate sensitive data, the latter remain in the company inside the proprietary Iris software.

Iris, the Arneg management program, is an innovative technological support useful for business planning as it monitors in real time the management of every single point of sale. Iris has the peculiarity of being shared free of charge with customers who can therefore have an overview of all the technical interventions, energy consumption and economic savings of the store. The program is based on a pyramid structure that allows users to be subdivided according to the role played, so as to show only the data useful to it: Arneg's energy manager will have access to all the cards of all the supermarkets of all the customers, while the branch manager will have access only to the data of its structure. The choice to provide it for free was a winning choice for Arneg, the costs were almost nil having already developed the platform internally, but the impact on the end customer is great. Iris becomes the litmus test of the efficiency of Arneg services, ensuring maximum transparency and therefore gives the customer the security that all the company does are useful actions to pursue the savings and efficiency. Iris is above all the normalizer of information that arrives in the system from the tele-managed plants. For the creation and implementation of this system are still employed about 15 people inside Arneg and about 5 external software companies, each concentrated in a different implementation for the system. Arneg has focused on specialization and has chosen small local companies to help her coding Iris, this choice is strategic because it allows to maintain all the technical know-how internally how on the management of the system in its entirety, taking from the external the technical capacities of construction of software so important for the effective operation of the system, but not strategic as each of these software houses is replaceable. Doing so Arneg has the freedom to follow the market and always rely on the company that at that time is useful to develop that given technology.

For the management of calls extra cold Arneg then had to equip itself with Call-centres for a prompt answer; In this area work from 25 to 30 people, all trained as tools to meet the standards of efficiency.

The set of cloud, Iris and call-centres is the basis on which all the services offered by Arneg are based, these pillars are fundamental to be able to be ready for different needs from all over the world. Alongside these technologies is the sales force scattered throughout the territory. The sales network consists of several agencies and agents that are under about 12 Area managers. This structure is very solid and branched but strongly concentrated on the product. The service team works closely with the area of research and product development; The design area has specialized technicians with a deep knowledge of the components of the product while the service team has on its side the proximity with the customer, understanding therefore its needs, and the data regarding the efficiency of the machinery. By working in synergy, the two Arneg teams are able to build only products that meet a market need and

thus ensure the satisfaction of the final customer and, consequently, the continuity of the relationship over time. The side in which the service is more deficient is the sales force; To date, the team's three central figures are responsible for approaching and advising brands.

3.2.4 Future developments

Among the trump cards of Arneg, we can find the affirmation: "Nothing is certain and definitive, everything is variable, refundable and rewritable, the company has always had a strong push to renewal with the aim of satisfying the growing needs of customers.

Talking with energy manager Marco Foralosso has shown a growing interest in Big data, Machine learning and the IoT. Foralosso describes the current historical moment as a dangerous moment as potentially the company could integrate into its systems several new controllers that would monitor many more variables than those currently used but without the certainty of being useful to satisfy the needs of the customer.

The scope of Arneg, to date, has always been the satisfaction of the end user without compromises, with the object of selling only what can be useful to the customer. With the addition of additional sensory techniques, there is a risk that the cost of the product will increase excessively and, secondly, there is a risk that a given instrument will be inserted only to make it more attractive to the purchaser. In both cases the fidelization built with the years would go to crack risking to lose the customers that with so much effort had conquered. The Arneg strategy, therefore, wants to remain bottom-up: I see a need in the market, I analyse it starting from the design and only in the last phase I propose it to the customer if the results demonstrate an added value regarding the current composition.

With regard to Big Data, Arneg already has a large pool of data that it could use for future projects, the service called Extra Cold presented before could be the beginning of one of these projects. The idea, far away, that describes us Foralosso is to equip himself directly with maintainers who now, with the Extra Cold program, are instead chosen by customers. Arneg would then change from being a resolver intermediary to providing a complete service, a global service that solves every possible problem internally. To be able to provide an efficient service, the "submerged" structure makes great use of machine learning. Through the features offered by AWS the company searches for unexpected correlations that give way to increase even more the differentiation compared to competitors.

Apart from the technological side, a great challenge for Arneg in the coming years will be to lessen the productive complexity of which it is now a slave. The company has always been recognized as a leader in the customization of the product, this is a positive feature that has

led Arneg to differentiate itself but, with the passing of the years and with the extension of the offer, The company is in danger of going against serious production inefficiencies.

4. Conclusions: inside-out and outside-in data servitization

We introduced this elaboration by talking about how the digitization of the processes combined with the enabling technologies of the industry 4.0 can help companies to implement their offer with new services. Technology is a disrupting factor that can be applied in various businesses leading to an increase in business value, both in economic terms and in value chain importance. Although it is not a new concept, servicing strategies have gained growing importance in the business of many companies by going to define their core traits. The objective of this thesis was to present two emblematic cases of servitization, both winning but different in terms of possibilities and applications.

Let us now analyse and compare the characteristics of the two productive realities. Both companies have made a digital revolution that has led them to manage a large amount of data in the cloud today. Arneg uses computer systems to remotely control its installed base and to do so has chosen the path of a single proprietary software developed by different software houses, in collaboration with an internal team, through which also the customers can keep track of maintenance and measures. On the other hand, Sariv uses the technology mainly to trace internal processes and as a result has been equipped with about four systems that, collaborating together, verify the correctness of the production process. For Arneg Iris, its software, is a service given for free to the customer to give credit to the promises made during the bargaining process, giving in the hands of the end user all the data in real time; for Sariv instead the data produced by its systems are useful for the purpose of certifications and design analyses of the R&D department. In both cases, the digitization process is useful to reinforce the productive and organizational qualities of the two companies.

A second characteristic common to the two cases is the strong propensity to the final customer, for Arneg, born like craft company, this has always been the business focus also before the advent of the services; for Sariv instead this characteristic was born together with the awareness of knowing how to make personalized products and no longer only standard components. Going towards the product consultancy Sariv also interfaces with a different interlocutor: it is no longer the contractor focused on the price but, most of the time, it is the technical department of the big car making companies that choose on the basis of quality and functionality. For Arneg, however, has not changed so much the user, as it always relates to the signs of the GDO, but the change lies in the frequency of relationship that was previously stopped to the renewal of the premises or to the maintenance operations and now instead is a

continuous relationship carried out daily. Continuing in the presentation of the similarities, both companies exploit the potential of big data in machine learning processes; their self-learning systems with experience, what differentiates them is the provenance of data, which for Arneg is external While for Sariv internal; and the intended use which, as before, is internal for Sariv and external for Arneg. Sariv uses the data produced internally to increase its know-how and thus optimize the production processes but also the process of creation and design of the customized component. In this case, the company does not have particular data produced externally to the production process because of the peculiarities of its product: a poor product and not implementable with remote control systems. Arneg has, on the contrary, the possibility to work on a very complex product, composed of multiple pieces that are, potentially, all implementable with antennas and transmitters for remote control. This feature causes Arneg to come into contact with a large amount of data coming from outside, these data are then processed internally to improve the experience of use and productivity of the systems in charge to the end user. From now on we are going to describe the direction in which data moves as outside-in, if these data are collected outside the border of the company, or inside-out in these data comes from internal operations. We can therefore affirm that the element that has most characterized the direction in the within of servitization and the use that the company makes of the technologies has been the offered product and its characteristics.

Following the model of Coreynen et al (2017) introduced in chapter two, Arneg would be positioned between the companies that implement a strategy of commercial servitization, while Sariv would be classified between the companies of industrial servitization. Returning to the theoretical concepts, the former implies the co-creation of a digital product that directly impacts on the processes of the final customer, while the latter is described as the translation of the company's internal knowledge into services with high added value for the customer.
Using a different point of view, we can define Arneg as a company in outside-in servitization. Arneg has built a system in which the end customer, using its machinery, produces the data that will then be analysed internally by Arneg in order to be reused in process optimization. Sariv, on the contrary, uses a model of inside-out servitization in which it uses its knowledge and its research department to offer technical support of planning for final customer becoming in some way an external R&D centre. In the case of outside-in servitization the company needs a large base installed with sensors for remote control, as well as a powerful data analysis platform; For the inside out model, the knowledge and skills of the team are fundamental, together with strict control of internal activities. The characteristics of the two business cases have been summarised in the following table:

Table 2 - Characteristics of the two business cases

Sariv	**Arneg**
Sariv use four generic digital systems that, connected together, guarantee an overview of internal processes	Arneg create, in collaboration with many local software houses on a proprietary software called Iris
The use of technology is focused on the internal and external traceability of the product	Technology is mainly used for remote monitoring and preventive maintenance
Sariv exploit technologies as cloud and big data to build up a self-learning system	Arneg uses technologies like big data and cloud in every step from the collection of data, to the elaboration and storage of them. Arneg is also implementing processes of machine learning inside Iris
Digital solutions help both in reinforcing the image of the company through certifications and in helping the company in growing technical knowledge internally	Digital solutions are useful for keeping Arneg in touch with its final customer acquiring the role of consultant
Sariv is focused on customer's needs	Arneg is focused on customer's needs
Sariv produce a poor product with only one raw material and no possibilities of direct digital implementation on it	Arneg produce a complex product that lends itself to implementations as antennas for remote control
Sariv collects its data from its production process and then use them externally in order to satisfy customer's needs	Arneg collects data from its installed base on customer site and then use them internally with the aim to optimize the system
Sariv's model could be defined as Industrial servitization in which the company translate its knowledge into customer's process	Arneg's model could be defined as Commercial servitization in which
To be able to pursue this strategy Sariv has to focus on internal capabilities and on digital technologies for traceability	The strategy of Arneg rests on its huge installed base and technological solutions for the acquisition and storage of external data

In conclusion, we summarize here the changes in business model faced by the two companies. Sariv proposed itself as a manufacturer of generic components and now has the goal of becoming a centre of problem solving, development and engineering; the key resource for the implementation of its strategy was the only productive skill while now the importance and added value are given by the R&D laboratory and the technical department of product development. For Arneg, too, we were talking about a production company that made its craftsmanship its strong point, now this same company proposes instead as a centre of efficiency and control of plants ranging from the single counter fridge to the whole building. The main resources of the company were in the beginning customized production related to

the customer's requirements while now, in addition to this, the capacity of analysis of the different situations combined with the promptness and capacity of adaptation of the service department is fundamental.

These two cases, Arneg and Sariv show us how all the companies can succeed in differentiating themselves through the strategies of servitization whichever is their initial business. Sariv shows us that servicing is not only a prerogative of companies producing complex products and cannot be summarized in the only remote control or preventive maintenance as most people would tend to think. Trough digital technologies Sariv was able to convert internal capabilities into competitive advantages recognised by the leading brands of the automotive sector. On the other side, Arneg shows that also a traditional manufacturer with a prevalent product-based servitization mindset can overcome the difficulties linked to cultural barriers succeeding in the service transition. Thanks to the passion and believing of the top managing level linked to the customer-centric perspective that Arneg has from day one, the company was able to build a new division entirely dedicated to services in a sector in which services had not been yet tested.

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