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"Industry 4.0 and Firms' Business Models: An Overview of Enabling Technologies and an Empirical Investigation on The Strategic Impact of IOT"

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Introduction

The goal of the following work is to develop an analysis useful to understand the upcoming digital transformation that the economic environment is undertaking. Especially in Italy, innovations struggle to spread and most of the SMEs do not perceive technology innovation as one of the most critic source of value. The question that we asked ourselves was: how can we understand where technology innovation will hit businesses and what is the impact of the plans that companies are undergoing to exploit Industry 4.0 revolution?

To approach the analysis, we decided to start with a general overview of what is the Digital Transformation. We did not focus on the explanations of the term "Industry 4.0" since it is a catchword that encompass many different aspects of technology innovation. In Italy we have Industria 4.0, Industrie 4.0 in Germany, in France it is Industrie du Future and in America they call it Manufacturing USA. The point is that all the different names point to the same thing: Digital Transformation.

So, in the first chapter we decided to explain some basic concepts and to provide an overview of the so called "key enabling technologies". In this part most of the literature is based on recent academic articles and many reports from consulting companies working in many different industries. Some theories or concepts explained here could reveal in the future to be wrong, but trying to describe and understand an ongoing process, being it economical or technologic, it is not easy.

The second chapter is about the frameworks we decided to use. There are many analysis frameworks to choose between, however, we decided to limit our choice to the Business Model CANVAS by Osterwalder and Pigneur (2010) and to rely also on the concept of Supply Chain, to better show and understand the dynamics and the relations between the players of the industry. We introduced a general overview of the two theories and then moved on to show some use cases.

We found that consulting firms and other sources, provide many use cases related to the topic but mostly with not enough information for our purpose. So, we picked the four with the most insights to introduce some cases from companies that already invested in Industry 4.0 and Digital Transformation. We closed the second chapter with these use cases to introduce the forma mentis adopted for the analysis of the companies.

In the third chapter we show the information collected during six interviews with managers from three Italian companies. The shape we gave to this chapter is similar to the one adopted in the second chapter: first an analysis of the supply chain, with concern of the relations and the critic points, highlighting how the IoT introduction will impact the relations and the information flow. Then we moved to the analysis of the Business Model basing the analysis on the CANVAS model. We did not cover all the "building blocks" of the model because we tried to focus on the most important aspects. For example, we did not highlight the costs structure since there were no relevant or outstanding data to show.

Our empirical investigation is based mainly on qualitative data: companies preferred not to disclose data. Also, the thesis will be confidential and there will be an embargo on the contents for a period of two years.

Chapter 1 – Understanding Digital Transformation

1.1 – Premise

Innovation has been identified as the core process leading to growth and economic expansion for a century. Every industrial revolution introduced new technologies, and every time, these technologies enabled different grades of innovation permitting economic growth at both company and market level (Schumpeter, 1934). Innovation can be considered as the trigger that redefine products, markets and industries and the reason behind the survival of existing firms inside a market (Utterback, 1971). However, innovation is not a static concept. It is considered one of the main source of competitive advantage permitting firms to shift their position inside the market, but, at the same time, it could be seen as one of major threats to company not able to deal with it (Porter, 1980).

In XVIII century the steam engine innovation gave birth to the first rudimental machineries, trains and the power loom. The textile industry faced a complete disruption and reshaping. In latter XIX century electricity was the main character among that period innovations, and made possible things such as the telephone, the light bulb, radios and the first assembly lines. Chemical and steel companies were flooded with new products and production means, and the automotive industry together with the telecommunication industry found the right nurturing to take flight. XX century put on the accelerator and thanks to the Information Technology around the 50s and the first computers permitted to handle information without paper, and moreover, to automate individual activities in the value chain. This phenomenon started a deep shift of the value creation from secondary to tertiary sector, other than giving birth to industries related to informatics and electronics.

Nowadays the rise of the internet, now a cheap and almost ubiquitous source, is revamping the effects of the IT revolutions from sixty years ago. IT are more and more pervasive, and nowadays its presence not only in machines, but also in everyday life products, is becoming a game-changing presence (Porter and Heppelmann, 2014; 2015).

Past industrial revolution always led to new products and production means, and the current historical phase we are facing is not so different: it’s a period in which physical and digital world are becoming closer and closer, and companies need to understand this transformation.

1.2 – How to Define Digital Transformation

Digital Transformation is one of the main discussed themes of these years. It stepped out form the pure engineering-related research field and it landed in the business industry, disrupting the traditional ways to do business. But how can we define this revolution that is changing so many aspects of our economy?

Digital Transformation is a process like every disruptive innovation (Christensen et al., 2015). It involves a shift of the business' operations along two major dimensions: 1) Digitization of Products and 2) Digitization of Business Models (Planing, 2016). This is a process driven by the large, scalable and affordable availability of computing means (Nordhaus, 2015) that is creating more and more tools allowing companies to discover and get new opportunities. In a narrow sense, Digital Transformation involves the use of computers and internet to develop and deliver digital products or to manage information flows to improve efficiency. In a broader sense, we can define it as the whole ensemble of dynamics related to the operations, interactions, configurations and value-creation inside a system powered by digital tools. It is an error to consider IT and Digital Transformation in a traditional way as function-related and we must start to think this transformation as a pervasive process inside all internal functions (Planing, 2016).

As the words Digital Transformation suggest, we are talking of a process that is not accomplished in the short-term but needs time to evolve and give out stable results. There are short-term actions to undertake but the main issue is starting to think of it as a long-term goal that needs to be achieved through smaller steps. In these years there are plenty of cases of big new companies, that started from simple businesses to grow becoming behemoth just like Amazon (Reddy and Reinartz, 2017). Or even old companies, that from traditional business are nowadays seen as tech-companies, like Nintendo, that starting over fifty years ago managed to shift its core business from card games to consoles and video games (Storia Nintendo, nintendo.it).

The process is completely driven by the last technology developments and because of that it needs to be handled by people understanding both new technologies and the way they are transferred to the economic environment (Singh and Hess, 2017). The new digital technologies are indeed the most influencing achievements of the last decades and are reshaping the way to do business in many aspects that we will discuss later on this thesis:

since the economy is based on relations, the fact that the introduction of technologies is reshaping the way we think relations, we must also reconsider the way we think the economy. So, the process we are referring to is deeply related to the way companies can transform their relations within them and with respect of external stakeholders.

To sum up, we can try to describe Digital Transformation with three keywords: 1) It is a Process, so it needs time and to act with a long-term approach; 2) It involves Technological and IT investments, in terms of assets and know-how, in order to develop the capability to exploit all the tools available; 3) It is a Business Transformation, in terms of culture and in terms of business organization, since new digital means reshaped the very essence of economics: relations.

1.3 – How to Design Digital Transformation

Digital Transformation has many facets and it is hard to outline a specific description. Because of all the themes involved in such a process it is useful to analyze them in four theme clusters (Bharadawaj, El Sawy, Pavlou and Venkatraman, 2013): 1) the scope of digital business strategy, 2) the scale of digital business strategy, 3) the speed of digital business strategy, and 4) the sources of business value creation and capture in digital business strategy. Reducing Digital Transformation to these four aspects (see Figure 1) is useful in order to develop a general framework to analyze specific cases.

It is important to keep in mind that Digital Transformation must be considered not separated from strategic decision making (Chan and Reich, 2007; Hirschheim and Sabherwal, 2001) since at the current state of IT and technologic improvements, digitization has become a pervasive presence in every aspect of business-doing: from supply chain management to digital-based products, from the new methods of Customer Relationship Management to the data analysis of real time control inside manufacturing facilities.

The fact that almost everything has been digitized, needs a business strategy point of view. The impact of Digital Transformation is not anymore a matter for just the IT function but a strategy matter: for example, considering just the launch of a new product, it is important to decide if and how it will be able to collect data from the customer and the environment, it will be important to analyze this data, it will be a key strategy to insert that product inside a so called “digital ecosystem” and moreover, it will be fundamental to be the main player inside

that ecosystem. These are just a few key decisions that every company looking for long-term success will need to answer and to embed inside their business models.

The *Scope of a Digital Business Strategy* is the key to understand where the boundaries of the strategy are. It helps to design and manage the relations among firms, industries, IT infrastructures and the stakeholders. The fundamental aspect to remember is that Digital Transformation is cross-functional, so the whole strategy must be enclosed under the umbrella of Digital Business Strategy considering digital resources as touch-points across different areas and sub-strategies. To formulate an effective Digital Business Strategy the design of products and services cannot diverge from the idea of merging them within the digital resources of the company in order to create an ecosystem where external information can be blended with information from the inside. The fact that products and services will need digital resources, being at the same time a digital resource themselves, make difficult to understand the real scope of a Digital Business Strategy and how it influences all the supply chain (Bharadawaj et al.,2013).

The *Scale of Digital Business Strategy* has been one of the first drivers of profitability for companies adopting Digital Business Strategy. The costs for digital infrastructure are rapidly and constantly decreasing (Nordhaus, 2008; Diane Coyle, 2016) making available faster and more efficient technology almost every six months. In this environment, where digital infrastructures are fused with business strategy, it is important to have the dynamic capability to effectively scale up new technologies in an effective way. To do this it is becoming more and more common to exploit Network Effects (derived from high number of users of a platform, being them customer or suppliers) and Alliances or Partnerships, even across unusual industries (e.g. Google and Levi's for Project Jacquard).

The speed has always been considered of primary importance in every business environment. The fact that digital economy is faster than traditional business environment makes so that the *Speed of Digital Business Strategy* is just more important than ever before. The way we gather information and the way we use it affect the speed of a strategy to take off (Eisenhardt, 2008) and when it comes to Digital Business Strategies there are four main dimensions influenced by digital transformation: 1) the speed of product launches, accelerated by pure-play digital companies, 2) the speed of decision making, since it is possible to gather huge amount of data and information it is vital to manage them faster than others; also this made possible to lower

barriers such as hierarchy and information flow inside companies, 3) the speed of supply chain orchestration, fundamental in many of the biggest companies working in retail at the moment, 4) speed of network formation and adaptation, in order to achieve higher scale effects.

Lastly, Bharadawaj et al. analyze the *Sources of Value Creation and Capture*. Digital economy relies on information, so modern business models are shaped in such a way that can be defined as "multi-sided business models", since it is common to use information as basis for multiple layers of value creation. Not only software houses but also more traditional companies are finding more and more profitable to operate with different, coordinated business models operating inside bigger networks across the supply chain (Bharadawaj et al., 2013).

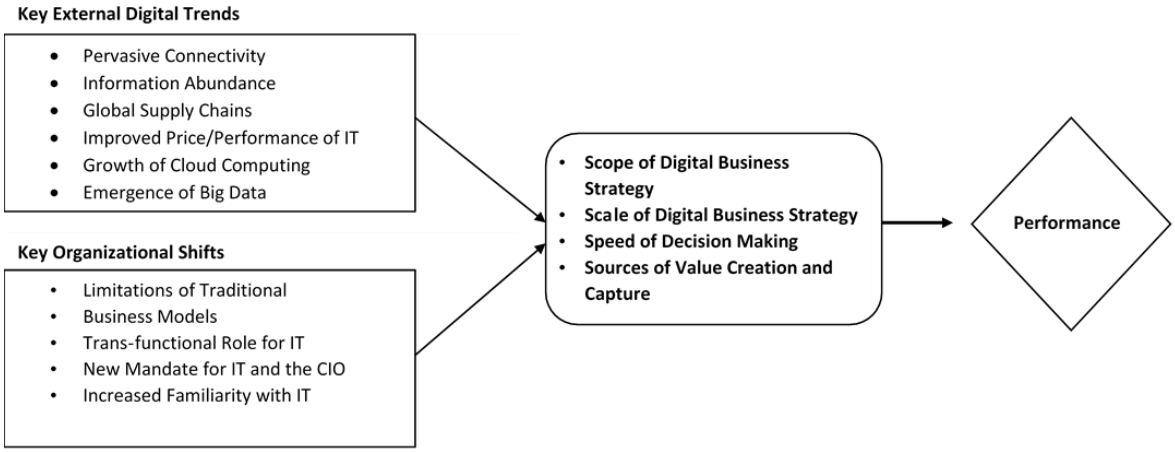

Figure 1 - Drivers of the Four Key Themes of Digital Business Strategy (Source: Bharadawaj, El Sawy, Pavlou and Venkatraman, 2013)

1.4 - The 9 Enabling Technologies of Digital Transformation

All the process described above is triggered by some specific disruptive technology that showed to be precious at the point that many countries started financing specific programs to enable Digital Transformation inside companies, especially SME. Industrie 4.0 in Germany, Industrie du Future in France, Manufacturing USA in America, and Industria 4.0 in Italy are just some of the ongoing projects financed by states. Each state defined different kind of solutions to help companies in the transition, but the target technologies are almost the same in every country. For example, Italy fostered Piano Nazionale Industria 4.0, an incentive plan for companies in order to spread nine key enabling technologies (KET) recognized as key drivers of innovation and value-creation (Rüßmann, et al., 2015):

1. Internet of Things (IoT) and Industrial IoT;
2. Cloud Computing;
3. Simulation;
4. Horizontal and Vertical Integration;
5. Autonomous Robot;
6. Big Data and Analytics;
7. Augmented Reality;
8. Additive Manufacturing;
9. Cybersecurity.

1.4.1 - Internet of Things (IoT) and Industrial IoT

The Internet of Things is defined as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies" by the International Telecommunication Union (Recommendation ITU-T Y.2060, 2012). We are used to relations between person and person and between person and device, but in the near future we will need to adapt to the relations between device and device.

The development of IoT is a multidisciplinary process that involves sciences, technology, business model design, public policies and modification in lifestyle. The main aspect of this infrastructure is the ability of so called smart objects to communicate with one another and build a network where information is created and shared. There are advantages for all sectors implementing IoT, from manufacturing to agriculture. The increased amount of information produced and available along the value chain is the key of this kind of technology and, thanks to the enhanced computing capabilities, the possibility to exploit this information is a disruptive improvement for the many different applications (Feola et al., 2017).

The massive diffusion of IoT inside Industry 4.0 plans in many countries is influencing the way people, governments, and companies interact. Most effects of the IoT would be visible to private users, in both, domestic and working life, for example in healthcare, domotics, assisted living and enhanced learning. In the case of business users, the main effects will be in logistics, intelligent transportation, automation and industrial manufacturing. Some opportunities that the information created by the IoT will have a positive impact on business are (Stergiou et al., 2016):

a) Smart power grids incorporating more renewable: improving system reliability and reducing charges on consumers providing cheaper electricity;
b) Engine monitoring sensors that detect and predict maintenance issues: this will improve inventory replenishment and even define priorities in scheduling maintenance work, repairs and regional operations;
c) Sensors in homes and airports: or even in shoes or doors, will improve safety by sending signals.

Beside the most common solutions, another branch of IoT is developing. Called Industrial Internet of Things (IIoT) is focused on industrial applications of IoT. According to David Floyer (2013) the two, main feature of IIoT are 1) The connection of industrial machine sensors and actuators to the internet and 2) the onward connection to other important industrial networks that can independently generate value. The difference with the consumer/social IoT is the value created (see Figure 2). When considering IoT the biggest part of value creation comes from advertising. IIoT manage the information produced by smart objects in a totally different way and the value created has three main components (Floyer, 2013):

1. The value of increased efficiency, ranging between 10% and 25%;
2. The value contribution to adjoining IIoT (e.g. balancing short term positive cash flow against long-term costs like maintenance);
3. The value created exploiting innovative business models, estimated to be between moderate to, in some cases, extremely high.

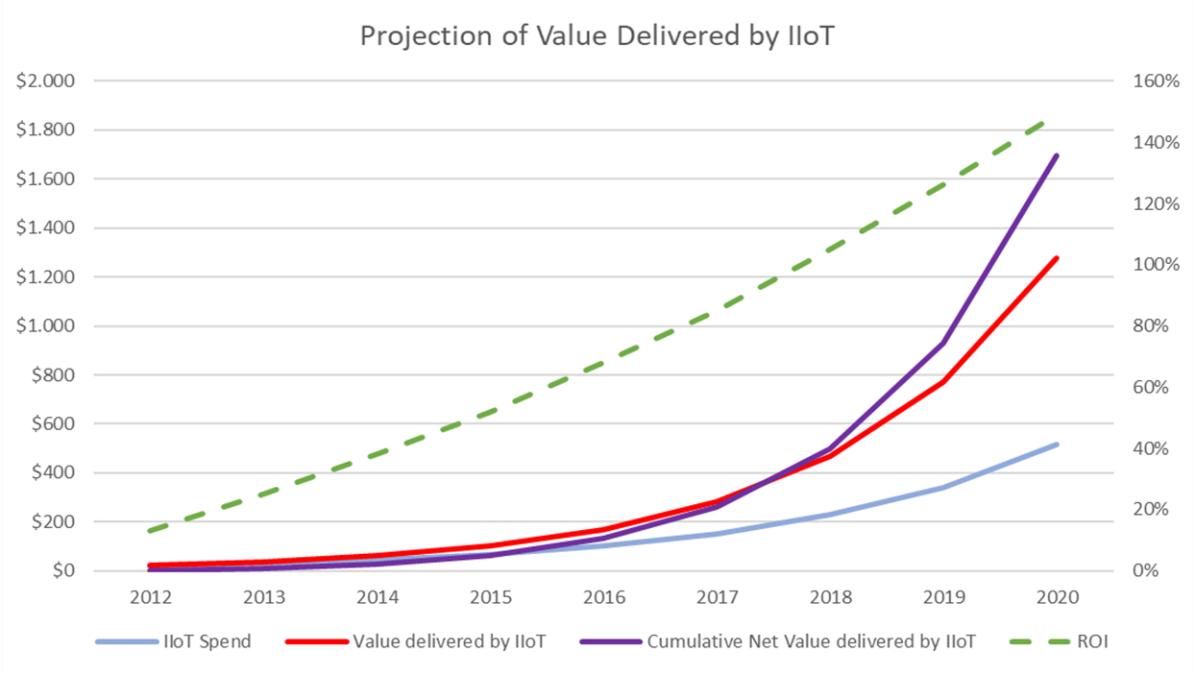

Figure 2 - Source: Wikibon, 2013

Especially operational efficiency is considered one of the key attractions of the IIoT, becoming a competitive advantage for early adopters. Just to give some data, by implementing automation and more flexible production techniques, manufacturers could boost their productivity by as much as 30 percent. Moreover, predictive maintenance could save up to 30 percent costs compared to standard management of maintenance works and avoiding 70 percent of breakdowns. (Daugherty et al., 2015). The counter-effect of embracing the path of IIoT is the increased competition with new digital entrants and even companies from very different industries (e.g. Apple with Apple's HealthKit, entering an ecosystem occupied by caregivers, insurers and pharmaceuticals).

1.4.2 - Cloud Computing

It is not simple to define Cloud Computing with all its feature in few words. The key characteristics of Cloud Computing could be sum up in the provision of ubiquitous, on-demand available, dynamically scalable, virtualized IT services and facilities to the customer based on the minimum intervention of the provider (Bogataj Habjan and Pucihar, 2017). Cloud Computing is the result of two main trends in IT: 1) IT efficiency, thanks to highly scalable hardware and software resources, and 2) business agility, using IT as a tool to gain competitive advantage (Marston, Li, Bhandhopadhyay, Zhang and Ghalsasi, 2011). Chen, Chuang and Nakatani (2016) consider Cloud Computing as a simplification of techniques to

use and manage computing resources. The services enabled by Cloud Computing are divided in three main categories (Loukis, Kyriakou, Pazalos and Popa, 2016):

a) IaaS, Infrastructure as a Service, through which the user gets access to remote use of providers' storage and computer facilities;
b) PaaS, Platform as a Service, including also operating system support and software development environment, for the development and deployment of applications;
c) SaaS, Software as a Service, software applications, given to use in remote, running on provider's systems and maintained by them.

Good examples of the mentioned categories are Amazon.com's EC2 (Elastic Compute Cloud) as an IaaS, Microsoft's Azure as PaaS, and NetSuite or Salesforce.com as SaaS. However, IT Outsourcing must not be misunderstood with Cloud Computing. The first usually is characterized by eight factors such as: 1) medium- to long-term contracts; 2) single customer per contract; 3) contracts based on performance, incentive or time and materials; 4) customized covenants; 5) negotiated pricing; 6) a single vendor; 7) a custom product; 8) specific relationship. Furthermore, the development of IT systems or services is fully customized (Choudhary and Vithayathil, 2013). Differently from IT Outsourcing, Cloud Computing has two faces: the advantage of low adoption costs, also thanks to the policies "take-it-or-leave-it", and the disadvantage of limited customization since it is a standardized service for mass market. (Choudhary and Vithayathil, 2013).

Why Cloud Computing represents a major shift in computing with respect to the IT outsourcing? Firstly because of dramatically lower costs, enabling SMEs to benefit of compute-intensive business analytics. Second, it provides almost immediate access to hardware resources without upfront capital investments, shifting from cap-ex (capital expense) model to op-ex (operational expense) model. Cloud Computing lowers IT barriers to innovation and permits to smaller enterprises to scale their services according to client demand. It also makes possible new classes of applications and delivers services like a) mobile interactive applications that are location-, environment- and context-aware (e.g. sensors); b) parallel batch processing, allowing users to benefit of huge amount of processing power; c) customer profiling through business analytics; d) extension of compute-intensive desktop applications that will leave the processing to the cloud keeping the rendering (Choudhary and Vithayathil, 2013).

1.4.3 – Simulation

Before introducing the Simulation technology, it is useful to discuss briefly of the environment in which such IT application can produce the most effective effects. The Digital Enterprise Technologies (DET) concept is "*the collection of systems and methods for the digital modelling of the global product development and realization process in the context of life-cycle management*" (Maropoulos, 2002, as cited in Pfeiffer, Kadar, Monostori and Karnok, 2008). So, to effectively use tools such as Simulation technology it is paramount to start mapping all the processes running on the shop-floor. In this way all data can be digitalized and transported inside simulation environment.

Simulation is one of the key technologies inside DET and it is a powerful tool when working on design and analysis of complex systems. It is a computer model that tries to recreate specific environments, such as the workflow of a manufacturing process or the functioning of a product, in order to get the most information before the process or the product is actually created. This is called pre-processing and it is very useful especially when trying to structure a new process or test in advance some feature of a product.

Beside the off-line decision making regarding pre-processing, Simulation is a powerful tool when it comes to on-line decision-making. As stated by Pfeiffer et al., the DET environment is the most suitable to use Simulation in real-time control. The limit that until a few years ago this method encountered were related to the computing power and three main issues regarding 1) data acquisition, 2) quick response and 3) instantaneous feedback. DET is supposed to provide all the data and the responsiveness of the system needed to use a real-time simulation able to help understand in real time problems inside a manufacturing line.

The data required for the simulation should have two main features: availability and quality. The first depends on the quantity of data measured or recorded, the latter depends on the errors made when recording or measuring. For this reason, all the software tools used to build up simulations are usually equipped with data sharing interfaces (Mourtzis, Papakostas, Mavrikios, Makris and Alexopoulos, 2015).

With the high computing power that nowadays is largely available 3D Factory Simulation is becoming a breakthrough technology especially for machine builders, system integrators and manufacturers allowing them to simulate their total process and learn from the simulation how

to cut down on waste and save materials costs (Walter, 2012). "Ferdinando Cannizzo from Ferrari said that the company's aim for the near future is to conduct 90% of the testing and development of its vehicles solely using simulation software, before physical validation of the results in real-world tests. This is largely because of the advances that have come in simulation software as well as in Internet of Things (IoT) technology" (Blake, 2016). The IoT is making it possible to create a digital twin of a factory that combines real-time data about a physical product with the organization's digital information about the product, thus, it is possible for companies to extract more value from their processes using this information combined with Simulation models (Ansys Inc., 2017).

1.4.4 – Horizontal and Vertical Integration

New technologies regarding data collection, storage and management, are increasing the importance of data inside the overall supply chain. Big Data are becoming more and more disruptive inside value chain dynamics (Waller and Fawcett, 2013) and the integration of these data across the supply chain is becoming a key success factor when it comes to Supply Chain Management (SCM).

Data integration generally refers to the implementation of standard definitions, codes and terminology inside a structure with the aim of adopting a common conceptual schema (Heimbigner and McLeod as cited in Goodhue, Wybo and Kirsch, 1992).

Supply Chain Management is "a digitally enabled inter-firm process" (Rai, Patnayakuni and Seth, 2006) meaning that one of the key to successfully handle the process are digital sources. SCM strategies try to improve and innovate processes between firms and customers. Through case studies, it has been shown that supply chain fragmentation represents a problem for companies' efficiency, while good IT skills have been documented as a positive factor influencing the issue (Rai et al., 2006).

Thus, IT and particularly the Internet are the big factors fostering Supply Chain Integration. While the most visible consequence of the Internet is seen in the emergence of the Electronic Commerce as a new retail channel, it is likely that a deeper impact on business to business relations is happening (Lee and Whang, 2001).

Internet is redefining the back-end operations' conduction (procurement, design and development, production, inventory, distribution, after-sales service support), altering roles, networks and business models (Lee and Whang, 2001).

However, data integration across the supply chain cannot be considered separate from information sharing. SCM is deeply affected by the information sharing between players inside the chain to coordinate interorganizational business activities (Wong, Lai, and Cheng, 2012). Again, it is critical to develop electronic connectivity among companies to access and share information. Wong et al. (2012) label this connection as *"information integration"*, considered essential but needing to be handled carefully, since sharing information does not lead automatically to cost reduction and efficiency inside the supply chain. Performance and value creation rely on business environmental conditions and operating characteristics (Wong at al., 2012).

To sum up, the concept of Horizontal and Vertical Integration inside Industry 4.0 plans can be considered as the implementation of new technologies to create a network in which a focal firm use its IT capabilities to transfer consistent and high-velocity information (Rai et al., 2006) to the supply chain's companies.

1.4.5 – Autonomous Robots

In order to remain competitive in a globalized environment, manufacturing companies constantly need to evolve their production systems and accommodate the changing demands of markets (Pedersen et al., 2006 as cited in Kocsi and Oláh, 2017). Robots are not new in large facilities running fixed and repetitive processes. For example, hey have traditionally incorporated automated guided vehicles (AGVs) to move materials along fixed routes. But, according to what said above, if technology upgrade, the manufacturing processes upgrade as well, and with that, also the manufacturing facility need to be updated (Mullen, 2017). The market trend is shifting from mass market to mass customization (Pichler et al., 2017) so the future production systems must meet new flexibility requirements. The strong product individualization and, with that, the need for highly flexible production processes are pushing companies to adopt more and more innovative solutions to solve the issues related with manufacturing. Robots ensure high quality and flexibility and help companies meet efficiency standards to save on fixed costs.

According to the International Federation of Robotics (IFR), there are 1.7 million industrial robots installed in today's factories with 230,000 installed in the last year alone and 15% annual growth expected. As more industrial robots are being installed, they are also getting smarter (Smelík, 2016). "These improvements are helping to drive demand. In fact, we expect the global industrial robot population to double to about four million by 2020, changing the competitive landscape in dozens of fields" (Miremadi et al., 2015). Modern robots are considered "smart robots" since the aim of their technology is to work side-by-side with human. Because of that, this new kind of robot requires a fast and precise mutual understanding with the human worker. Specifically, the robots are designed to assist humans in given tasks understanding, interpreting and eventually interacting with human actions (Pichler et al., 2017).

To sum up, the reasons behind the success of modern robots are related to three main trends: 1) they are cheaper, according to the data their costs have fallen by about 50%, 2) they are smarter and more autonomous, thanks to advancements in sensor technology and guiding algorithms and 3) safety systems, making the human-robot work more efficient (Miremadi et al., 2015). Smart robots are already moving huge quantity of money. According to Goldberg (2016) Germany approved a $5B sale of Kuka to Midea Corp in China to provide robots for assembly automation. General Electric Corporation is now focusing on automation algorithms and data analytics and predicts this will be a $225 billion market within five years. Moreover, "Industry leaders are already capturing value. A multinational company struggled for years to coordinate the flow of multiple products and steam pressures among the units of a fertilizer operation, resulting in an estimated 10% in lost revenues. Engineers installed sensors at each step in the process and an artificial intelligence and machine learning system to track and adjust changes in flows across units. Efficiency improvements have cut the revenue losses by three-quarters so far, in effect boosting revenue by 7% to 8%" (Miremadi et al., 2015).

1.4.6 – Big Data and Analytics

Modern digital economy has its foundation on the information produced by digital activities. Data have become a key source of value, and companies are producing and collecting it in huge amounts. "Companies churn out a burgeoning volume of transactional data, capturing trillions of bytes of information about their customers, suppliers, and operations. millions of networked sensors are being embedded in the physical world in devices such as mobile phones, smart energy meters, automobiles, and industrial machines that sense, create, and

communicate data in the age of the Internet of Things" (Manyika, Chui, Brown, Bughin, Dobbs, Roxburgh and Byers, 2011). All the amount of data collected is defined Big Data, even if this is not a precise definition. Some scholars argue that Big Data should be described as a "moving definition" which varies with time as well as industrial sectors (Sheng, Amankwah-Amoah and Wang, 2017).

According to McKinsey Global Institute Big Data usually refers to "datasets whose size is beyond the ability of typical database software tools to capture, store, manage and analyze" (Manyika et al., 2011). It is not a specific, narrow definition since it is impossible to set a specific amount of data to consider "standard", moreover, this amount of data is assumed to grow with developing of new technologies and IT solutions to handle big amount of data. Collecting digital data is not a new tool that companies use to improve themselves, however, until a decade ago, "many companies remained data rich and information poor" (Pigni, Piccoli and Watson, 2016) and just recently the tools to gather useful insights from huge amount of data started spreading also to smaller, or IT-follower, companies thanks to a variety of analytics techniques that has spread in the last years: i.e. predictive analytics, data mining, case-based reasoning, exploratory data analysis, business intelligence, machine learning techniques, and so on (Tan, Ji, Lim and Tseng, 2017). This variety of tools are considered a pillar of all the Industry 4.0 plans, because the most complexed methods capable to handle big volume of unstructured data are still not well established or companies do not understand their real value.

There are many applications of big data analytics, for manufacturers these tools can drive the value creation through cost savings and enhanced quality (see Table 1). Efficiency and customization will be the levers to exploit (Manyika et al., 2011). Moreover, the increasingly digitalization of routine activity, both side, company- and customers-side, leads to a fast and constant flow of data called Digital Data Stream. Handling DDS will create even more value since it will enable not just ex-post data analysis (such as customer profiling) but primarily real-time processing and event response (e.g. algorithmic trading).

Big Data levers can deliver value along the manufacturing value chain in terms of cost, revenue, and working capital

	Lever examples	Impact: Cost	Impact: Revenue	Impact: Working capital	Subsector applicability
R&D and design	- Concurrent enngineering/PLM	+20-50% PD costs	-20-50% time to market		High - Low complexity
	- Design to value	+30% gross margin			High - Low complexity
	- Crowd sourcing	-25% PD costs			B2C - B2B
Supply chain management	- Demand forecasting/ shaping and supply planning	+2-3% profit margin		3-7% onetime	FMCG - Capital goods
Production	- Sensor data-driven operations analytics	-10-25% operating costs	Up to 7% revenue		Capital intense - CPG
	- "Digital Factory" for lean manufacturing	-10-50% assembly costs	+2% revenue		Capital intense - CPG
After-sales services	- Product sensor data anlysis for after sales service	-10-40% maintenance costs	+10% annual production		Capital intense - CPG

Table 1 - Expert interviews; press and literature search (Source: McKinsey Global Institute analysis, 2011)

1.4.7 – Augmented Reality

Augmented Reality (AR) is not a new concept. Harvard Business Review (Porter and Heppelmann, 2017) describe the basic equipment in a camera-equipped device loaded with AR software (see Figure 3). "When a user points the device to an object, the software recognizes it through computer vision technology, which analyses the video stream. The device then downloads information about the object from the cloud, in much the same way that a web browser loads a page via a URL. A fundamental difference is that the AR information is presented in a 3-D "experience" superimposed on the object rather than in a 2-D page on a screen" (Porter and Heppelmann, 2017).

The first AR application appeared in the 1990's when Caudell and Mizell (1992) firstly reported a patent for the use of Augmented Reality in aircraft manufacturing. Other applications for AR have been around for decade but just in recent years it has become possible to exploit the full potential of this technology. At the core Augmented Reality use data and analytics conveyed by products or machinery to convert the input into images or animations overlaid to the physical world (Porter and Heppelmann, 2017). It is considered a highly promising technology that through the visualization of multiple layers of computer graphics over the real world will benefit those who work in a busy environment (Yew, Ong

and Nee, 2014). According to ABI research the value of AR market by 2021 will increase to $96 billion, and 60% will be addressed to industrial and commercial use. (Tynan, 2017).

Consumer applications have been developed, like Snapchat or Pokémon Go, and AR devices are increasing their market penetration, like Oculus Rift, Samsung Gear or HTC Vive. But AR "it's no longer just for fun and games" (Kugler, 2017) and it will reshape the way we work. According to Kugler (2017) AR is useful in many field of operation. It is useful to train people faster using real time digital models, from doctors to customer service staff. By overlaying digital information over real objects AR allows to mentally process digital and physical information simultaneously, without need to bridge them (Porter and Heppelmann, 2017). Also, it helps manufacturer to better collaborate on designing and maintaining of components. 3D models could change the way manufacturers work: a field engineer instead of travelling between locations could work, refine and design products without moving from the home office, together with colleagues from anywhere in the world (Kugler, 2017). According to Porter and Heppelmann (2017) the key capabilities of AR are three: 1) Visualize, revealing internal and external feature that would be difficult to see otherwise, 2) Instruct and guide, providing real-time, on-site, step-by-step visual guidance training, instruction and coaching are completely redefined, and 3) Interact, using user interfaces superimposed to the actual product or machinery AR redefines the already old concept of touch-screens. The main steps of the value chain that will be redefined are (Porter Heppelmann, 2017):

a) Product development, giving life to 2-D CAD models;
b) Manufacturing, providing real-time information enabling monitoring and diagnostic at a completely different level compared to now;
c) Logistics, AR replaces standard paper-based or screen-based tasks inside warehouses;
d) Marketing and Sales, showrooms and product demonstrations have been redefined. Also, brick-and-mortar stores may end up being less important since e-commerce could improve even more its shares thanks to downloadable product holograms.
e) After sales service, in which AR hides a huge potential, giving to consumer the same opportunities of technicians in shop-floor to use the data generated by the product and through analytics to convey a full product assistance, for example, to repair or maintain.

f) Human Resources, in this field AR is already used by some companies, or even the Navy, to train new personnel.

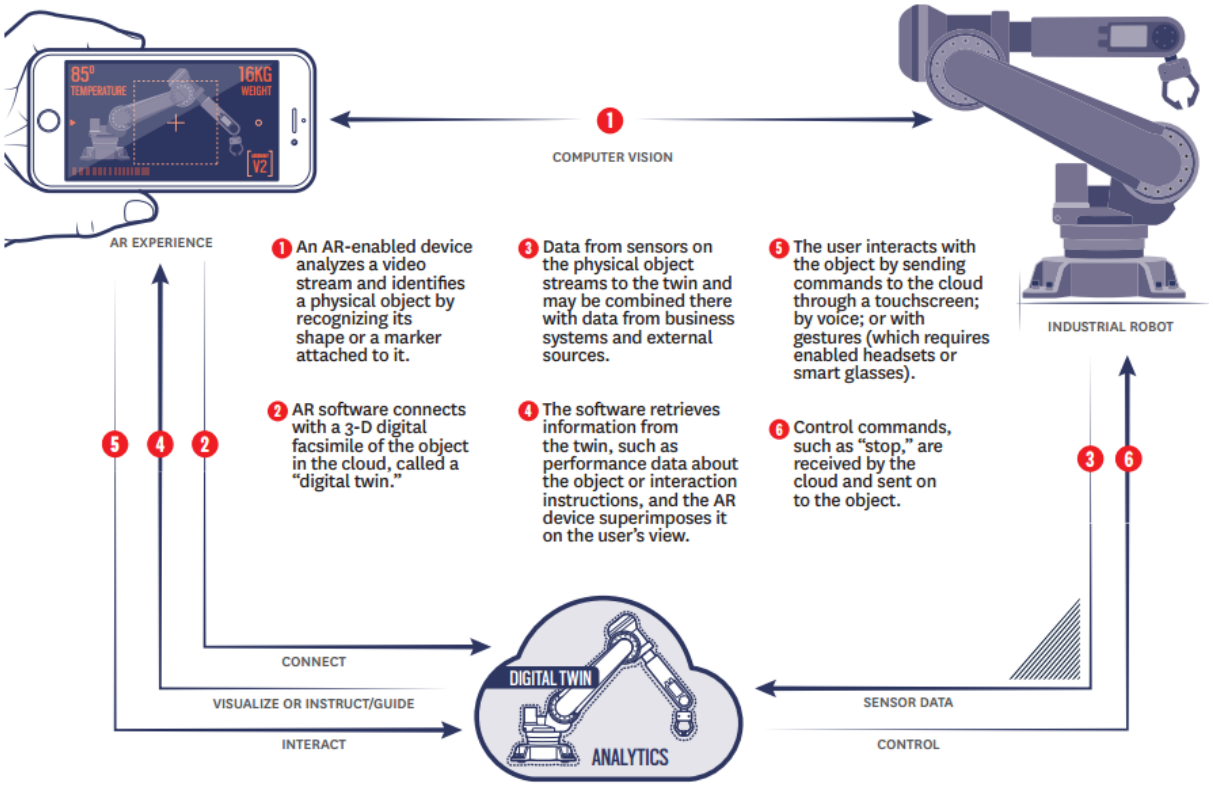

Figure 3 - How Does Augmented Reality Work? (Source: Porter and Heppelmann, 2017)

1.4.8 – Additive Manufacturing

In an ever-shrinking world, due to technologies, global competitors and new heterogeneous customer demand, organizations must be flexible. To survive they must serve diverse markets with varying demands. Flexible Manufacturing Systems (FMS) allow companies to do so. Producing small- or moderate-sized batches of many various products is a key success factor for many organizations in many industries (Belassi and Fadlalla, 1998). With its characteristics Additive Manufacturing (AM), or 3-Dimensions Printing, becomes a key tool inside an FMS.

Rapid Manufacturing (RM) is a similar concept involving Additive Manufacturing. It is defined by Hopkinson, Hague and Dickens (2006) as "the use of a computer aided design (CAD)-based automated additive manufacturing process to construct parts that are used directly as finished products or components". According to them, AM is, again, the key to innovate traditional manufacturing systems and manage more efficiently and effectively all

the processes between the product idea and the sale. Why AM is considered such a disruptive technology?

Unlike other technologies, Additive Manufacturing manages to influence the most different industry, and it is attracting interests from engineers as well as medical clinicians (Hopkinson, et al., 2006). Additive Manufacturing is a wider definition of many available processes, including Stereolithography (SLA), Fused Deposition Manufacturing (FDM), Selective Laser Sintering (SLS), laminated object manufacturing and others (Niaki and Nonino, 2016). All these production systems share the AR definition because they are basically manufacturing processes using a 3-D digital blueprint to fabricate an item adding layer-by-layer the material needed to produce the final product (Achillas, Tzetzis and Raimondo, 2017). Already used in many industries, AM is expected to grow even more thanks to various advantages such as (Achillas, et al., 2006) production of one-of-a-kind products without high initial costs, high speed for injection mold making compared to other traditional processes and the possibility to follow heterogeneous demand and current trends and need for mass customization.

Additive Technologies development can be divided in three steps (Niaki and Nonino, 2017):

1. Created for New Product Development, useful for designers and creation of prototypes;
2. Developed to produce end-use parts, a step defined “direct digital manufacturing”;
3. Current use of 3-D printers, available also to final customers.

Leaving aside the most engineer-related applications and definition, we can state that AM is bringing with her many economic advantages to companies able to “deeply understand the process taking place within the additive manufacturing machine, to understand the materials and how they are changed in the additive manufacturing process, and then to rethink their production process to identify where the new capabilities can, well, transform the business” (Hans Lenger in Panchak, 2016). Since there are so many processes undergoing the transformation, managers need to understand very well their company. The introduction of AM in the manufacturing process influence both side, revenue generation and costs management (Ryan, Eyers, Potter, Purvis and Gosling, 2017):

- Transportation costs
- Lead times

- Inventory
- Product quality and reliability
- Production flexibility
- Productivity and scale economies
- Supply chain sustainability
- Business Models
- Opportunities for new suppliers.

An interesting aspect involving the cost cutting possibilities is shown by Hopkinson, Hague and Dickens (see Figure 4): current AM results under best practices on part production cost breakdown of:

- 50-70% for machines;
- 20-40% for materials;
- 5-30% for labor.

AM is a strong disruption also outside the internal processes. This fact, for example, leads Berman (2012) to draw a strong line between mass customization and additive manufacturing. As shown in Table 2 there are indeed some key differences between the two involving different supply chain management and integration, with consequences at business-model level. As Bartel (2015) pinpoints, AM is not anymore just a tool for engineers and designers, but it has already become a strategy tool that strategists inside companies must know and understand "to enable innovation and add value to overall operations" (Bartel, 2015).

Characteristic	Mass Customization	3-D Printing
Manufacturing Technology	Based on pre-assembled modular parts in different combinations or delayed differentiation.	Automated manufacturing based on CAD software and additive manufacturing.
Supply Chain Integration Requirements	Need for highly-integrated supply-chain management to ensure right goods at right times from multiple supplies.	Uses readily available supplies available from multiple vendors.
Economic Benefits	Ability to produce custom products at relatively low prices. Low inventory risk. Improved working capital management.	Ability to produce custom products at relatively low prices. Low inventory risk. Improved working capital management.
Range of Products	Computers; watches; windows; shoes; jeans.	Prototypes; mockups; replacement parts; dental crowns; artificial limbs.

Table 2 - A Comparison of Mass Customization and 3-D Printing (Source: Berman, 2012)

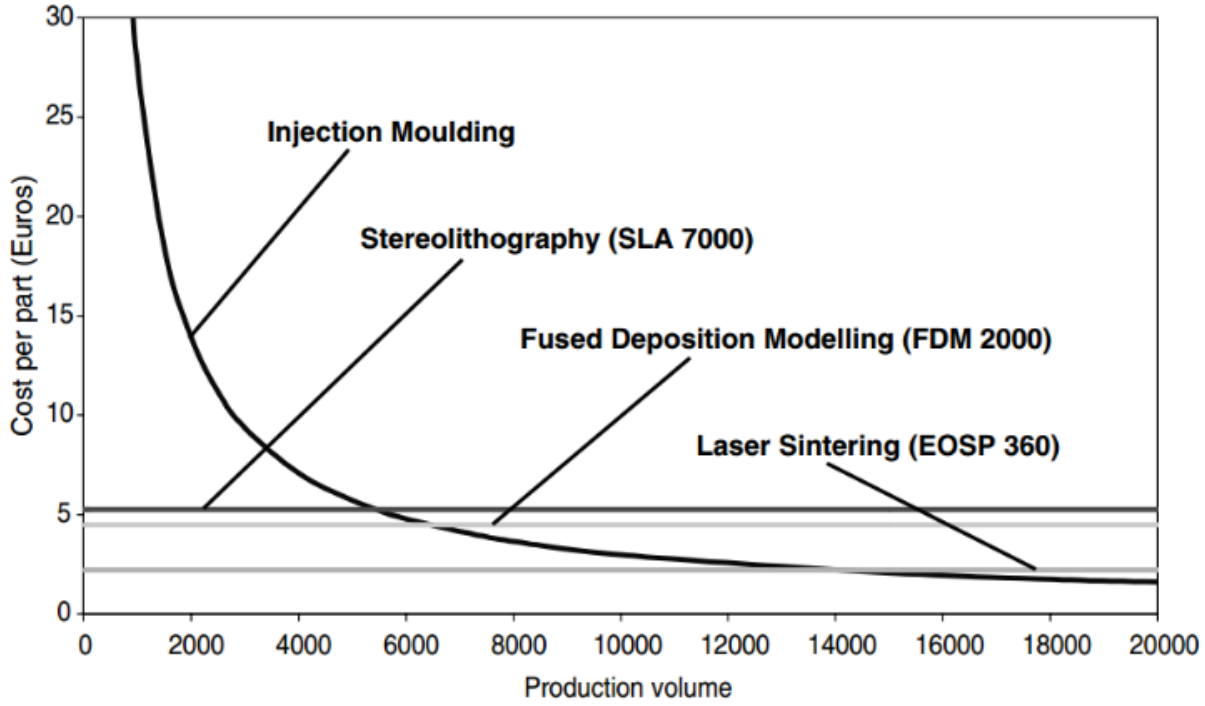

Figure 4 - Cut-off volumes for the 3.6 g part by different processes (Source: Hopkinson et al., 2006. Chapter 9)

1.4.9 – Cybersecurity

We entered an era in which society tries to digitize everything valuable, thus, while the value is carried online, at the same time, crime is also going online. It is not just a matter of data, but with the possibility carried by Internet of Things (IoT), also the physical world can be affected. The IoT would embrace so many devices, with so many different applications that successful hacking attacks will impact human lives (Lindqvist and Neumann, 2017). This is why Cybersecurity is a hot topic when it comes to digital transformation.

"Cybersecurity" describe a wide group of security issues related to the internet. According to Weber and Studer (2016) "no standard or universally accepted definition of the term exists". O'Donoghue (2012) remarked in an article for the Internet Society that "Cybersecurity" is an inexact catchword meaning an "endless list of different security concerns, technical challenges, and "solutions" ranging from the technical to the legislative." It is a term whose exact definition is still evolving since not every crime occurring online can be considered a Cybersecurity problem (O'Donoghue, 2012). More in details, it could be defined as "the collection of tools, policies, security concepts, security safeguards, guidelines, risk management approaches, actions, training, best practices, assurance and technologies that can

be used to protect the cyber environment and organization and user's assets" (Weber and Studer, 2016).

Indeed, Cybersecurity involves not only technical expertise, but also, and mostly, laws at government level and training for workers. 45% of all breaches in 2015 were due to insiders, and 95% of those, were due to human error (IBM Research in Perez, 2016). This statistic demonstrate how much important is to educate modern workforce to digital awareness.

For example, researches show how the so-called Shadow IT is grown inside companies: Shadow IT is the term used to define all the IT systems and solutions built or used inside the company without the permission of the technical department (Wilson, 2017). It goes from using personal USB pens, to installing unauthorized software on the computer, to even installing macros on Excel. In a Stratecast survey 80% of workers admitted using Shadow IT, and Gartner estimate that 30% of cybersecurity compromises will be due to Shadow IT by 2020 (Wilson, 2017).

Some data about Cybersecurity collected by Nagurney, Daniele and Shukla (2016) reveal the economic scope of the Cybersecurity issue for companies: JPMorgan in 2014 had been hacked affecting 76 million customers. Retail giant Target had data stolen of 40 million payment cards and around 70 million other personal records. Reports as of 2014 estimate an annual cost of more than $400 billion for global economy due to cybercrime (CSIS research in Nagurney et al., 2016), or more than $500 billion according to others (IDC research in Greengard, 2016).

More recent cyber-attacks are starting to use connected devices. A recent DDoS attack that targeted the service provider Dyn, seriously interfered with accesses to major services such as Twitter, Amazon, Tumblr, Reddit, Spotify and Netflix. The attack involved tens of millions of compromised devices, while previous of the spread of IoT the range was the hundreds of thousands of devices (Lindqvist and Neumann, 2017).

Digital crimes increased of 19% in the last year according to Ponemon Institute's 2015 Cybercrime Study and now they cost $7.7 million on average to companies worldwide (Greengard, 2016). Moreover, Cybersecurity is becoming more and more a shared issue across the supply chain: the investments in cybersecurity made -or not- by a player of the supply chain will affect other players. So, the fact that suppliers, IT infrastructure and other

gears of the supply chain are shared increase the probability of a successful hacker attack due to common vulnerabilities (Nagurney et al., 2016)

Some best practices to avoid cyber-attacks suggested by Wilson (2017) are:

- Employees education;
- Establish data classification models, defining levels of confidentiality;
- Strong data encryption;
- Implement and Audit firewall policies;
- Work with employees and Business Units to improve or implement cloud solutions;
- Define internal cloud usage standards;
- Implement a threat monitoring solution;
- Utilize a shadow IT discovery tool.

1.5 - How Digital Transformation Reshaped Businesses: Some Data

Even if Digital Transformation is a process underway, many researches already focused on this theme and many companies as well as academics started to gather data about what is going on inside those firms that are already embracing this transformation.

First it is useful to think that just few companies have already achieved a stable and complete degree of digital transformation, only 5% out of 1000 companies interviewed “Stage 4 – Transformed”, while the great majority of them was between “Stage 2 – Emerging” (41%) or “Stage 3 – Evolving” (42%) (De Mattia, 2017). This data was collected by Adam de Mattia for a research insights paper in April 2017 commissioned by Dell EMC to ESG and showed how just few companies are not moving to keep up with change. This difference in the grade of digital awareness can be found as a deep competitive advantage for those companies considered Transformed: they outperform the so-called Legacy companies (12%) in terms of business agility, being able to complete IT projects ahead or behind of schedule 34.2% of times, against 11.3%. This capability to be faster in terms of project completion permits to develop more project than competitors and create more value.

Despite the data stating the benefits deriving from successful digital transformation, in terms of customer experience and operational improvements, an interesting report by Fitzgerald, et

al. (2013) for MIT Sloan Management Review, highlights that a sort of paradox is evident. The article starts dividing the sample of companies participating their interview in four categories of digital-awareness. After that, it shows how digital companies, defined "Digirati" (15% of the sample) strongly outperform other companies in terms of revenue creation (+9%), profitability (+26%) and market valuation (+12%) compared to the average (Kruschwitz et al., 2013, p. 5) 82% of CEOs interviewed define Digital Transformation as a problem that needs to be faced in a very short term (from now up to maximum two years), however, their organization lack of the urgency of undertaking the process (40%), this because of many reasons, from the fact that old companies are usually more rigid, to problems like vision and motivation at management level.

In a research made by CISCO (Macaulay, et al., 2015), the researchers try to answer to the problems that manufacturer have to face these years with the digital technologies spreading ever more and with a globalized world that create problems with labor-based competition. The first insight from the research is that almost every company interviewed (92%) stated that their business model will have a shift from standard manufacturing (the sample comprehend different industries, from both machine builders and end users) to a service-oriented business model in various degree, from large extent (67%) to a moderate degree (25%). This reflects the intention of many players to exploit the opportunities of digital technologies to change their business model, or at least include in it, and achieve higher expected profitability brought by servitization. Many respondents think that the major revenues will come from the synergy with the core business centered on the product. 38% of them see servitization as a way to reduce costs and improve productivity, and 36% think that it is useful mainly to deepen relations and deliver more value to the customer. However, even if they continue to see the product as the core of their business, 86% of them expect their revenues to be driven from moderately (38%) to a large extent (58%) by services enabled by digital technology.

An interesting analysis made by BCG (Rüßmann et al., 2015) shows how embracing digital transformation is leading German companies that moved to Industry 4.0 to perform better than the competitor that did not decide to invest in new technology. Industrial component manufacturers are expected to achieve the best results, with big improvements in productivity (20-30%) and the whole market would benefit of a 6% increase in employment rate.

1.6 - Conclusions

Digital Transformation influences almost every value-creating area, and other than the right investments in technology and know-how it is paramount to spread digital culture across organization if you want the transformation to last in the long term. Digital Transformation and spreading a Digital Culture are two issues that need to be planned considering four aspects:

1. The scope of the investment in technology
2. The spread of organizational need-for-transformation across the company
3. The capability of acquiring a cross-functional digital-oriented culture
4. How to manage the pace of further innovations. In the long-term every innovation will develop differently for every company, requiring different future investments.

Digital Transformation is influencing companies and society worldwide, this is why almost all the countries are adopting economic plans to face the so-called Industry 4.0 revolution. There are some key technologies that are recognized to be the most influencing in business for the next years, thus companies must decide whether to face the revolution investing in new technologies or risk to stay behind.

In the next chapter we will see two strategic aspects in which digital transformation will disrupt the way they have been managed until now: Supply Chains and Business Models. The first largely innovated thanks to modern information production and analysis systems, the second being rethought to include new opportunities for new digital products and, especially, services.

Chapter 2 – How Digital Transformation Influences Business Models and Supply Chains

2.1 – Premise

In this chapter we go deeper in some strategic aspects of Digital Transformation. As said above, Digital Transformation is a process involving almost all companies' areas. From marketing to logistics, from manufacturing to post-sales management. We will introduce the concepts of Supply Chain and Business Model, and we will discuss about the way they are influenced by new technologies. We will see that Supply Chain Management has been deeply influenced by technologies such as IoT (Porter and Heppelmann, 2014), Big-Data analytics (Manyika et al., 2011). To discuss about Business Models, we decided to start considering the Canvas framework (Osterwalder and Pigneur, 2010) to guide our analysis. Then we will move forward describing how business models evolve to embrace digital disruption and we will provide some examples based on real cases collected by academics and international consulting firms.

2.2 – Supply Chain and Supply Chain Management

Supply Chain is a basic concept that academics have studied since long time. It is an important factor to analyze when it comes to understand the profitability not only of the industry but also of the specific companies operating inside the chain. The basic concept of how a supply chain is shaped and how it should work belong to the common knowledge: as the name suggests, we can imagine a group of companies that one after the other contribute adding value to the final product, and, as the links of a chain, they are strongly and tightly interdependent.

2.2.1 – Overview of the concept

There are many academic definitions of what a supply chain is: following Hult, Ketchen and Arrfelt (2007) we can define Supply Chains as "value-adding relations of partially discrete, yet inter-reliant, units that cooperatively transform raw materials into finished products through sequential, parallel, and/or network structures". In this definition the authors underlined the relations-based entity of the supply chain, that manages to add value at each step thanks to the network of companies involved.

Chopra and Meindl (2016), instead, adopt a more functional point of view and focus on the physical transformation of the product, meant as both manufacturing and transportation and implying the presence of parallel relations across different supply chains (see Figure 5). Because of these inter-relations they also propose the label "supply network". The two authors defined the supply chain as the ensemble "of all parties involved, directly or indirectly, in fulfilling a customer request. The supply chain includes not only the manufacturer and suppliers, but also transporters, warehouses, retailers, and even customers themselves. Within each organization, such as a manufacturer, the supply chain includes all the functions involved in receiving and filling a customer request. These functions include, but are not limited to, new product development, marketing, operations, distribution, finance, and customer service" (Chopra and Meindl, 2016).

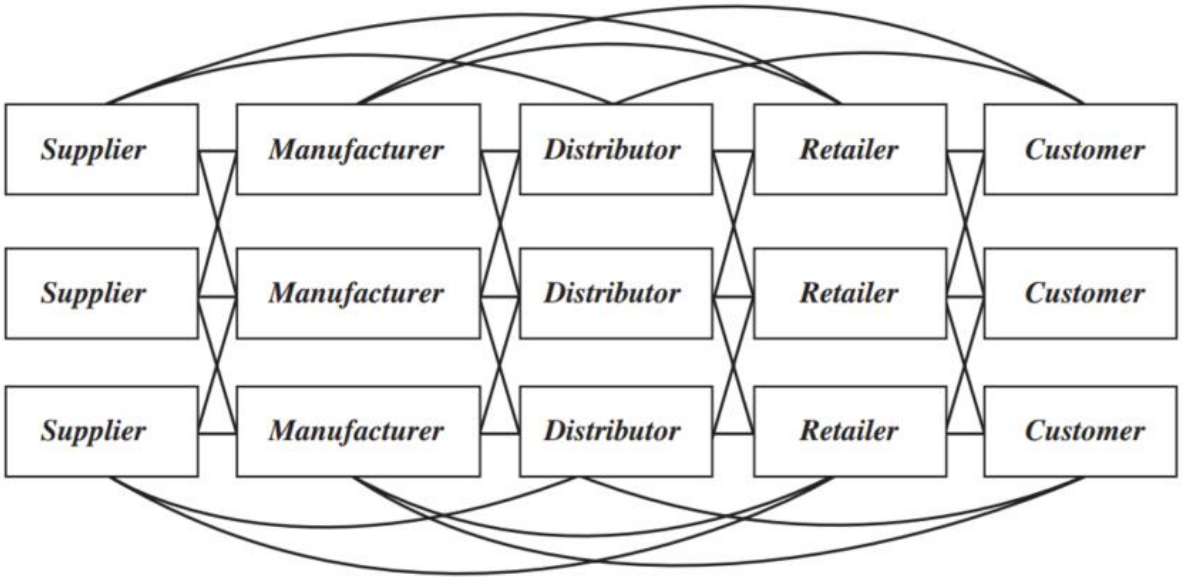

Figure 5 - Supply Chain Stages (Source: Chopra and Meindl, 2016)

However, no definition will be able to encompass all the characteristics and the facets of a supply chain. Supply chains have various and heterogeneous players of different dimensions, geographical scope and bargaining power. The differences among the players make the supply chain a dynamic entity: not only economic and technology factors, but also laws, regulations, sustainability agendas and strategic choices influence the overall structure of the chain and the relationships among companies (MacCarthy, Blome, Olhager, Srai and Zhao, 2016).

These differences, together with the different flow of information across the supply chain, give birth to the so called "bullwhip effect". This is a distortion of the information that flows across the chain causing problems related to inventories and production since the first data being produced by the customer itself do not spread correctly upstream, from the retailer to the supplier (Lee and Whang, 2001). This information distortion is well-known since a long time; it was Jay W. Forrester (1958) one of the first to try to measure this distortion. In his work he starts from ex-post data regarding retail-level sales, increased of 30%, caused the increase of 400% in the factory production at manufacturing level. These findings made him research the reasons behind this phenomenon. The answer was that the estimation for the sales together with the little delays related to information management (accounting, mailing, purchasing…) influenced the budget for the inventory at every step of the supply chain causing every time an increase in the production and a consequent higher demand for materials in inventory (Forrester, 1958).

Since "the objective of every supply chain should be to maximize the overall value generated" (Chopra and Meindl, 2016), the "bullwhip effect" is one of the main problems detectable when managing the inbound and outbound logistic and this is one of the reasons for it is becoming more and more important implementing and studying the Supply Chain Management.

Among the forerunner of the Supply Chain Management (SCM) we have Oliver and Webber (1982). In their work they used the term "Supply Chain Management" to define the techniques used in management of inventories in order to decrease stocks. In the last years the Supply Chain Management (SCM) has become more and more one of the key success factor for many companies. The exasperated competition in some industries shifted from "company vs. company" to "supply chain vs. supply chain" (Hult, Ketchen and Arrfelt, 2007) thus SCM is more and more a discussed at strategic level. For many firms SCM has become a strategic weapon to outperform peers: the examples of Toyota, Wal-Mart, Zara and Dell are part of almost all academic articles regarding SCM (Hult et al., 2007). Even if SCM is a trend topic of the last years, there are no exact definitions of it. Cristopher (1998, as cited in Larson and Halldorson, 2002) defined SCM as "management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole"; however, it is not so simple to define this concept.

Larson and Halldorson (2002) tried to make clearer the different theories around SCM. Starting from the definition provided by the Institute for Supply Management: "the identification and management of specific supply chains that are critical to a purchasing organization's operations". From this point they found that the majority of works concerning the matter reduce the research to a distinction between SCM and purchasing, and highlighted four main perspectives:

1. Traditionalist, seeing the SCM as a strategic aspect of the purchasing process;
2. Relabeling, including purchasing in the general definition of SCM, together with logistic and marketing channels;
3. Unionist, that consider Purchasing as part of the SCM process;
4. Intersectionist, considering SCM a cross-functional process.

However, whatever is the best definition, the key to implement a successful SCM involve the decision making related to the flow of the information, the production and the funds across the chain (Chopra and Meindl, 2016). It is because of these choices that we will discuss later the evolution of the supply chain and its management, enabled by modern technologies impacting heavily on the flow of information and production.

2.2.2 – Two Typical Examples of Supply Chain

The Steel Industry is one of the forerunners of modern concept of factories. Large-scale steelmaking was born in late XIX century thanks to the industrial revolution. 1950s and '70s have been the two periods with the most innovative wave of new technology implementation. After the Second World War many innovations included: the transfer of the factories to the coast, the fall in freight rates, the discovery of enormous deposits of raw materials, the improvements made in the blast furnace process, the substitution of the open-hearth furnaces with oxygen converters and, subsequently, the adoption of continuous casting (Díaz-Morlán and Sáez-García, 2016). Up to last year the volume and variety of steel products is still increasing (World Steel Association, 2017).

The upstream steel supply chain usually is composed by the raw material supplier, a steel producer, manufacturing semi-finished goods, and a steel user, acquiring and transforming the semi-finished product (Melton, 1999). Being steel a raw material common to a huge variety of industries, it is not possible to depict the whole supply chain that it involves after the first few

steps in manufacturing of the semi-finished products. However, MacCarthy et al. argue that the steel industry is currently a mature industry. Thus, it is important to underline how, even if the volumes of steel produced in different countries have changed in the last three decades, the overall structure of steel supply chains has remained relatively stable, supported by mature technologies. So much stable that "Frederick Winslow Taylor, who did much of his pioneering work on "scientific management" in the Pennsylvanian steel industry would still recognize many of the inputs, value adding stages and material flows in the sector, if not the diversity of steel products and their applications" (MacCarthy et al., 2016).

The Clothing Industry is one of the most ancient in history and as well as the above-mentioned Steel Industry, it has been one of the main characters in the industrial revolution process. The textile sector involves the steps of the production and processing of the primary materials and it ends feeding the clothing industry. Together they are one of the most fundamental drivers of the world economy (MacCarthy and Jayarathne, 2010). However, contrary to the previous example, the textile industry did not face relevant technology disruption across the years. Material and machineries innovation are not considered the key success factors of the overall industry. "A garment factory today looks remarkably like one 50 years ago". Its strength point has always been the capacity of being mobile and flexible (MacCarthy et al., 2016).

As mentioned, the supply chain of the clothing industry starts in the textile sector, and this sector is still highly reliant on human work. The most cost-adding activities are sewing, seaming and joining (MacCarthy and Jayarathne, 2010) that no-robot up to now is able to carry on autonomously. Thus, the only way to generate profits during the year passed through two main points (MacCarthy and Jayarathne, 2012):

1. Stretching the supply chain agility, in order to reduce the lead time;
2. Relocate manufacturing in places where labor costs are lower.

These aspects make the supply chain one of the most mobile and geographically diffused of the world (see Figure 6) (MacCarthy and Jayarathne, 2010).

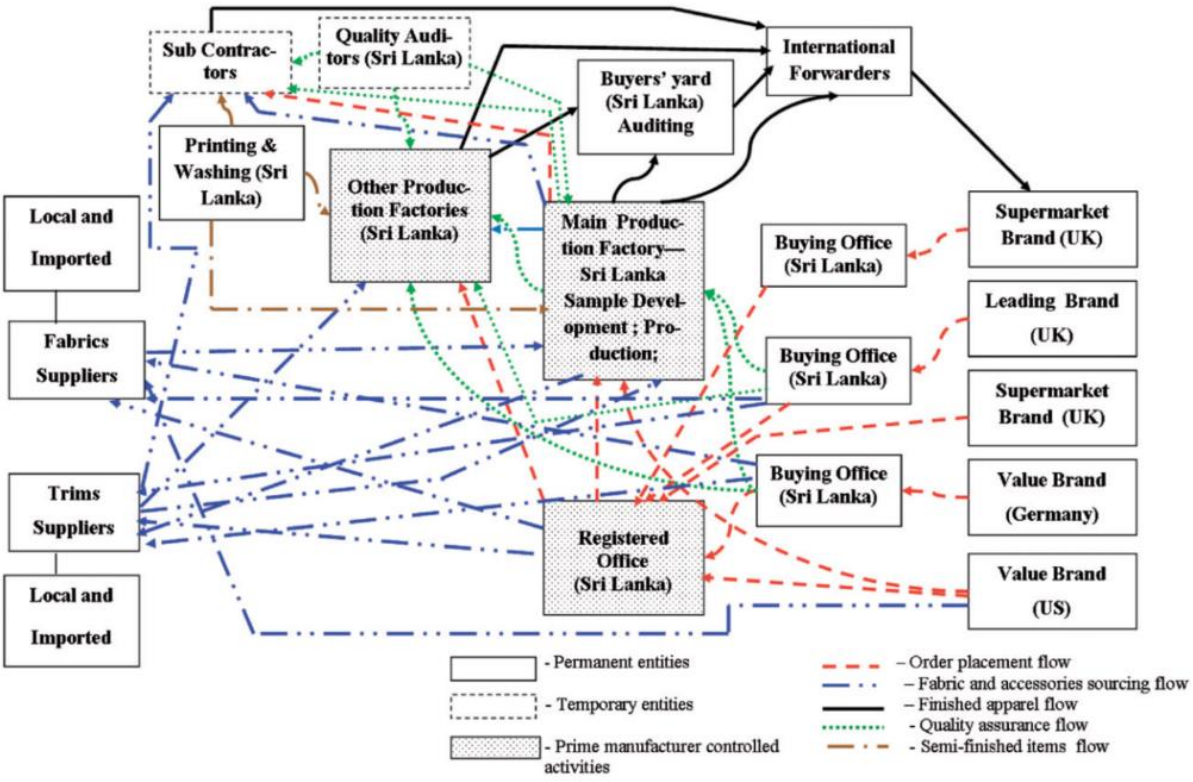

Figure 6 - Illustration of Clothing Supply Network (Source: MacCarthy and Jayarathne, 2012)

2.3 – How Technologies Are Disrupting Supply Chains

The two examples reported above help to give an idea of how the supply chain in that two industries plays a fundamental role in value creation and profit generation: the more competitive is a market, the more the companies competing focus on cost cutting (Nickell, 1996). Thus, Supply Chain Management (SCM) is one of the most effective way to cost cutting and for a more efficient management of the end-to-end process (Swaminathan and Tayur, 2003).

According to Swaminathan and Tayur (2003) Supply Chain Management issues concern two main area:

1. Configuration, or the way the chain is designed;
2. Coordination, or the way the chain is executed.

The configuration level is the one design-oriented and so it relies on the decisions that firms have to take with concern of production, distribution, information, material flow and others (Swaminathan and Tayur, 2003).

However, today's global market place can be best described as "volatile" and decision making got more difficult. The growth that economies faced in last years has been a consequence of a more interconnected and global world; and with that, economies, and companies as well, are more exposed than ever to international shock and disruptions. Supply chains play a key role in this environment (IBM Global Services, 2009): in the last decade these forces compelled industries and companies to analyze and revamp their supply chains. To survive to the global competition companies strived to enhance their coordination and collaboration. Competition has become a matter of how much companies integrate their supply chain together with their partners (Lee and Whang, 2001).

Supply Chain Integration (SCI) is one of the main competitive approaches that last year technologic advancements enabled. IT, the Internet and all the technologies encompassed by the term Industry 4.0 are the key driver of the digital transformation that is disrupting the way companies manage their relations in the supply chain.

2.3.1 – The Supply Chain Integration Supported by New Technologies

A useful approach to describe the impact of new technologies in the process of SCI can be found in the work of Lee and Whang (2001). They highlighted four key organizational dimensions (see Table 3) in which new technologies help the SCI:

1. Information Integration
2. Planning Synchronization
3. Workflow Coordination
4. New Business Models

Dimension	*Elements*	*Benefits*
Information Integration	- Information sharing & Transparency - Direct & real-time accessibility	- Reduced bullwhip effect - Early problem detection - Faster response - Trust building
Synchronized Planning	- Collaborative planning, forecasting & replenishment - Joint design	- Reduced bullwhip effect - Lower cost - Optimized capacity utilization - Improved service
Workflow Coordination	- Coordinated production planning & operations, procurement, order processing, engineering change & design - Integrated, automated business processes	- Efficiency & accuracy gains - Fast response - Improved service - Earlier time to market - Expanded network
New Business Models	- Virtual resources - Click-and-mortar models - New services - Mass customization	- Better asset utilization - Higher efficiency - Penetrate new markets - Create new products

Table 3 – Supply Chain Integration Dimensions (Source: Lee and Whang, 2001)

The authors state that "integration=cooperation" since they consider the two aspects as two sides of the same coin. They think that a tight link should exist between firms at different levels: *communication channels*, with clear responsibilities and roles, *performance measures*, for linking and monitoring performance between different members of the supply chain, and *incentives*, that should be aligned in order to let the supply chain work in a proper way.

The main benefit deriving from *electronic information integration* is the higher profits generation linked to the faster and easier level of information sharing. The article cites a research made by Stanford University and Accenture (1998) that shows how companies that reported higher than average profits were the ones who were engaged in higher levels of information sharing.

Lee and Whang (2001) consider *Planning Synchronization* as the natural second step after the information integration. After the exchange of information partners can collaborate to develop a joint production strategy, agreeing on the critical actions to undertake for mitigating the yet mentioned "bullwhip effect". Again, this integration step has shown to payback those who invest in joint electronic management of the logistic replenishment and planning.

The *Electronic Workflow Coordination* permits companies to step further into an efficient and effective collaboration. Procurement, order execution, design optimization, engineering, financial exchanges: these and many other processes are influenced by electronic management. However, contrary to the previous steps, here companies benefit of cost-cutting, fewer errors and faster operations.

For what concerns *Business Models,* I will discuss about it in a more detailed manner later.

2.3.2 – Digital Supply Chains

Every IT innovation wave of the last decades made academics respond with new researches to investigate deeper the impact of new technologies in the economic environment. Useful theories developed in the past 15 years need now to be integrated with newer ones trying to encompass the digital disruption of these years. Indeed, where at the dawn of the XX century the main disruption was the Internet, and many academics started to investigate how this new tool could change Supply Chains, now we face Digital Transformation.

Digital Transformation is reshaping companies' and industries' boundaries: companies may shrink or expand, and new competitors may emerge since different industries now are crossing their paths (Reddy and Reinartz, 2017). All this instability is triggered not only by geographical spread of supply chains, but also by the increased number of companies involved (IBM, 2009) and the new type of products: smart, connected products raise new issues about the way value is created and captured. Moreover, the new built-in functionalities and capabilities go beyond the traditional boundaries that firms are used to know (see Table 4) (Porter and Heppelmann, 2014).

Like it or not, products are becoming smart and connected. This will produce one of the main source of value for supply chains: a lot of data. In order to handle this flow of data in a proper way, businesses need to be ready to implement all the digital features available. So, on one side, we have products and operations producing data, and on the other the SCM that tries to

use digital means to extract value from it. The question arising is: what are the main feature of a digital or smart supply chain?

The first and maybe evident characteristic is that traditional supply-chains still rely on a mix of paper-and-electronic handling of processes and documentation, while digital supply chains "have the capability for *extensive information availability* and enable superior collaboration and communication across digital platforms resulting in improved reliability, agility and effectiveness" (Raab and Griffin-Cryan, 2011).

Back again to the data production, leading digital supply chain are shaped on a *Demand-Driven Value Network*. For example, the trend is to centralize on regional level the customer service in the consumer product companies. This permitted to a leading company to implement a service center where the supply chain support work side-by-side with suppliers' representatives. Hi-tech companies are some of the best in this field, reshaping contracts and partnerships, even with one-time projects, just to deliver tailored products to customers (Aronow, Burkett, Nilles and Romano, 2016).

Visibility is another value-driver. It is not just a matter of being transparent to your customers (for example with parcel tracking) but also, and mainly, with your partners. "It does not simply mean visibility into your own supply chain and your own shipments. It means visibility among partners, which enables collaborative decision-making closer to the customer" (Stoffel as cited in Butner, 2010). The real technology disruption here is that it is not people who report about units on assembly line, shipments leaving or warehouse's movement, since all of this is managed by smart objects. And all of this data will be processed through data analytics, to unlock the real value behind information (Porter and Heppelmann, 2015).

Smart supply chains benefit from the *risk mitigation* effect deriving from the almost in real-time information flow analysis. There are many risks that companies cannot handle, usually geopolitical disorders or economic crises. However, playing in a smart value chain enables some sort of defense mechanisms. Having good information in time thanks to smart objects can help react to problems inside the supply chain: thanks to simulation and risk modelling, companies can identify and avoid risks faster and jointly. In this way executives have a much wider set of options to evaluate not just economic but also social and environmental risks (IBM, 2009).

Lastly, we can consider *flexibility* as another advantage of digital supply chains. The information flowing from the operations permit to managers to better decide whether to centralize or not, whether to outsource or to do in-house. These basic decisions influence greatly the SCM and an effective data management enable companies to retain more value-adding activities (Raab and Griffin-Cryan, 2011).

The technology	**The impact**
Physical Internet (based on the IoT)	- Improved supply chain transparency, safety and effciency - Improved environmental sustainability (more effcient resource planning)
IT standards	- Enabling collaboration horizontally - More effciency and transparency
Data analytics	- Improvements in customer experience and operational effciency in operations - Greater inventory visibility and management - Improved 'predictive maintenance'
Cloud	- Enabling new platform-based business models and increasing effciency
Robotics & automation	- Reduction in human workforce and increased effciency in delivery and warehousing (including sorting and distribution centres) - Lower costs
3-d printing	- Lower transportation demand - Transported goods would mostly be raw materials

Table 4 - The Future of the Logistic Industry (Source: Tipping and Krauschke, 2016)

2.3.3 – Examples of Digital Supply Chain

In its public website the German company *Klöckner* define itself as "one of the largest producer-independent distributors of steel and metal products and one of the leading steel service center companies worldwide" (www.kloeckner.com, 2018). The company is a perfect

example to show how, even in a mature industry, like the steelmaking industry is, it is possible to outperform competitors through a digital supply chain. The digitization of the supply chain brought more efficiency and transparency.

The difficulties faced by the steel industry in Europe because of Chinese oversupply, and the typical business model that relies too much on speculation, made the CEO, Gisbert Rühl, decide to digitize the company.

Because of the speculative business model companies' inefficiency due to high inventories was profitable thanks to the periodic increasing price of steel. Now it is not possible anymore to sustain such revenue generation model.

To start the innovation the company created a separate unit, basically a start-up, in Berlin. This new company had the task to acquire knowledge about digital tools and innovations suitable to the mother company. And they came out with two solutions (Kirkland and Rühl, 2016):

1. An internet service platform working as integrators between suppliers on a side, and customers on the other side, and Klöckner in the middle as proprietary.
2. A second independent platform used as industry platform, where also competitors can enter.

These two solutions make so that the downstream supply chain players will get advantage of higher price transparency (Kirkland and Rühl, 2016) and the upstream companies will benefit of higher margins and increased efficiency (www.kloeckner-i.com, 2018). Also, all the companies will have the opportunity to implement the platform directly in their ERP systems (Our Strategy: Klöckner & CO. 2022, 2018).

"Cisco is the worldwide leader in IT that helps companies seize the opportunities of tomorrow by proving that amazing things can happen when you connect the previously unconnected" (www.newsroom.cisco.com, 2018). Cisco is a hardware, software and services company that provides products and solutions for networks and it is considered a leading example for its supply chain. The recently appointed CEO created a whole new role inside the company: a team that will manage both, supply chain and the IT group. This move generated a high interconnection between the two areas and reflects the intention to implement new IT solutions for managing the supply chain; and for now, it is paying back (Aronow, Burkett,

Nilles and Romano, 2016). The team focused on the collaboration with suppliers leveraging the high internal IT skills and deployed some innovations:

1. A cloud-based platform developed in partnership with the supplier. The platform works as single and common source of data that minimize the bullwhip effect. Online there is full visibility and through automatic alerts suppliers can handle shortages (Aronow, Burkett, Nilles and Romano, 2016).
2. A digital logistic function, with data shared automatically in the cloud using standards, automated event management and machine management (Aronow, Burkett, Nilles and Romano, 2016).
3. An open-source library of best practices that leverage the participation of partner companies. These best practices help companies to quantify risk exposure and develop resiliency programs (IBM, 2009).

An earthquake hitting China in 2008 proved the power of this solutions: when the earthquake hit the system allowed to identify immediately the critic nodes of the supply chain involved in the disaster. Within hours Cisco was able to assess the economic impact, the potential exposure and start a mitigation plan together with its partners (IBM, 2009).

Grocery Retail is becoming a ruthless competitive battleground. Discount stores, Convenience Stores, and e-commerce acknowledged the power of fresh food as a loyalty driver for customers: good fresh food drive store visits and basket size. Fresh food value for around 40% of grocer's revenue and one-third of costs of goods sold (Glatzel et al., 2016). However, fresh food is a perishable product that face volatile demand. Lead time are risky and the fact that a factor of differentiation is the presence of ever more broad assortments, including exotic fresh products, increase the uncertainty level with suppliers. Every store has to make trade-offs when ordering for replenishment: too much is costly, too little erodes loyalty. As of now, the SCM is based on fixed and rule-based planning systems. However, being fresh food more affected by local demand, local planners must insert different kind of data for each store replenishment system. This process' consequences are time consumption, errors, and dependence on store planners' experience (Glatzel et al., 2016).

Now, new technologies come in help to grocery stores. Many retailers decided to implement Machine Learning in their supply-chain planning system. Algorithms-based software automatically execute all the formerly manual tasks using data produced not just by historical

sales: current discounts, store opening times, internal factors, and, if the whole supply chain is integrated at a high level, even suppliers' constraints. This system increases accuracy of forecasts, and as a consequence, of orders. Data collected from some retailer show reductions up to 80% in out-of-stock rates, lower write-offs in inventory by more than 10% and a gross-margin increase of up to 9% (Glatzel et al., 2016).

2.4 – A Brief Overview on Business Models

Business Models benefited in the last years of quite a momentum. While the basic concept behind the question "What is a business model?" is commonly acknowledged, from an academic point of view it still lacks a proper definition and description (El Sawy and Pereira, 2013). According to El Sawy and Pereira (2013), the term spread in the period around the "dotcom revolution" of early 90s. Since the matter gained prominence just in the past years, academics still have to develop a common language and terminology (Zott et al., 2011). However, we can briefly state that Business Models are complex systems and they consist in tangible and intangible elements interacting with one another. It is their interaction that makes the business model work (Vermeulen, 2017). "The essence of a business model is in defining the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit" (Teece, 2010). Since the dynamics inside a business model rely on value creation, proposition and delivery (Osterwalder and Pigneur, 2010) the main aspect of business models is their changing shape. Or better, innovation in key areas oblige who manages the business model to take repair from disruption reshaping the business model (Markides and Oyon, 2010). However, an innovation can be game-changing in the sense that a completely new business model is required to embrace it, or it can be just an incremental technology that business models will integrate more easily (Chesbrough, 2010).

Vermeulen (2017) states that digital technology will be both, a complement and an alteration to already existing sources of value. Businesses will see two main areas to change with digital transformation (Berman, 2012):

1. The value proposition: what is the value offered to the customer;
2. Operational model: how the value is offered.

The digital trend does not influence only Business-to-Consumer models, but also, and significantly, Business-to-Business models (Hausmann et al., 2015). To manage effectively digital transformation companies will need to implement effective digital strategies with concern of the right reconfiguration of their business, taking advantage of the right enabling technology. However, using the right enabling technology depends a lot on the digital maturity level: moderately mature companies use technology only to improve customer relationships. More mature companies, instead, use digital technologies more broadly (Kane, Palmer, Phillips and Kiron, 2015). What's more, not every business model needs to transform. It may be working profitably enough already (Andriole, 2017).

This difference is not a consequence of a misuse of new technologies. Instead, it reflects the different approach of different digital cultures (Kane, Palmer, Phillips and Kiron, 2015). It has been shown that technology per se does not mean automatically a profit growth. Unless it is proprietary, technology does not imply revenue generation if the company has not the right culture and mindset to manage it (Carr, 2003 as cited in Kane, Palmer, Phillips, Kiron and Buckley, 2015). So, business models can adjust just as fast as the company's digital maturity evolves (Kane, Palmer, Phillips and Kiron, 2015).

To adjust business models to technologic advancements, firms need first to understand well how new business models work (Markides and Oyon, 2010). Academics try to provide many different frameworks to do so: Hamel's Business Model (Hamel, 2000), Stähler's framework (Stähler, 2002, in Delmond, 2017), the Business Model Canvas (Osterwalder and Pigneur, 2010), VISOR framework (El Sawy and Pereira, 2013) or the 360° Business Model Framework (Rayna and Striukova, 2016). However, we think that it could be easier to take in consideration the Business Model Canvas since:

- It is easy to build but exhaustive in contents;
- It is a tool to visualize business model dynamics;
- It emphasizes the value creation and proposition.

2.4.1 – The Canvas Framework (Osterwalder and Pigneur, 2010)

We decided to show the effect of digital transformation starting from the CANVAS framework and its 9 blocks (Osterwalder and Pigneur, 2010). We think that it will be easier

later to understand how, and in which phase, the digital transformation modifies a business model. The nine blocks that we will discuss briefly are (see Figure 7):

1. Customer Segments
2. Value Propositions
3. Channels
4. Customer Relationships
5. Revenue Streams
6. Key Resources
7. Key Activities
8. Key partnerships
9. Cost Structure

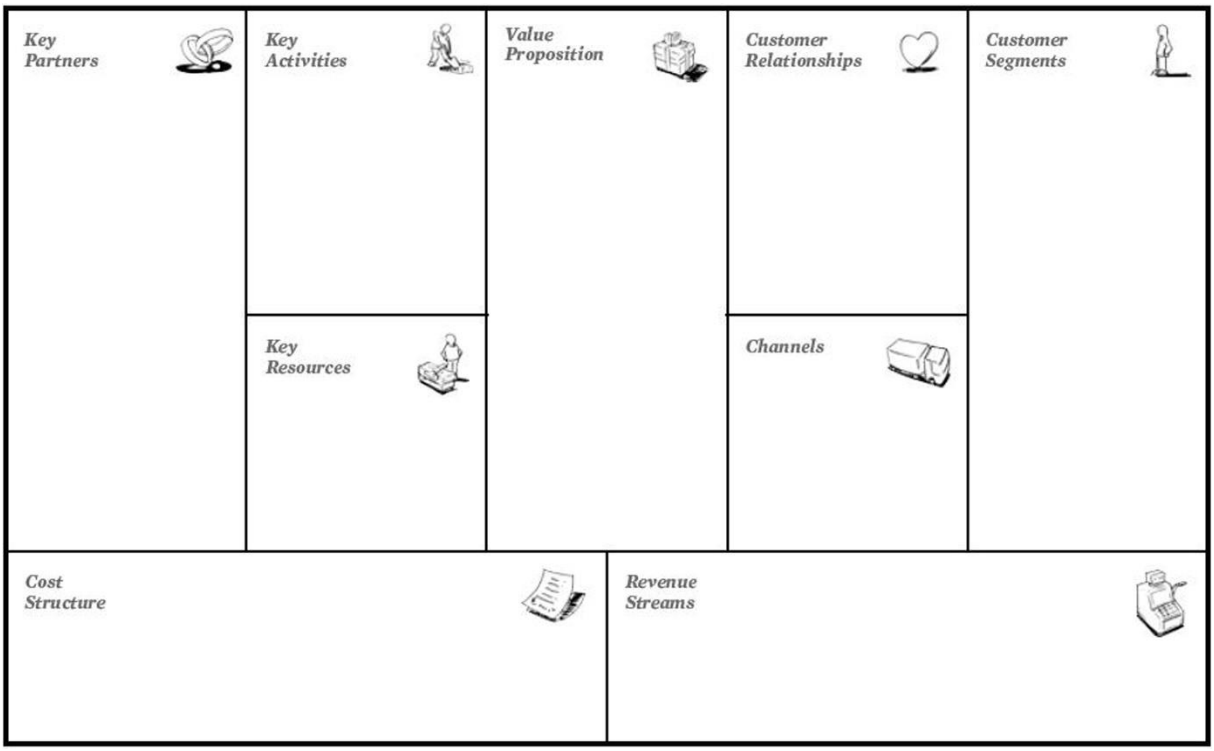

Figure 7 - The Business Model CANVAS (Source: Osterwalder and Pigneur, 2010, p. 44)

Customer Segments: it is a basic concept that should be clear to every company carrying on its business. Customers are the core of every business model and make the difference between profitable and not profitable businesses. It is important to group them in smaller segments to better understand their needs. Once it is done, a business model can be defined using one or more segments to relate with: it is important to define who will be your customer and who

will not. There is no standard size or diversification rule to define segments, the most important guidelines to understand if you are serving different segments are:

- They have different needs requiring distinct offer;
- Different channels are required to reach them;
- They need different kind of relationships;
- Profitability is different among the segments;
- Different aspects of an offer will encounter different willingness to pay.

Mass market, niche market, segmented market (related segments), diversified (unrelated segments), multi-sided platforms: these are some examples of customer segments.

Value Proposition: it is the bundle of product and/or services that provide value to customers segments. It is the dividing line that distinguish a company from another and makes customers decide between the two. It can also be considered as the benefits that the company provide to the customers. The point is not being more or less innovative but add specific features. The added value could be quantitative or qualitative and, even if it is not possible to list all the possible value-adding elements, a company must know which of its specific values are delivered.

Channels: another important building block refers to how value is delivered. It comprehends all the means that a company uses to communicate with its customers and deliver to them its value proposition. These are the interface that company need to know and be known. These touchpoints play an important role in the customer experience: for example, a fast, effective and easy access to information regarding products or services will make the difference for customers between two different companies. Channels serve several functions, including: Raising awareness about products and services; Help evaluate the value proposition; Allow and ease purchases; Provide post-purchase support. Five different phases are covered by one or more channels:

1) Awareness
2) Evaluation
3) Purchase
4) Delivery
5) After-sales

The important part is to find the right mix of channels.

Customer Relationships: this building block describe the relationships that a company wants to establish with customers: from personal to automated, there are many shades of relationships that a company could choose. This choice will influence deeply the customer experience. Some categories of relationships are:

- Co-creation: customer and vendor participate in the value creation;
- Dedicated personal assistance: an individual assistant that serves the customer;
- Personal assistance: customers communicate with human customer service;
- Communities: online or offline communities that allow users to exchange knowledge;
- Automated services: a mix of means provided by the company and automated processes;
- Self-service: the company provide to customers all the needed to help themselves.

Revenue Streams: they are the revenue generated by the company's activity. If the value proposition is delivered successfully to customers, then we have revenue generation. An important point in generating revenues is to understand the willingness to pay of the customers and adjust the pricing policies accordingly. There are two different kind of revenues streams that a business model can generate: 1) transactions from one-time payments and 2) revenues from ongoing payments for the value delivering or the post-purchase assistance. There are several ways to generate revenues:

- Asset sale;
- Usage fee;
- Subscription fees;
- Lending/renting/leasing;
- Licensing;
- Brokerage fees;
- Advertising.

Each revenue generation method needs a different pricing strategy that could be either static, with predefined prices, or dynamic, with changing prices accordingly to predefined variables.

Key Resources: they could be defined as the assets that the business model needs to work. They allow the company to create, offer, and deliver the Value Proposition. Every business model requires different resources. These can be physical, financial, intellectual or human. Key resources often generate make-or-buy decision, since they can be owned, acquired or leased.

Key Activities: every business model needs specific things to be done to work. Key activities are the actions required to operate successfully. Similarly to the mentioned key resources, they are needed to create, offer, and deliver the Value Proposition. Not every activity create value for companies, thus, every company needs to understand which the real actions are to undertake to make the business model work. We can categorize key activities in:

- Production-related;
- Problem solving;
- Platform/network.

Key Partners: companies live inside an open environment, and partners are vital to sustain the business model. Suppliers and other partners play a fundamental role in the overall value-generation of the firm. Partnerships are useful in many ways: to reduce risks, to acquire new skills or assets, or to optimize scale economies. We can list four main types of partnerships:

1) Alliances between non-competitors;
2) Coopetition: partnership between competitors;
3) Joint Ventures;
4) Buyer-supplier relationships.

Costs Structure: here we describe the costs faced by the company to make whole business work. Value-creation and delivery, customer relationships, distribution channels, even the revenue streams: everything come at a cost, but some business models are more cost-driven than others, as well as cost reduction is more relevant in some business than others. We have value-driven businesses, in which costs reduction are not the main concern of the firm: usually it happens in those companies delivering a high value proposition. Instead, we can define as cost-driven those companies in which margins are generated stretching the cost structure to the limit, like no-frills airlines. However, we can identify four main characteristics in costs structure:

1) Fixed costs: independent from production volumes;
2) Variable costs: increase or decrease accordingly to production or other factors;
3) Scale economies: decrease with higher volumes;
4) Scope economies: gain cost advantage due to larger scope of operations.

2.5 – Introducing Digital Transformation in Business Models

As said in the previous paragraph, even if business models are by now a well-established concept, academics still argue on the definition of the right tools to analyze them (Zott et al., 2011). Many contentious issues fuel the academic debate (Baden-Fuller and Morgan, 2010), however, one of the common critical points is the influence of new technologies and innovation on firms' business model. For some researchers, business model innovation derives also from technology advancement, since new technologies, if correctly adopted, produce superior performances impacting on various aspects of the business model itself (Osterwalder and Pigneur, 2010; Zott et al., 2011). Others think that technology ca be disentangled from the dynamics of the business model, and that technology does not necessarily drive business model innovation, but there is a sort of critical point that separate business model innovation from general improvements of the business model (Baden-Fuller and Haefliger, 2013).

2.5.1 – Digital-driven Business Models

Since Internet and the Digital Transformation are the main innovation that are transforming business models many firms need plans to adopt digital business model, or, at least, introduce remedies to embrace new digital products and services and face new competition (Porter and Heppelmann, 2015). Here we will show some main examples of digitally enabled business models and, with reference to the Business Model Canvas, we will try to highlight the main area disrupted by Digital Transformation. To do this, we started our analysis from some of the Business Model types provided by Bhattacharya et al. (2017):

Multilocal Manufacturing: Industry 4.0 enables companies to reshape standard global business models and supply chains. Traditional production strategies, focused on outsourcing labor costs or offshoring the production in low-cost countries, will shift from the archetype of the huge factory with thousands of employees in few countries, to a more flexible strategy. Multilocal Manufacturing is about exploiting new manufacturing technologies to adopt a more cost-efficient approach to production and global activities: smaller factories, located in

many key countries, with up to few hundreds of employees producing more customized products, with the possibility to bring them to market much faster (Bhattacharya et al., 2017).

Cross-Borders Servitization: The traditional revenue source of manufacturers has been the one-time sale of a product, and time to time, the sales of replacement parts. More rarely, they also provide maintenance. However, because of macroeconomic factors combined with emerging markets with low financial resources, it is hard for manufacturers to exploit anymore their traditional business model. Digital transformation is bringing a fresh breath to those company able to invest in digital technologies. Indeed, many manufacturing companies are leveraging these new technologies to catch new growth opportunities, delivering digital services and end-to-end solutions. The value for the companies is created by the services provided in-bundle or on a fee-base, are the new revenue source for manufacturers. This model is incentivized by the IoT and the general preference of customer not to own assets (Bhattacharya et al., 2017).

Global Digital Ecosystem: Many companies are choosing to use digital technologies to leverage networks of international and cross-industry partners. Digital technologies bring the possibility to create platforms working as digital ecosystems. These ecosystems are used to deliver new services, technologies, product features, aid interoperability of IT systems and accelerate commercialization. The collaboration of many partners with specific industry-related know-how and partners coming from different industries, in particular IT, has the possibility to achieve and deliver high quality and innovative products. Also, innovate and revamp projects become easier and companies manage to introduce more often innovations (Bhattacharya et al., 2017).

Global Personalization: Big Data and advanced AI are powerful tools in the hands of companies that know how to use them. It is possible with these tools to craft highly personalized experiences and products for customers. These products and services are delivered directly to customers' devices thanks to digital platforms developed ad hoc. Big Data analytics enable a deeper understanding of customers' tastes and permit to company to shape a product, or a service, accordingly (Bhattacharya et al., 2017).

To better understand these few examples of digital-driven Business Models it is helpful to introduce some use cases to carry on the analysis and to catch the practical aspects of the transformation ongoing in many businesses.

2.5.2 – Adidas and Strategies for Multilocal Manufacturing

Employing more than 60,000 people in over 160 countries, Adidas produces more than 850 million product units every year and generate revenue for €19 billion. Of the 850 million units produced, 360 million are shoes (adidas-group.com, 2018). The relevance of this business for the German company need a lot of effort to keep on innovating many aspects, from design to sales and marketing. Production and value chain are the next frontier in which the Ansbach company will invest. R&D expenses increased by 18% from 2015 to 2016, up to €164 million (Adidas Annual Report, 2016). These expenses reflected the investments the company made to create two main manufacturing innovations (Adidas Annual Report, 2016):

- Speedfactory: a smart factory that will produce up to 500 thousand shoes units employing only 160 high-skilled people.
- Futurecraft: 3D engineered design to implement 3D Printing for shoes, powered also thanks to Simulation software.

For what concern the Speedfactory project, it started to run in mid-2017. The plant will manufacture shoes using the most advanced autonomous robots. Currently the landscape is made of huge factories in Asia where thousands of employees assemble components or sewing, bonding and shaping the materials. From the first design of a trainer to the shelves of the store usually the shoes industry need up to 18 months. However, for fashion reason, companies need to renew a product almost every year and the shipment of new products for replenishment take 2 or 3 months. These two aspects, the heavy dependence on labor costs and the slow supply chain are the two drivers pushing Adidas to invest in Industry 4.0 (The new manufacturing footprint, 2017).

The first effect of developing Speedfactory and Futurecraft projects is the possibility to reshore activities in western countries since the labor costs will be balanced by the automatization of many processes thanks to the advanced manufacturing. This will also put back inside the company the manufacturing process, since up to now almost 100% of the production is done by 297 independent manufacturers (Adidas Annual Report, 2016). The second aspect is the possibility to intervene faster on production thanks to the manufacturing based on additive manufacturing, thus responding faster to changing customers' demand. Third, since fashion is not the only reason behind the benefits of being less time-consuming, also the supply chain will benefit of shorter shipment times, with an estimated cut down to

less than a week the time to shops once the design is complete (The new manufacturing footprint, 2017). This smart manufacturing will enable more customization, with the possibility to change quickly the product produced by the machinery and to leverage on the engagement of customers in the shoemaking.

So, with these information, we can see how Advanced Manufacturing, Additive Manufacturing and Simulation constitute the core of a radical business model change. The Speedfactory is dawning just now, but we can already forecast which are the main aspects involved in the change from a Business Model Canvas point of view:

- Key Activities are the center generating the innovation: less people, more robots; Additive Manufacturing instead of handcrafting; Simulation to test
- Key Partners: less independent partners and more in-house operations;
- Key Resources: HR will need to employ high skilled resources to manage smart factories;
- Costs Structure: Labor costs will have less impact; faster time to shop lead to a more flexible supply chain, with relative variable costs;
- Value Proposition: higher product customization and probably the possibility to revamp products more often.

2.5.3 – Kone and Cross-border Servitization Applied to Elevators

Even if international trade is experiencing a downturn due to a decrease of sales in China, with its revenue close to €9 billion Kone remains one of the leading companies manufacturing elevators and other equipment to "improve the flow of urban life" (Kone Annual Report, 2016). More than 400 thousand buildings use Kone equipment and with nearly 160 thousand new units ordered last year will increase its presence (Kone Annual Report, 2016). However, for products like Kone's, maintenance is a crucial service to provide to customers.

As most of the manufacturers, Kone already carries in its business model the provision of maintenance services to equipment, like its elevators, that serves thousand people a day. However, with the upcoming digital technologies the company decided to invest in two main technologies to improve their services: IoT (IBM Watson IoT), Cloud Computing (IBM Cloud) and Big Data Analytics. In this way they manage to collect and process all the data generated by their 1.1 million installed units (IBM, 2017).

All the data analysis is provided with the Kone 24/7 service to customers permitting them to dispose of the real-time information related to their equipment. This feature is expected to improve the product life-cycle thanks to a more accurate management and maintenance: the equipment dialoguing with the monitoring system via IoT will generate alarms and reports on malfunctioning. The accuracy of the report will be so that many emergency calls will find a solution already with the first intervention. As of now the services already deliver lower equipment downtime, fault and delays (IBM, 2017).

Beside this proactive approach to the maintenance, Kone 24/7 is implemented to take a step forward. The Big Data generated by the equipment in real-time are stored in the Cloud provided by IBM. From there, the AI provided by IBM will try to find use patterns leading to Predictive Maintenance solutions. In this way, the customer will get advised even in advance for emergency or downtime (IBM, 2017).

Here we have the example of what is happening to many OEM around the world, since the competition on product does not work anymore, and services, as of now, are provided in similar ways by all the competitors. Digital services are real game-changers permitting to customers to get first-hand information and generate more value by having more power over the product. The business model of Kone will be surely deeply influenced by this innovation:

- Partners: IBM is the key partner in this project and will be a strong resource as well as a limit to change IT systems;
- Value Proposition: the main aspect of the partnership is that Kone will provide high quality digital services combined with their products;
- Revenue Streams: multi-level services based on fees will generate streams delayed on time after the sale of the product;
- Relationship: the system is a tool through which the company can automatize some "unpleasant" (for the customer) communication without losing value, and instead, providing higher customer retention;
- Channels: the 24/7 system provide a completely new, efficient and effective system through which deliver and get information to multiple users, end-users or maintainers.

2.5.4 – John Deere: A Farm OEM Working on a Global Digital Ecosystem

John Deere is the biggest company in the world for what concerns farm equipment. With revenues of more than $29,5 billion the company found in new technology a way to exit from a struggling period where national policies and macroeconomic factors were affecting performances (John Deere Annual Report, 2017). The company decided in 2012 to launch a new platform: MyJohnDeere. Now it is an open platform where farmers and agricultural producers can find suggestion on how optimize data management, equipment information and the overall operations (Perlman, 2017).

MyJohnDeere was born as a software bundle that the company, together with other players of the value chain, developed to connect all the participants to the project. The functioning of the software was based on the data acquired from many sensors displaced in many different places: on John Deere's equipment, soil, weather stations. The resulting information flow was shared between the stakeholders to help users optimize processes, from fuel consumption to fleet management. All available on smart devices (Perlman, 2017).

In 2013 the platform evolved and became open, and new players entered the system. Suppliers, agriculture retailers, agronomists and software companies provided new tools and applications. So far, MyJohnDeere is available for free for all John Deere's farm equipment owners and they can access the database powered by all the stakeholders above mentioned without fees (Perlman, 2017).

This is a clear strategy in which John Deere, leveraging on its wide presence in the market, is playing the role of central node for the supply network of the final user. However, it is doing so through an open platform and without any revenue from the final user, with the advantage of acquiring the Big Data generated using the platform. From a business model point of view, we can assume some main changes:

- Value Proposition: it is not anymore just the equipment and the maintenance service, but also a useful tool for end-users to monitor the everyday routines powered by Big Data analytics;
- Channels: the touchpoint with many customers has become the platform, that provides also reports useful for the maintenance;

- Customer Segment: the platform users generate data about their habits, behavior, demographics and so on thanks to the IoT;
- Relationships: a useful and performing platform that put in contact final users and other players becomes a powerful tool to improve customer retention;
- Partners: the open platform model make so that John Deere does not need to invest too much in IT related to the platform since many IT partners joined the open platform themselves; this is a way to increase relations with them and bring together new ideas.

2.5.4 – Netflix and Its Service Based on Global Personalization

An outstanding example of great implementation of these technologies in the business model is Netflix. The big entertainment company deliver its products to over 93 million customers all over 190 countries. Their products include TV shows, documentaries, films and other kind of video entertainment products. Everything without commercials embedded in the watching experience thanks to the subscription system, that allows an "all-you-can-watch" mode to customers (Netflix Annual Report, 2016).

Netflix started in 1997 with a traditional pay-per-rental business model delivering DVDs in USA. Their first disruptive innovation came with the adoption of a subscription model: the subscribers could pay the monthly fee to have access to unlimited DVDs rental and delivery. This seemingly marginal shift happened to be disruptive for many competitors - most notably the giant Blockbuster (Rayna and Striukova, 2016).

The second great business innovation happened in 2007 when they launched the online subscription-based streaming service. This move produced the double effect to disrupt even more the competition and Netflix's business model itself: many customers moved from the DVDs home delivery service to the online streaming (Rayna and Striukova, 2017).

However, it is not the subscription-based revenue model, the many channels available to use the service, or the quality of the products offered that create value for Netflix. Instead, the two above mentioned technologies are the reason behind the success and the sustainability of their business model. Big Data analytics make possible for Netflix to segment its customer base into 1300 global "taste communities" based on individual preferences, and consequently, to propose through an algorithm the shows that most probably will encounter the customer's preferences (Bhattacharya et al., 2017).

The huge database made by customer preferences also enabled the company to start providing original contents that more and more encounter people enthusiasm. Basically, the company can leverage the Big Data to create specific shows with the most favorite features that people will appreciate, increasing in this way the likelihood of people to renovate the subscription (Rayna and Striukova, 2016)

Netflix's business model is not too complicated; however, it is difficultly replicable since the company can leverage a huge database that constitute an entry barrier for many little players. Going in deep we can see the main aspect of the business model innovation:

- Customer segment: the company thanks to Big Data analytics understand very well its customers and provide ad hoc value proposition;
- Relationships: the main revenue stream of the company are subscriptions, so it is crucial that members renovate their subscription; the algorithm permit to be highly customer-focused and suggest new shows to influence customer retention; also, the easy "no-frills" subscription method that permit with just one click to end the subscription is a plus that guarantees transparency to the customer;
- Channels: the online streaming is offered over many different platforms, from PC to smart devices and even game consoles; this multi-platform approach is useful when you consider that in this way it is impossible for customers not to enjoy the contents almost everywhere;
- Key resources: Big Data in this case constitute a huge resource for both, customer retention and Value Proposition innovation;

2.6 – The Path to Digital Transformation and the Obstacles to Face

We have seen how Industry 4.0 is disrupting traditional businesses in many different ways. Since the process is dawning in these years, the number of academics studying the effects of the digital transformation is increasing. While, as mentioned, studies on traditional business models are quite familiar to the academic landscape, studies on digital business models and applications to Industry 4.0 projects are more focused on qualitative research. Often, these researches' aim is to understand if a standard approach could exist. To do this, academics and researchers try to figure out common transformation paths through interviews with companies' executives.

2.6.1 – Is there a standard way to reshape a Business Model?

According to Berman and Bell (2011) the two dimensions that are driving business decisions regarding digital transformation concern the focus on the value proposition or on the value delivery. In other terms, it is a matter of deciding to revamp products or operations. This is not an either/or choice: as shown by authors of the study, there are companies that decide to innovate in both the area (see figure 8). So, the choices are (Berman and Bell, 2011):

1. Reshape the customer value proposition;
2. Redefine the operational model;
3. Approach simultaneously the two paths.

There is no perfect decision and companies must take into account many different variables. Usually, if the value proposition is strongly focused on physical aspects of a product, the transition starts from the operations (like in minerals and mining). In other cases, it could be better to develop digital products or downstream digital feature. Many companies and even industries instead, need to approach the 3rd path, and build brand new digital capabilities (Berman and Bell, 2011).

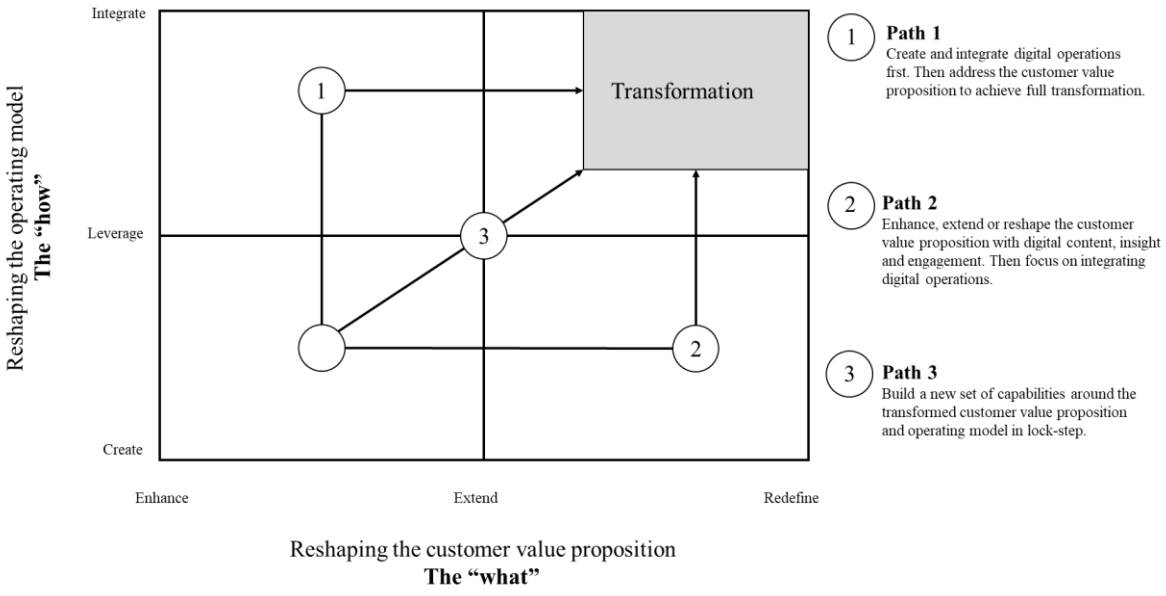

Figure 8 - Paths to digital transformation (Source: Berman and Bell, 2011)

Reshaping the Customer Value Proposition comes in three stages: enhance already existing products with new features (digital entertainment software in new cars); extend services or

products finding new revenue streams (service for traffic alerts); and then redefine the value delivered (the car as digital product) (Berman and Bell, 2011).

Redefining the Operating Model also needs to cross three advancement stages. Define and create the needed digital capabilities and customers' touchpoints, learn to leverage the information produced, and lastly to optimize the value delivering processes (Berman and Bell, 2011)

Executives see the potential hidden behind digital transformation, however, they cannot identify the right decisions to get the wanted results (Fitzgerald et al., 2013). Depending on businesses and industries, there are high risks behind these choices.

Another research shows how two other main factors influence the decisions on adopting digital technologies, especially IoT (see figure 9): the position in the supply chain and the distribution channels that a company uses (Paiola, 2017). These two dimensions are addressed by the author as main factors conditioning companies in choices regarding IoT investments. The research takes into consideration typical Business-to-Business (BtoB) companies playing different roles in the supply chain.

It is shown that digital transformation hits OEM business models pushing to adopt IoT technologies. This kind of digital products help to blur the boundaries of the roles across the supply chain that once were very clear, like, for example, maintenance services and manufacturer (Paiola, 2017). Also, the research shows how having a direct or indirect channel to reach customer create conflicts between supply chain operators since often these technologies are implemented to bypass distributors and get direct access to customer-related information (Paiola, 2017).

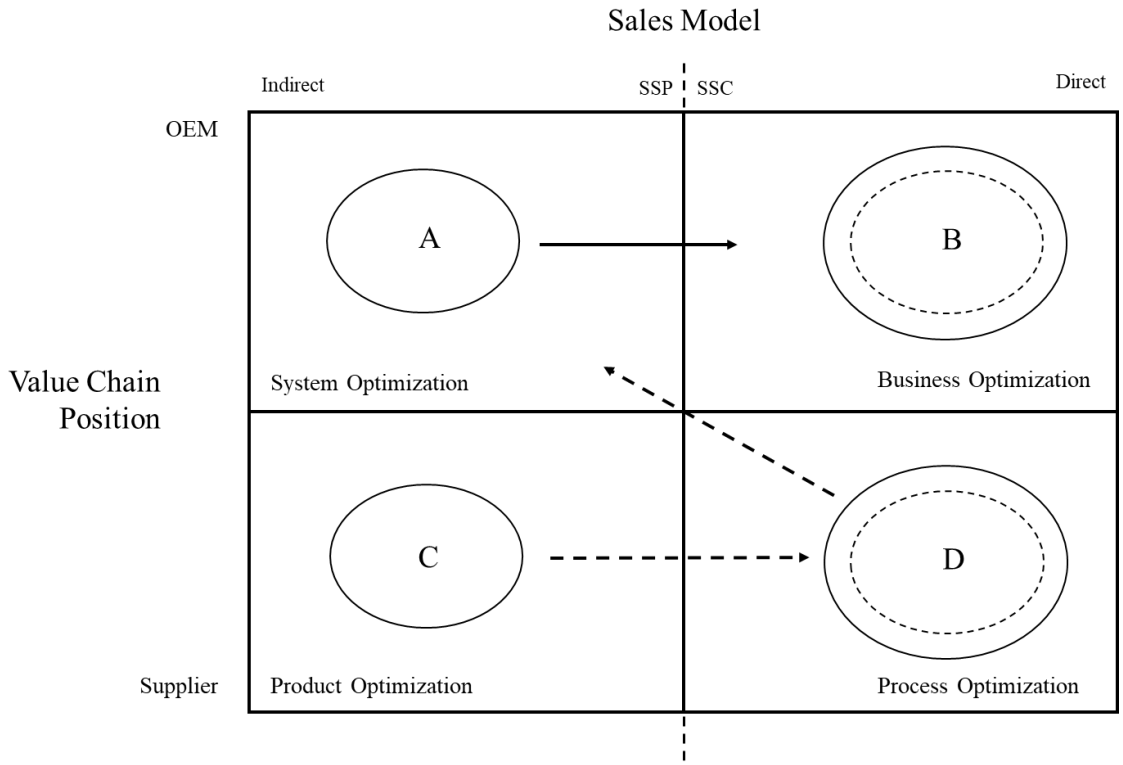

Figure 9 - The Business Model Change Matrix (Source: Paiola, 2017)

OEMs and suppliers with few experiences with final users usually engage in offering some Services Supporting the Product (SSP), involving just product or system optimization. Players with direct channels and more relations with final users Services Supporting the Customer (SSC) are preferred, in order to strengthen the already existing relationships (Paiola, 2017).

2.6.2 – Troubles to face on the path for Digital Transformation

Industry 4.0 and digital transformation do not come with no costs or troubles. Incumbent companies are the most likely to face problems during the process compared to newly born digital companies. Being first movers or set business transformation at the speed at which technology change are not the real game-changers: it would be an error to jump on every digital project just because there is potential for big returns in the long run (Vermeulen, 2017). So, companies must know the right pace suitable for their digital transformation.

Many researches show that the transformation boat hits first the rock of the company culture (Westerman et al., 2011; McKinsey Center for Business Technology, 2012; Fitzgerald et al., 2013; Arora et al., 2017;). Often executives lack impetus to undertake actions because they are skeptical about possible revenues (Arora et al., 2017) or because company's good

performance influences the decision: if everything is going well, managers do not want to interrupt the momentum (Westerman et al., 2011).

Another point is the customer-centricity of the value proposition. Often companies do not really know their customers and cannot understand their digital trend. Companies should adopt, or at least understand, the digital technologies their customers use and build their value proposition with that in mind (Wright et al., 2017). Better, they should start to think that with new digital means it is possible to co-create value together with customers, and not just propose a product to the market hoping to intercept the demand (Gandia et al., 2017). Moreover, some kinds of digital value propositions are considered more a premium than a necessary product/service feature (Probst et al., 2016).

Building this new value proposition usually lead companies to lose focus. Some managers adopt the "let a hundred flowers bloom" strategy, deciding to invest broadly and hoping for some of the projects embraced to develop successfully (Arora et al., 2017). Instead, other companies are stuck without a clear view of which is the best choice to do. The research by Fitzgerald et al. (2013) shows how in less digital mature companies fewer than 25% of the respondents perceived their leaders aligned on common roadmap to follow. The ratio increased to a bit over 40% in more digital friendly companies (Fitzgerald et al., 2013, p.8).

After the above-mentioned culture-related aspects, there are also problems related to the internal resources. New technologies require new skills, and often companies lack people with the right competencies, especially SMEs (Gandia et al., 2017). Company rarely invested in developing internally these skills because of the wrong mindset (Fitzgerald et al., 2013). Also, companies often do not know which talent is required to acquire these skills (Arora et al., 2017) and even worst, some sectors, like OEM struggle to hire and retain talents inside the company (Probst et al., 2016).

Lastly, organizations do not understand the holistic impact of digital transformation that need to be embraced at all operational levels from back- to front-offices (Wright et al., 2017). From bureaucratic aspects (Westerman et al., 2011) to sales and services (Probst et al., 2016).

2.7 – Conclusions

To sum up, we have seen how the Supply Chain and the Supply Chain Management are deeply influenced by digital technologies. Relations across the supply chains are the fuel to

make everything work. The fact that Digital Technologies deeply impact on the information flow is a disruption of pre-existent relations and it could be a cause of conflicts. Usually it happens in BtoB environments since Original Equipment Manufacturer try to overcome distributors and retailers (see figure 10) implementing digital features in their products, seeking direct access to customers.

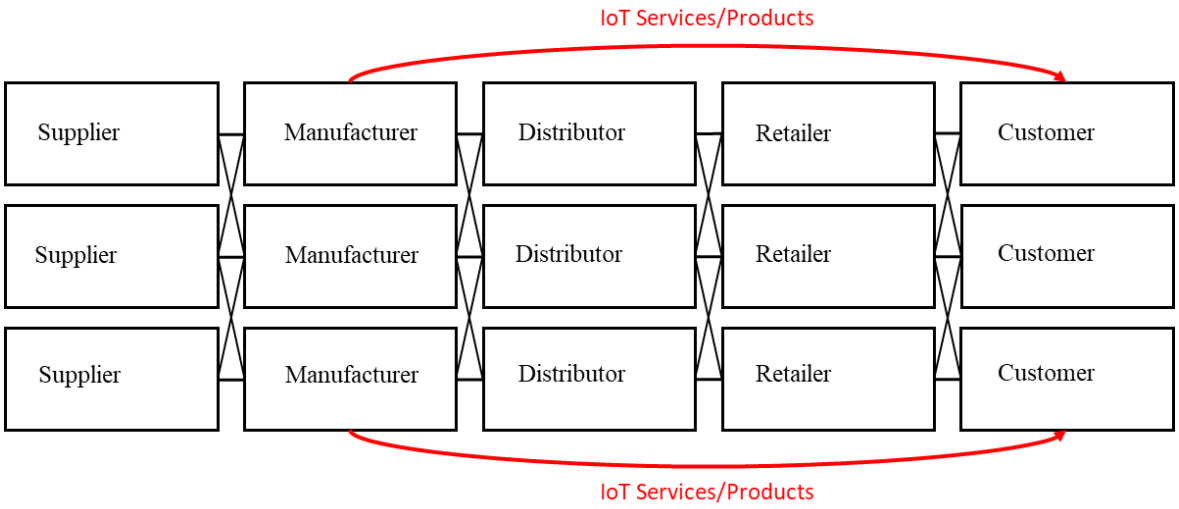

Figure 10 - The Effect of IoT Technologies on Supply Chain Relations (Source: Our elaboration)

However, we have also showed that, if players of the same supply chain manage to integrate their information flow, the transparency of the data lead to higher general value creation. Also, smart supply chains succeed in lowering the effects of the "bullwhip effect" and the consequent distortion of the procurement at each step upstream in the chain. Moreover, through the examples, we have shown the application of these technologies is already being implemented by companies in very different industries, from the mature traditional steelmaking industry to more hi-tech industry like hardware components.

We also analyzed the impact of new technologies on Business Models. We decided to base our analysis on the Business Model CANVAS by Osterwalder and Pigneur (2010) and we have seen how companies innovated their ways to carry on business thanks to new digital technologies.

Industry 4.0 is already entering many firms' business models in the shape of the 9 technologies that we presented in the previous chapter. Based on the use cases shown and many others, analyzed but not presented, we can state that usually (see figure 11):

- Technologies impact mainly on the value proposition creation, thanks to the synergies that the business model manages to create between the Key Activities and the Key Resources; we have shown in the first chapter that beside new technologic equipment and solutions, human resources are the main driver that helps create positive synergies. Having employee and mangers committed to understand the scope of digital transformation is important as well as investing in new technologies if you want the process to run properly.
- Value Proposition is strongly pushed to include digital services beside the physical product, however, many of the technologies we described impact more on operative processes than in the value proposition. Technologies targeting value propositions help companies mainly to implement new product's features and to shift from a pure product-based business model to a much more service-based one; or at least to develop a multi-layered business model. For example, integrating IoT solutions in many products is becoming mainstream in many industries if companies want to invest in Industry 4.0, especially in Big Data Analytics.
- Partners are more relevant than ever, since companies cannot develop internally all the needed skills and/or do not have the financial resources to acquire new companies with these skills;
- Channels and Relationships are critical in generating the Big Data needed to fuel Activities and Resources, revamp Value Proposition, and Manage the Supply Chain;

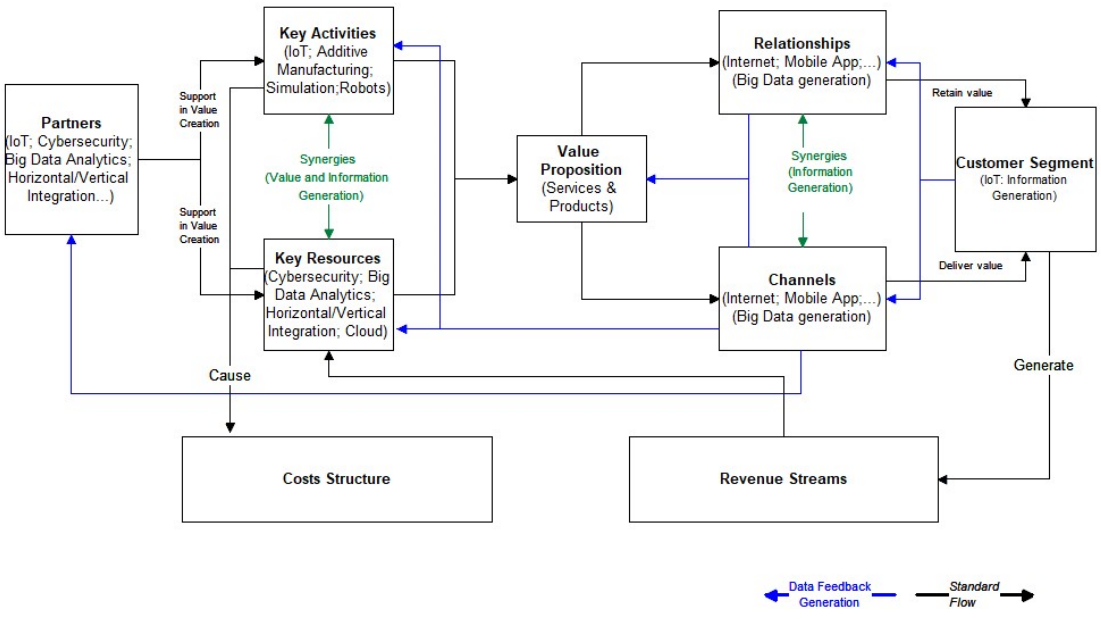

Figure 11 - Digital Business Model Dynamics (Source: Our Elaboration)

Digital Business models reshaped the dynamics of traditional BMs and increased a lot more than in the past the importance of collecting data. Nowadays, a company investing in Industry 4.0 projects will need to collect data across the whole value chain, from customers to equipment functioning, to production and shipments. All these data will need to be integrated in the whole business strategy to effectively manage the business model.

We will use the concepts acquired in this chapter to develop a similar analysis in the next chapter. We conducted semi-structured interviews with three Italian companies investing in Industry 4.0, more specifically in IoT. We will see how the digital transformation is guiding their business decisions and we will analyze the impact of these decisions on their business models.

Chapter 3 – Cases from Italian Firms Investing in IoT

After using use cases collected from other academic researches we decided to go deeper in the matter and to collect three more cases from Italian companies. The information was collected through a brief survey and a direct semi-structured interview with some executives from the three firms.

The firms were selected thanks to Professor Paiola that shared his contacts in order to help investigate the impact of new digital technologies in Small and Medium Italian Enterprises. The interviews involved the main aspect of the companies' business models and supply chain, the current digital features implemented in their products and the outlook for future investments in new technologies.

As described in the previous two chapters of this work, digital transformation is a deep and changing process that firms are undergoing. Especially SMEs can have difficulties trying to implement certain degrees of innovations, and while the term Industry 4.0 as of now is widely known by most of the entrepreneurs, it still remains a critical challenge for many firms.

With this research we tried to figure out which are the decisions that Italian OEM are likely to take. Moreover, since digital transformation forces companies to rethink their business models, we tried to figure out where the main impact will be for their business models in terms of transition from pure manufacturer to provider of different products or services.

Our interviews involved:

- A SME that produces control technology and humidification for air conditioning and refrigeration.;
- A large OEM (Original Equipment Manufacturer) that produces various equipment for ice-cream making and similar machines;
- A SME that manufactures professional ovens.

The basic framework of the interviews was intended to provide insights about the internal dynamics of the supply chains in which the interviewees operate and to understand the business models they adopted to work in their industry. With this information our aim was to analyze which are the impacts of adopting Industry 4.0 in the dynamics of both, supply chain relations and business models (basing our analysis on the above-mentioned Business Model

CANVAS). Also, we tried to understand if there are differences with the provided use cases in the strategies that Italian firms adopt in the digital transformation process.

3.1 – Carel Industries – IoT solutions for Air Conditioning and Refrigeration

We interviewed Alberto Bianchi, Group Chief Product Development Officer, and Umberto Bianchini, Chief Technical Officer. We met two times, on December 11th, 2017 and on January 31st, 2018, at Carel's headquarter in Brugine, and spent 2 hours and a half talking about their current business, the ongoing projects and the plans for future investments.

Carel Industries was founded in 1973 in Italy, near Padua and started producing steam humidifiers. After 10 years they already switched to producing microprocessors for Heating Ventilation and Air Conditioning/Refrigeration (HVAC/R). This switch highlighted the path that the company still follows, designing and producing HVAC/R solutions. In the 90s Carel opened its first subsidiaries, in order in France Germany, Brazil and United Kingdom. During the first years of the new millennium the expansion does not stop, and new subsidiaries are founded in other European and overseas countries. China, Spain, Russia, India are just some.

The geographical expansion proceeded in parallel with product innovation and the introduction of new solutions. Nowadays the company claim a world-wide scope and a full set of cross-market solutions. They serve more than 3700 customers in 87 countries generating a turnover of around €230 million in 2016, and a forecast of €254 in 2017. Their components are used in places such as The Louvre Museum in Paris or the London Underground.

The company is committed to continuous improvement. They consider their products as an innovative solution to environmental protection through energy saving. To do so, they try to develop further every product to achieve higher efficiency at every innovation. This is why they invest around 7% of consolidated sales in R&D and 3% in new production technologies.

Carel's subsidiaries work directly for the geographic region in which they are. The Italian headquarter is the hub that manages all the subsidiaries and branches. Beside the direct subsidiaries, there are some "affiliated" companies: Carel Japan, Carel Ireland, Carel Turkey

and Carel Spol (Czechia and Slovenia). These are managed indirectly by the regional subsidiary.

Commercial subsidiaries work to support customers and customize on-demand HVAC/R software. Carel aims to control directly and the most globally possible its distribution channel with the help of external agents and distributors which report directly to the regional hub.

3.1.1 – Carel: The Supply Chain

Carel is a BtoB company, and it works quite upstream in the supply chain (see figure 12). The main aspect of its position in the supply chain is that they have OEM as direct customers. This place the company in a difficult position when it comes to understand all the end-users of its product, in fact, producing components, they are a node for many different supply chains (refrigeration, air conditioning, heating…).

Upstream: Carel has no critical or scarce supplier upstream. The main technologies that they buy outside are microprocessors, but the presence of many different competitors in the sector allow Carel not to be too bounded by the relations with only few producers. The only bound they have is the economic feasibility of switching. There are consolidated relations that limit the possibility to switch, but in the case a supplier cannot renew the contract or any other similar crisis scenario, there would not be many problems to substitute the supplier. In other terms, we can consider electric and silicon components as commodities for Carel, that suffers only in terms of times to substitute suppliers. In any case, most suppliers have been working with Carel for thirty years already, with strong and long relations.

> […] currently the electronic components industry works with lead times between 20 and 40 weeks. We plan orders with a Material Requirement Planner software based on statistical analysis and sales forecasts made by our sales network […]
>
> *Umberto Bianchini*

A common issue to all the supply chains working with electronic components is the problem with lead times. An order for new parts require from 20 to 40 weeks, and it requires statistical models to plan new orders and accurate sales forecast. Usually in technology 40 weeks change completely the landscape of new products, however, since this kind of component are considered commodities, the long delay does not affect the development of new products. Moreover, the launch of a new product needs around three

years, since it is a BtoB market, components producers suffer from the bullwhip effect and distortions in the times that OEM need to perceive new market needs. Also, Carel's product have a long lifecycle of around ten years, and this balance the technology obsolescence.

To sum up, the upstream environment has no relevant issue related to switching-costs or bargaining power dynamics. Old and consolidated relations with performing suppliers are the only bound for the company.

Downstream: here we have a more complicated landscape since there are many different customers that decide to use or buy, Carel's products:

- Original Equipment Manufacturers (OEMs) are the most relevant buyer and account for the majority of sales. Here we have manufacturers of cooling appliances as well as heating solutions; producers of air conditioning equipment, and manufacturers of general equipment for retailers.

> […] To say it simply and short: we sell to OEMs. To manufacturers. Then to sell, let's say, to a Big Supermarket Chain, they do not come to us directly for the electronic component, but they buy it through the OEM they work with. They go and ask for Carel components or specific products with Carel inside […]
>
> *Umberto Bianchini*

- Spare parts distributors account for around double single digits of sales, they work mainly with installers and maintainers that need to substitute components. Rarely, some distributors have also developed some products to sell with Carel components inside, like semi-finished systems (so called Value Added Reseller);
- Installers and contractors, these two categories represent high single digits of sales;
- System integrators, accounting for a minimal part of the sales, are companies that offer to customers to organize all the building process for plants or specific areas, like professional kitchens. They contact all the suppliers and manage the whole process.

The first problem arising downstream is the distance from the final users. The only direct sales to final users are those to some Big Chains accounting for 2%. In all the markets covered by Carel the contact with the final user is rare, in the case the air conditioning solutions, it is practically inexistent.

This is due to the presence of OEMs or complementary services that are almost impossible to overcome. Here we must draw a distinction between the two main worlds in which Carel operates:

- Refrigeration: here Carel gets access to the final users since they are big chains that often integrate a technical office inside and relate directly with the components provider. Moreover, Carel directly promotes their products to these chains. With and without the help of OEMs. However, big chains have big bargaining power and rarely accept to share information regarding the use of the equipment;
- Air conditioning: this is a completely different world made of dispersed little private final users. We could just think to all the air conditioners sold in the world by big and famous OEMs to understand what is the power of the OEM in handling information about customers.

To understand better the supply chain, after clarifying the direct channels of sales, it is useful to say that the landscape further down on the supply chain becomes quite various. Since many applications for Carel products concern BtoB products, like Refrigerated Cabinets, there are many actors playing in the supply chain. This complicate even more the relations with end-customers.

A common thing that we found with other companies analyzed is that there is no standard and differentiation between installer, maintainers and distributors. Also, OEM sometimes manage to provide all the services from sales to post-sales. This changing environment create many difficulties to manage relations in a standardized way and this is the reason behind the existence of local subsidiaries: it would be impossible to manage customers from headquarters in a standardized way.

IoT and Supply Chain: we have seen how Carel is positioned in the supply chain and how difficult it is to get access to the end-user. However, the company is investing a lot of efforts in finding a way to bypass the problem. They started analyzing the opportunities to take through a special internal office. At the moment Carel offers a lot of innovative solutions but, for the environment in which they work, they cannot implement a direct control on features like the cloud system or the app generation system. The first is a cloud powered by Carel but in the hands of OEMs that provide it to the final customer if it wants, buying it from Carel. The multiplatform app generation system is another tool that OEM use to offer to develop

compatible applications with Carel components. However, also this system is provided to the end-user by the OEM that retain all the rights on the data.

Currently the company see as more effective to introduce technologies to improve the production than to improve their connection with end-users. One of the options they are thinking of is to invest in creating a separate entity. This entity will work even without the brand Carel, to provide services related to Carel products to end-users, and improving the relations and the information sharing. However, adopting this solution may present problems related to multiple business model's compatibility.

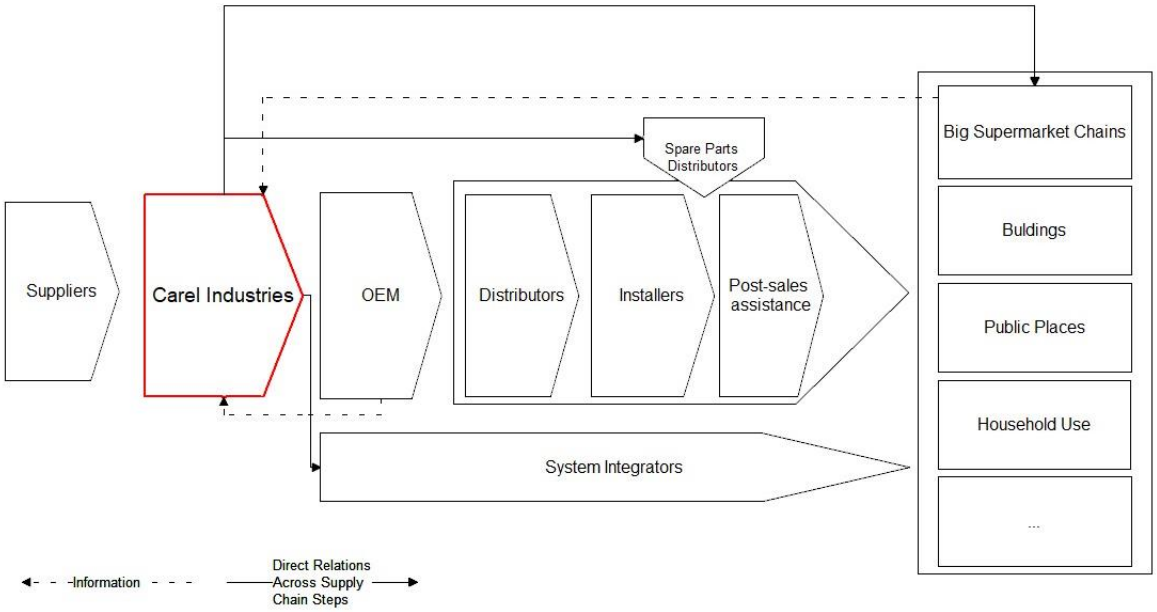

Figure 12 - Carel Industries' Supply Chain (Source: Our elaboration)

3.1.2 – Carel: The Business Model

The main customers of Carel are OEMs. As said above they account for nearly the 70% of the sales. There are a huge variety of customers depending on the peculiar applications of the Carel products. They range from air conditioners manufacturers to companies producing equipment for supermarket chains or ventilating systems. It is not simply to indicate the most important customer, but during our interviews we have been told that to understand Carel's supply chain and business model it was useful to focus on refrigerating and air conditioning sectors. Since the products are components with a narrow and very specific range of applications it is not too difficult to segment these BtoB customers, while the end-users are really varied.

Cleanrooms, data centers, supermarkets, hospitals, museums. These end-users have in common Carel technology in the equipment they use: electronic controllers, humidifiers, valves, sensors and monitoring systems. Carel develop these technologies to ensure general efficiency and energy saving in complex systems. Carel focuses on two areas to improve with its products:

- System solutions, those which aim to improve the efficiency of large spaces. In this case different systems are integrated in a bigger and more complex system that is optimized to run efficiently many different equipment. It is an example the management of a supermarket, in which the warm air conditioning in winter may conflict with the need of the cooling systems of refrigerators. Through Carel solutions, the system can find a balance between the single units and cut the energy spending;
- Unit control, focused on the single machine. It permits to control the routine of the machine and to implement specific algorithms to run it with the most efficiency. To stay in the example of the supermarkets, Carel analyzed that over 50% of the costs are related to refrigerating units, the second most costly item is the one for air conditioning. They developed new electronic expansion technologies to save more than 20% of the costs related to the unit. In parallel, they increased the performances of the compressors and decreased the malfunctioning cutting maintenance costs.

Carel's business model is close to those born in the last few decades with the rise of IT and electronic (see Figure 13). The sum up of Carel's value proposition is in the statement they adopt and show around in their website and other medias: *High Efficiency Solutions*. The focus is to build a component and provide a related software to implement and manage it in more complex systems. In fact, the most important and distinctive feature of Carel's value proposition are the suite provided with the product. Basically, they create an environment that OEM or end-users, if provided, can use to manage specific tasks or functioning of the product with built-in Carel's components.

More specifically, Carel provide a suite with all the electronic components that exploit a simplified system for the development of the algorithms governing the system. They provide a suite to optimize the consumption, another suite to manage the supervisory unit, and another one to develop apps compatible to the components, in this way the OEM can create its own mobile application for end-users.

This variety of solutions they provide has a fundamental reason: OEM wants to develop unique products. Carel components account for up to 10% of the final value of the product. However, Carel (as well as all the companies seeking for scale economies in the same industry) cannot afford a business model based on custom components. So, they decided to develop two solutions to handle the problem:

- Create almost modular products: they developed a durable platform that works as basis for modifications and products incremental innovation; it has been described as something similar to what happens in the automotive industry in which the same platform is designed to work with different cars, but also different accessories with standard connectors. This is also a choice to efficiently change the parts more affected by technology obsolescence, keeping the base platform and changing few parts;
- Provide ad-hoc suites that work as do-it-yourself kit through which OEM and others can develop their own management system.

> […] To sum up in few words our Business Model: we work with OEM and we do not just manufacture controllers, we provide suites to manage controllers. We do not just manufacture supervisory systems, we provide suites to manage sensors. The OEM finalize the product. […]
>
> *Umberto Bianchini*

The main channel Carel use to deliver its solutions is its international salesforce network. They have a wide range of countries covered by their direct subsidiaries and branches. These work to aware customers of the value of Carel's products and work to exploit upselling and retain customers.

Salesforce is also an important key to maintain customer relations. Differently to the two other companies analyzed, Carel is disentangled from the post-sales process at the end of the supply chain, so they relate only with other companies. This permits to maintain the relations also on a technical level. Even if in the past they experimented with partnerships with customers to develop specific customized solutions, they do not like to do it since usually they have to sign for giving the temporary exclusive to the partner, and this impact on costs due to and arising costs related to missed scale economies and other hidden costs that are rarely predictable.

The production system that Carel adopt rely a lot on scale economies and regional localization. All the products are produced in the regional plants and distributed in the competence area. Having multiple plants has been a decision driven by two points:

- Having a "disaster recovery plan": Even if contrary to the everyday practices, it happens that a plant in a region produces for another one to fix emergencies and serve orders at risk;
- Cost cutting: shipment costs, together with costs related to tariffs and other taxes, impact more than labor on the pricing of the finished product for abroad countries. Having plants close to the region served is better in terms of economics and marketing factors. Also, it helps to exploit overcapacity of specific plants.

> […] Suppose that during that a malfunctioning occurs, or that a freezer is shifted from stocking cheeses to vegetables: the functioning parameters are not the same. So, you have to do the commissioning. To set-up again all the new parameters in case of use shift, or to implement the old ones in case you change the freezer with a newer one [...]
>
> *Alberto Bianchi*

The company's focus on the activities to perform helps the overall cost saving and scalability. They claim to be "lean" since many years already and they develop internally most of the innovations related to the production. They spend 10% of the sales in innovation: 7% in R&D and 3% in general improvements of the production systems. They also built two laboratories to keep in-house researches in matter of thermodynamic and humidification.

Beside to the physical resources made by plants, laboratories and production systems, we highlight how human resources are a relevant asset since they employ 1426 people, of which 55% are graduated. Moreover, with reference to the Italian headquarter, around the 25% of the people are dedicated to R&D activities. The kind of product that Carel produces need high-skilled developers, mostly engineers and similar. It would not be possible to deliver all the bundle component with suites if the human resources were not able to develop, update and innovate such solution.

Currently, as we mentioned earlier, Carel is investing in develop a parallel business model based on services. Their aim is not to leave behind the one that is already running but find a

new complementary model developing a new value proposition. This would have the double function of:

- Get closer to end-user and data generation;
- Access to a new source of revenues;
- Secure against possible disruption in the industry related to new-comers offering similar services related to the software developed by Carel and similar;

IoT currently is not easy to implement to the value proposition. OEM constitute a major barrier to its development. Better, Carel already offer the possibility to connect the products using their components, however, OEM do not let the company access the data. Supervisory units are an example of the connected devices that the company offers. They are sort of basic PCs working as interface to do three main tasks with cooling systems: 1) visualize reports about energy consumption and other specifics; 2) sending alarms and notifications when malfunctioning occurs; 3) manage the commissioning of the equipment, the process through which are implemented specific parameters related to the use of the equipment.

Another IoT application they developed is a Cloud based platform that the OEM can use to update products. The OEM could develop an update, upload it on the cloud and permits to the connected equipment to autonomously download it. Currently, Carel in this system plays a secondary role releasing only the virtual machine that will be the base to build a new update. They could implement an entire service provider business model if they manage to start providing the software update in place of the OEM, however it would be difficult since every equipment has different configurations made by the OEM that does not want them to be disclosed.

The business model Carel runs, offering its bundle made of component and management software, can be summed up in three characteristics:

- Modular products produced in multiple plants, in order to standardize production and sell on catalogue-base;
- Let OEM customize their product with Carel Suites. So, the differentiation from competitors is made by customers themselves;

- Lock-in customers with the Suites. Since there are no competitors, even bigger than Carel, providing all the solutions that Carel does, the change would entail switch-costs and less benefits related to customization.

Our business model is not easy to replicate. Competitors tried to do it. Even companies much bigger than us, but they eventually failed. A business model is not just the engine, just the gears that you can see. There are relations and conditions that are difficult to replicate, even for big companies […]

Umberto Bianchini

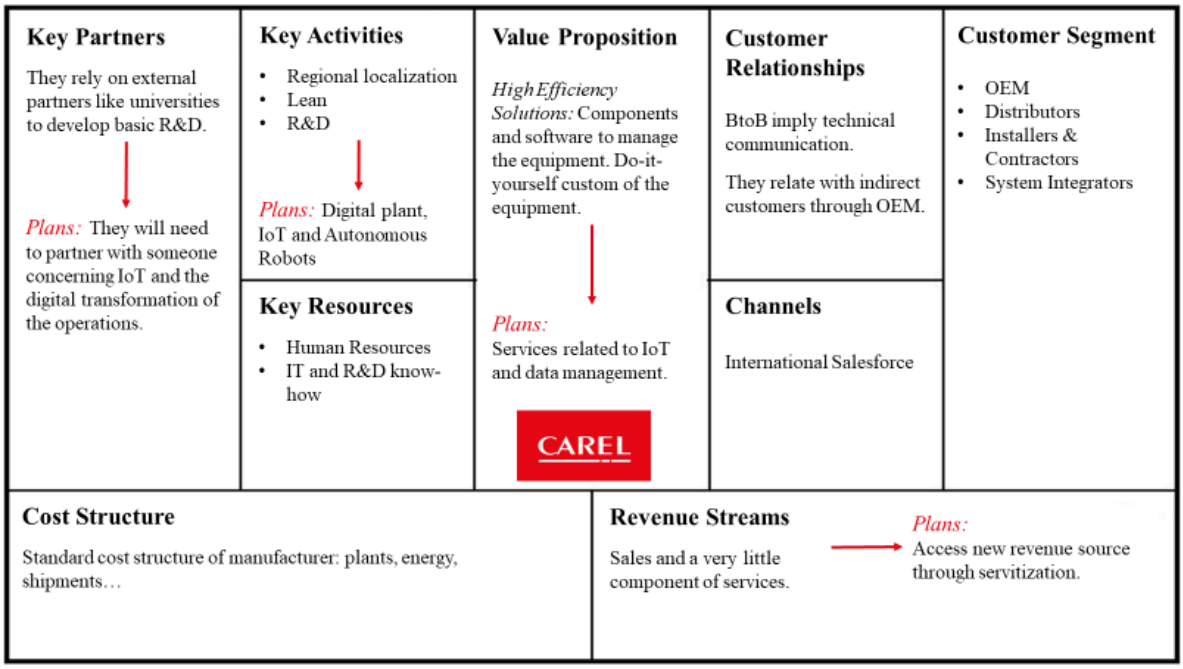

Figure 13 - Carel's Business Model (Source: Our elaboration)

3.1.3 – Carel: Plans for the Future

Carel is investing heavily on many different fields. Taking in consideration the nine technologies presented in the first chapter, the company is investing in almost all of them. The focus of the investments is on both side, production improvement and value proposition. However, they do not that Industry 4.0 is not an innovation for their business model, since they invest continuously in technology improvements.

The first improvement they plan to invest in is the digitization of the company's processes. The goal is to implement an end-to-end system that automatize the processes from the order reception to the shipment. It does not involve only the orders management but also

Autonomous Robots and Industrial Internet of Things applied to the production line. The project was ongoing at the moment of the interview so there were not many insights to get. To have a better idea we can use an easy example: just assume the customer want a Carel's parameter-based equipment, there is no software inside, just control parameters. If the customer wants a specific configuration of the parameters, in an ideal system the order is processed by the system that create a specific Bill of Materials (BOM). The BOM is expected to produce a file that goes to the test machine related to the equipment. At that point the machine can automatically change the label and the information for the shipment and process the shipment order. All of this without human labor.

On the field of IoT, they especially work in two fields. First, connected devices, to integrate the function with the suites they provide. Second, the most important, is related to the improvements related to the production. They are investing in IoT to improve efficiency and quality of the production. In this case we talk of Industrial IoT (IIoT) and it will be helpful in developing the other idea of the end-to-end system.

Another major innovation is related to Artificial Intelligence. In the sector of air conditioning they are investing a lot of efforts in the R&D department to develop a system to render homogenize data from different air conditioners. The system is based on Artificial Intelligence algorithm that permits to compare in standardized way air conditioners placed in inhomogeneous places across a region. This process of homogenization of the data is helpful to understand if there are variances in the performances of the equipment.

The first important feature of such system is the possibility to homogenize even different type of machines. It will be the inferential engine to clean the "noise" and give clear results thanks to a neural network. With this tool, the application of the system permits to compare the performances of different stores and outline the machines that perform better and consequently decide whether to change or repair the less performing.

The second feature is the possibility to implement preventive maintenance: the output data show where the variance is and help to understand which machine is not working. When the target is identified the system can help identify which component is the problem, plan the preventive maintenance in order to fix the problem and intervene before the machine gets broken. With further researches this system could become even a more useful tool, in fact,

with technology advancement it could make possible to implement predictive maintenance, a step further compared to the preventive maintenance.

To invest in these innovations Carel needs to find many skills and know-how that now they do not have. To do this they started to partner with Padua University's spin-offs to develop further the machine learning. The same is happening with other applications such as the research and implementation of autonomous robots.

Further opportunities: even if the outlook is not positive concerning services implementation, we think that Carel is doing the right thing in trying to switch from a single business model to a multiple business model in which manufacturing and services co-exist. They are planning to switch in the next years to this model to secure from disruptive new competitors and to add a new revenue source. In fact, they will probably separate completely the two models, separating also the revenue generation.

In this context we think that a useful use case could be IBM with its Watson service: during the interviews we have been told that now Carel works as a sort of Intel for HVAC/R sectors, but they cannot exploit a model similar to the "Intel Inside" creating a sort of "Carel Inside" since OEM do not want to show which components they use because many of them use the same parts. If this would happen, they would lose the differentiation advantage they have with their competitors.

In this case, Carel should leverage more on providing distinctive services that do not entail the end-user information directly. With this in mind, we think that Watson by IBM could be a service that similar in some ways to the one that Carel is developing. In brief, Watson is an AI programmed to analyze data and learn from them. The applications are many and range from performance monitoring to scenario planning. The source of power of the AI are data, and an environment rich of data provided by IoT is the perfect fuel for Watson.

Carel is developing right now its own Artificial Intelligence algorithms to homogenize the data from smart connected equipment (for now air conditioners). If they invest in leveraging this kind of solution and manage to scale up and realize an AI they could apply it to different types of products and places, and to new business-sensitive areas. For examples, the scenario planning could show solutions and related costs in case of malfunctioning of a piece of equipment. Let's say that a freezer stops working, the AI could provide to the store manager

the exact plan to quickly rearrange the products in the freezing in other freezers and suggest a new commissioning while waiting for the maintenance.

All of this could be provided as a service completely detached from the usual suites. In this case Carel would achieve two benefits:

- Get the data: they could make different plans with privacy options for the data, however, providing the software as a service, they would retain the property of the AI and the improvements it gets from running more and more data would increase the value and the accuracy of the AI itself;
- Multi-layer business model: they would run a second business model provided to customers and not, with all costs and revenues related. This would require a lot of efforts in developing the appropriate know-how, but we think that would eventually payback.

3.2 – Carpigiani – online support for gelato equipment

We met with Carpigiani two times in December. The meetings took place in Padua, on the 13th of December 2017 and at the company's headquarter in Anzola dell'Emilia, near Bologna the 22nd of the same month. We talked with Emanuele Barbieri, After Sales Director and Irene Marchetti, Software Engineer responsible for the Teorema® system. We discussed of their intention to develop new IoT solutions for the after-sales service and about the importance of a business model with double focus: on production and on after-sales.

Carpigiani is an Italian firm founded in 1946 and rapidly became the leader in manufacturing Italian-style ice-cream machines. Now they also produce all sorts of equipment related to soft ice-cream, pastry, frozen yogurt, shakes, slush and whipped cream. From being the Italian leader manufacturer in the fifties, now Carpigiani is the main global equipment producer and over 100 million people eat ice-cream produced with Carpigiani machines every day.

In the fifties the company opened the first European branch in France and already in the sixties and seventies the company started to develop an international market reach, opening overseas branches all over the world, also thanks to the spread of the Italian-style ice-cream

abroad: United States, Brazil, Argentina and Switzerland are the countries targeted in this period. Over the following years the internationalization process did not stop and Japan, Germany, United Kingdom, Northern Europe, Spain, China, India are as of now part of the Carpigiani network.

Today Carpigiani a turnover of €155 million, generated 15% in Italy and 85% internationally. Its installed base is around 1 million units with estimated around 700.000 active machines. Carpigiani. Productive plants are in Argentina, through a joint venture, in Valencia, Spain, in Forlì, Italy, and in the Guangdong province, in China.

Carpigiani has an international network with 8 branches worldwide, over 500 service centers Carpigiani, and more than 200 qualified distributors. All the qualified distributors, beside the show-room, can provide immediate availability of parts and components, other than project, commercial and post-sales assistance.

There are three kind of service support functions. The service centers, supported by engineers and technical specialists from the headquarters and the 8 world branches to guarantee reliability and availability of the services wherever and at any time. The technical support service, that provide all the maintenance and spare parts needed to keep performing equipment. The Customer Quality Service (CQS), the after-sales service that since 1995 works to provide customers with fast response to problems with traditional means, such as call centers, and more innovative, such as the Teorema® system. Moreover, the company can also boast the only post-sales service available world-wide with qualified technicians and original spare parts.

Carpigiani's equipment is one of the most reliable. The company can boast of its international technology leadership. A discrete amount of the revenues is reinvested every year in R&D to improve performances of the equipment. The innovation process involves people from many different areas: from marketing and salespeople, to engineers and even the experts from the Gelato University. All of them have a key part in providing suggestion to increase quality and usability of the machines.

Indeed, Carpigiani also invests part of its budget in spreading the Italian gelato culture. They opened the Carpigiani Gelato University with the aim to help people in foreign countries to learn about Italian-style ice-cream. The university is a hub where more than 30 experts teach

more than 300 classes yearly in many different languages. Also, the company has created a museum where people can learn about the history of the ice-cream making from ancient times until now.

3.1.1 – Carpigiani's Supply Chain

Carpigiani's supply chain has a traditional shape common to many Original Equipment Manufacturer (see figure 14). The main suppliers *upstream* do not represent an issue in terms of supply chain critic points since they mainly provide commodities and Carpigiani. Besides, being the world leader in its industry, Carpigiani has quite a bargaining power when it comes to negotiation.

Downstream: Carpigiani has three main customers:

- Distributors: usually they work on a geographic-base serving a specific region. Carpigiani sells directly to them and then they distribute the equipment and provide post-sales, maintenance and set-up services;
- National and International Chains: typically, they relate directly with these customers through service companies. Even if there are intermediaries, the relations are considered direct relations;
- End-Customers: the headquarter does not relate directly with end-customers, however, the subsidiaries do.

Carpigiani is a BtoB company, so distributors are the main customers and can be considered a barrier to overcome to access information related to end-users. However, thanks to the world-wide presence of the company and the existence of a post-sales department at Carpigiani, the company suffers only part of the distance from the end-user they do not relate with directly since distribution is not an in-house function. It must be considered that the company operates on a global scale, thus it is not easy to manage all the relations with many different end-customers world-wide. Moreover, the geographic location

> […] Typically, we consider production as centralized and services as local, since they depend on many local factors, such as culture, relations and understanding of local rules. Where is the complexity? It is in making people from all over the world, Chinese, Australian, Americans or Brazilian, in the same way, to provide services at the same level […]
>
> *Emanuele Barbieri*

of some end-customers complicate activities: we have been given the example of the Philippines, where the location of the users in many different islands makes difficult for distributors and especially maintainers, to reach them time-effectively. Another country-based characteristic is the size of the distributors: usually you will find big regional players abroad, while in Italy the market is made of smaller and more dispersed companies.

As well as in other supply chains, the borders between distributors, installers and post-sales services are not defined. The only defined aspect is the Carpigiani post-sales service that manages relations with qualified maintainers, installers and distributors through the subsidiaries instructed by the headquarter. Usually, when Carpigiani deals with big chains, it works in pair with service providers, especially abroad, since the distributor is bypassed and there would not be direct service for installing or maintenance.

Their main competitors are other OEMs from different countries, however, producing 50% of the machines sold in the world, Carpigiani has very few companies that manage to compete as peers on a world-wide scale. More specifically, the main competition comes from soft ice-cream machines makers since most of the global ice-cream demand is composed by soft ice-cream. In many countries like US it is the most common dessert sold in fast foods and usually also in restaurants. Italian-style ice-cream is mostly produced in Italy and few more countries like Argentina, Germany, Japan and United Kingdom.

IoT in the supply chain: Carpigiani is starting now to invest in IoT, however they already have a system that enable remote monitoring for the maintenance. Teorema permits to the headquarter of Carpigiani to see in real-time reports of the installed base's functioning. Through the system they implemented already ten years ago, the data about malfunctioning are shared across the supply chain among the players working in the post-sales service. The services are clustered on a regional-basis and maintainers need a specific login account to access the data about their territory. They could be distributors as well as service providers, it depends on the customer that owns the machine.

The important feature of the Teorema system in the supply chain is that it makes way more efficient the information sharing. There are four levels of information that the system filters based of the level of the account that accessed. Customers have just the basic info, User Admins have just a few more data, then Technicians that also gets email alerts, use reports and other insights, and lastly the Technician Admin, usually a Carpigiani engineer or a

specially trained technician, that also have remote access to the equipment. This information sharing improved a lot many different aspects of the supply chain but mostly:

- Timing related to the first-time exit of the maintainer;
- Percentage of successful fixes at the first-exit (first-time-fix);
- Downtime duration of equipment.

This system is a service on which the end-customers of Carpigiani can rely. This improves the relations with both customers, that get an efficient service, and maintainers, that need the system to cut costs and optimize the workflow.

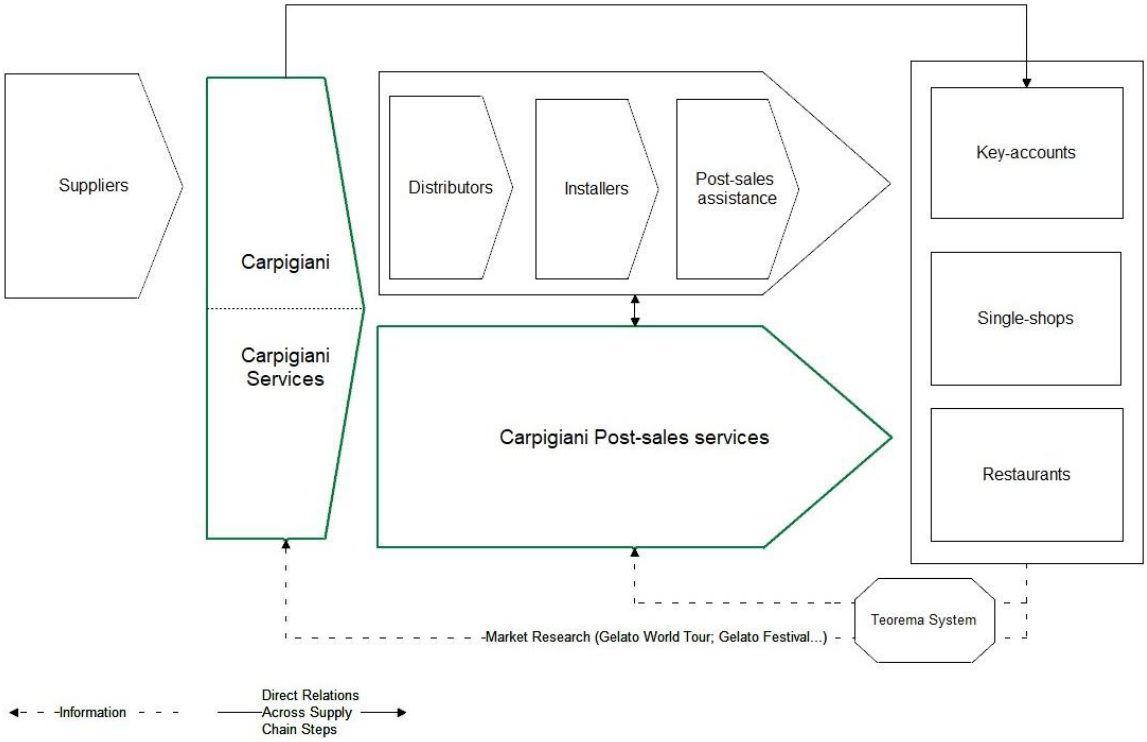

Figure 14 - Carpigiani's Supply Chain (Source: Our elaboration)

3.2.2 – Carpigiani: The Business Model

The first thing to highlight is that Carpigiani run a multiple business model in which the product and the complementary services work in parallel. During our two interviews we asked for information about the general business model related to the product, however, the main focus stayed close to the post-sales business model (see Figure 15). To give a general view, Carpigiani has the traditional business model of a manufacturer integrating post-sales services: the customers buying their products are other companies, however the relations with

the end-users are not established. Beside this, the manufacturer provides specific services in terms of post-sales assistance if something wrong occurs with the equipment sold.

Carpigiani's products arrive to many different end-users. The three main segments are:

- Single Shops: kiosks, ice-cream shops. They sell directly to the consumer and typically they are highly specialized in selling ice-cream;
- Restaurant chains: they also sell ice-cream to consumers, but ice-cream is not the core-business. It is usually a dessert. Here there is a higher probability, compared to the previous segment, to see sales of machines not specifically related to ice-cream.
- Key Accounts: they are not common in Italy. They usually ask for machines producing both, soft and Italian ice-cream.

To focus more on customers, the company decided in 2014 to separate the business in two different sales areas to improve organization and develop a more specific know-how in relation with the area served:

> […] We are described BtoB, Business to Business, but we define ourselves as BtoCtoB, Business to Consumer to Business. We look at the needs and behaviors of our end-customers. We look through market analysis, for example with our Gelato World Tour, if there are opportunities for fresh ice-cream to enter the market, in the case we give suggestions to those who thinks to start […]
>
> *Emanuele Barbieri*

- Chain solutions: McDonald, KFC, Pizza Hut but also IKEA are just some names of chains that use Carpigiani's products. In this case most of the equipment sold are related to the soft ice-cream. These chains are more operations-focused and need a product designed to standardize, reduce human labor and facilitate the maintenance. Usually this kind of equipment does everything automatically, also pasteurization. The operators just need to refuel the machine with the ingredients when they run out and ask to service providers to wash the components every few months;
- Professional: more focused on single shops and Restaurants, where the focus is on the quality of the product and the business usually is run by few people in an ice-cream shop. In this case the machines required for the ice-cream are pasteurizer, batch freezer and aging vats. The first sterilizes the mixes, the second mixes the solutions until they are creamy enough, the third allows the mixtures to thicken naturally.

Carpigiani provides solutions to both the industry, soft and Italian ice-cream, however, they try to spread the culture of Italian ice-cream to the world. For example, market analysis show that Americans and Australians are the biggest consumers of ice-cream, Australians, in particular, eat up to 30kgs yearly, however it is industrial ice-cream. Bring to these markets more awareness about the Italian ice-cream would increase a lot the sales of new equipment. To do so Carpigiani levers especially on factors related to nutritive aspects, like the less fats in the Italian gelato.

Two important *channels* they use to aware potential customers and at the same time collect information are:

- Gelato World Tour, an event sponsored by Carpigiani that tries to bring the culture of gelato abroad. During this event, consumers are invited to taste gelato, learn how it is made, which are the main characteristics of this food and attend to the competition between ice-cream makers. This event is strategically important since it is useful to measure the propension of people to eat Italian ice-cream and see if there are margins to grow in the area.
- Gelato University: it has two functions. It is a first channel to aware potential customers about the art of ice-cream making. Providing lessons and consultancy even on managerial aspects about ice-cream shops. This link the people to the company and somewhat ensure that they will probably become new customers if they will open a shop. Also, the university works like something between an R&D department and a tester for new products.

Carpigiani *value proposition* can be synthesized in two factors: 1) high-quality products; 2) high-level services. They claim to be a premium company when it comes to ice-cream machines, and they guarantee long-lasting and performing equipment. Besides, the services are the tool the company use to retain customers, lever on upselling and generate revenues. The reasons behind the choice to internalize after-sales services are three:

> […] Who deals directly with the customer, owns the customer […]
>
> *Emanuele Barbieri*

1. Prices of equipment are going down because of competition, so the company needs to develop a parallel business model for revenue generation;

2. Better understand customers' need and behaviors to fuel innovation and product development, not just sales;
3. Margins are higher in services of around 10/20% compared to equipment sales.

Indeed, Carpigiani post-sales services account for 12% of the total revenues, 44% of which is due to the subsidiaries. The competence division between headquarter and subsidiaries is quite sensible: subsidiaries work to attend quickly to customers' need. They are the operating arm of the company that knows the environment and the customers they work with and try to implement at the best the directives of the HQ. Instead, the Italian headquarter has the leading function. It develops procedures and standards, does market analysis and field research.

The services related to technical assistance evolved a lot in the last years. Once the *key activities* were on-demand: when the customer had a problem, he used to call the assistance and ask for repairmen. In this case providing a service is not so far from selling a product: the customer called for assistance that basically sells a component and the related set-up. The very base of the business model of the post-sales assistance are still the spare parts. There are three types of spare parts: consumable parts, that tends to wear out with time, accessories and upgrades, that still are not so spread in the ice-cream industry, functional parts, the core components that could get broken.

Now, with the technology innovation and the division of competencies, the service is made of two steps: first the headquarter provide tools and rules for Customer Relationship Management (CRM) in order to standardize the best practices and the data collected about customers and empower subsidiaries with a useful tool to understand better local customers. Then the subsidiary must deal with the customer without an invasive control of the HQ but applying the systems provided. With this tool the company can record and analyze the customers and measure the use of the machine. In this way the old maintenance service, close to mere spare parts sale, becomes a preventive service to avoid malfunctioning.

> […] Let's say that after-sales bring a sort of "consultancy" to the customer. We must help our customer so the he could do well its work. The equipment is perfect only if the customer can perform its business […]
>
> *Emanuele Barbieri*

Other two services that Carpigiani provides are:

- Cleaning: all the equipment needs a periodical cleaning that ranges from every three days, for the not-pasteurizing equipment, up to 42 days, for the newest models that implement an automatic pasteurizing model (typically the machines for soft ice-cream). The process consists of a disassemble of key parts and the accurate cleaning of every piece. The company is partnering with McDonald to extend the range up to 90 days;
- Labor: the periodic maintenance of the equipment and the warranties extension with service packages that ensure with complete maintenance, cleaning and assistance.

To develop further the services provided, Carpigiani is investing in innovation and technology advancement. The R&D department was born as internal, then after being put under the Post-Sales Division it is now external to the company.

> […] In the future we see the possibility to implement further the CRM. Imagine the technician that update the entry related to an intervention right after he goes away from the place. The system notifies the completion and an operator call the customer to ask if everything has gone well, if there is anything else that they need, and so on […]
>
> *Emanuele Barbieri*

The main *partners* for the Research and Development are universities: Padova for the researches on refrigeration, Bologna for Food Science and Ferrara for Software Development. The Teorema system itself was developed ten years ago with the contribution of Irene Marchetti while she was at the Ferrara University.

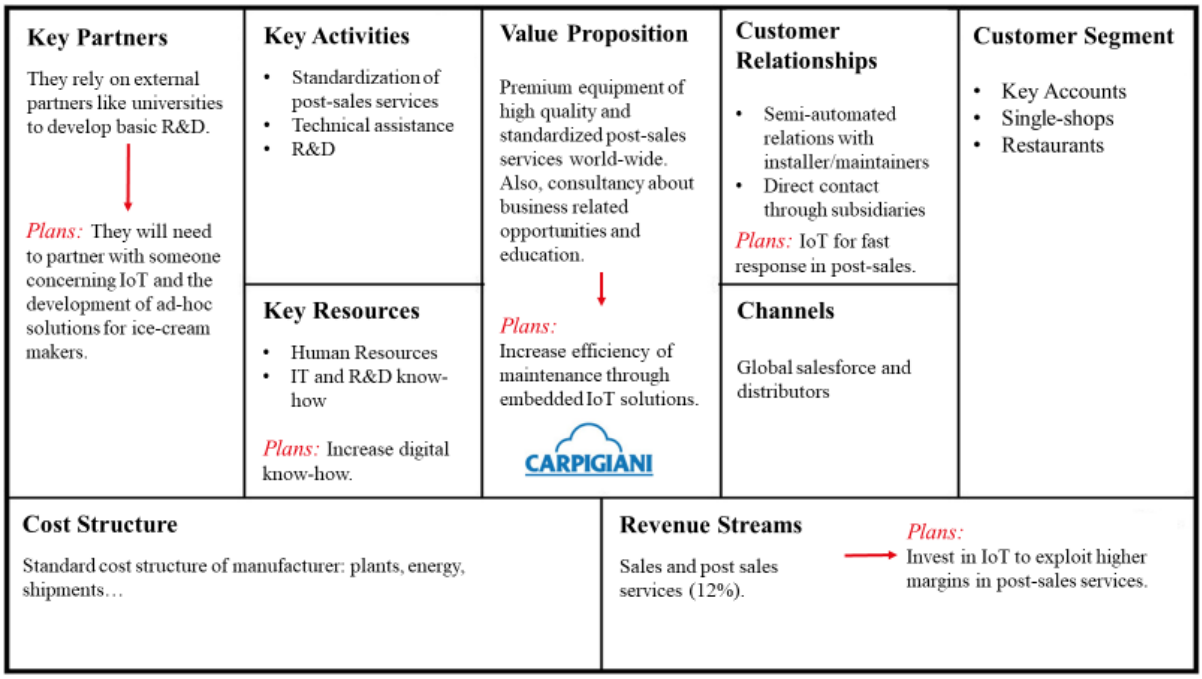

Figure 15 - Carpigiani's Business Model (Source: Our elaboration)

3.2.3 – Carpigiani: Plans for the Future

Carpigiani is a company focused on product development and it technology improvement. This is why they invest a lot in the development of new technologies to implement in their machines. However, the development is currently more focused on mechanical and engineering aspects than on digital features. However, we collected few examples of the digital technology already running in the company.

The first and most basic technology Carpigiani implement is an online platform for service providers. They can find online many information and confidential technical data about Carpigiani products. This has the double function of provide a better service to the end-user giving access to detailed instructions to external technicians and to rise the trust of the service provider in Carpigiani services.

The above-mentioned CRM tool is integrated with a mobile tool that helps technicians to register the operations performed. When the technician finish, let's say, the change of a component, then he could upload a report to the CRM platform providing data about the intervention and other information. This helps to keep update information about customers and helps the preventive maintenance.

The Teorema system is the most advanced digital feature in Carpigiani's products. It is a connected device that monitor in real-time the machine and give insights about what is going on. We mentioned already how it works on levels of confidentiality and give access to different information to different people.

Machines implementing Teorema have an integrated hardware made of a GSM antenna and an electronic control unit communicating with the CPU. The machines share information with a server that upload all the data on an online platform where customers and technicians can access.

The system collects and shows data concerning three main areas:

- Technical Data: temperatures, engines status, pressures, …
- Functioning Data: pasteurization completion, alarms, cleaning status, …
- Production Data: number of portions, number of use hours, …

The system can be accessed with any laptop through a web browser, while customers also have the possibility to log-in through smartphones to see the status of the equipment. Also, the system automatically alerts technicians in case of malfunctioning.

Carpigiani is the owner of the data and can perform Data Mining to collect more information about machines and improve the products according to market specificities. Also, the engineers from the Headquarter can intervene remotely if alerted by the in loco assistance, and along with remote fixes they can provide software updates.

The customer has the advantages of a fast intervention by the service provider with two options:

- Phone-fix, the technician can see the in real-time report and together with the customer explanation can remotely fix the problem. In this case the main features are the real-time reports, since, as we have been told, the phone-fix until few years ago was practically impossible since "describing the exact cause of the malfunctioning is difficult for the customer as well as it is for patients to describe to the doctor what is the reason for the pain";
- First-time-fix, the service provider already knows thanks to the reports which the problem is, or at least which components are involved, and this increase the

possibility of going to the customers with all the needed tools and spare parts. In this case the customer will have the equipment running right after the reparation is completed.

The Teorema system is currently implemented to the soft ice-cream machines since they are a more "closed" environment from which extract and monitor data. It is also useful to the customer to print HACCP and similar sheets to assess if the pasteurization worked properly. While the benefit on the technical side are huge, still there is a lack of features more business-oriented so that the user can get useful insights to use in carrying its activity. Carpigiani is investing to remedy to the situation.

For example, during the interview, Irene Marchetti told us that Carpigiani has in mind to start a project regarding big data analytics, however there will be some issues regarding privacy, especially with big customers like McDonald, that do not want to share data.

3.3 – Piron S.R.L.: bringing IoT in professional kitchens

In November 22nd, 2017 and January 26th, 2018, we met with Piron at the headquarter in Cadoneghe, near Padua. We had the opportunity to interview Davide Tommasin, Project Manager, CIO and IT Director of Piron. We spent together around three hours and our meetings involved current business model, their plans to introduce servitization through IoT and the supply chain in which they work.

Piron is a young Italian company founded in 2006 that already sells world-wide its products. The company has €5,518 million turnover, increased of around 18% from last year, and its main products are ovens for professional cooking. All the products are made in Italy and the small enterprise (currently it has 31 employee) is proud to be considered as an "ambassador of the made in Italy".

Through its distributors Piron's ovens are sold in 60 countries, especially in Northern-Europe, North-America, Sub-Saharan Africa and Asia. Currently, the focus of the company is on developing further the product and they do not think to start to sell directly their products. Indeed, around 20% of the staff is employed in Research and Development.

Piron's products can be divided in two generation: the older, that still contribute largely to the sales, and the new generation, the Explora ovens, which introduces digital and design innovation. Professional ovens have quite a traditionalist market in which end-users prefer to stick with older tools they already know more than switch to more advanced technologic solutions. For example, the old product line Colombo is still one of the most sold by the company even if they use both, analogic and touch inputs. This is because the average chef feels better to have at its disposal the analogic knob just in case the electronic touchscreen shows some problems.

Two years ago, Piron decided to make a brave step that actually is paying back the company. Launching the Explora model they have been the first oven producers to adopt only the touch-screen interface for a product, putting aside the knob interface. Moreover, the new design has a built-in touch-screen that is completely flat being under 5 mm of glass and characterizing the special design of the oven's door.

These two "little" features are the results of a deep research carried on internally and through a partnership with a spin-off of the University of Padua. The touch-screen interface needed an Operative System (OS) that has been developed by the R&D, moreover, many digital features are supported by the system and are the main product innovation. To permit to the touch-screen to work properly Piron needed to partner with Matech (the spin-off of the University of Padua) a company specialized in development of new materials. So, the two companies patented a new material that enables a higher thermal insulation. This is to avoid that the high temperature that the oven reaches could alter the functioning of the display and the electronics since they are integrated inside the door.

Explora provide the most typical functions of professional combi cooking ovens: they use pressure-less steam, convected heat, or a combination of both to cook dishes. Also, the oven has many traditional options such as the possibility to program the timing for cooking, or the possibility to monitor temperature, humidity and other internal variables. Another technical feature, that is a differentiation point compared to competitors, is the possibility to program the washing of the chamber. Through the display you can select which kind of washing program you want and program it for the time you want: the oven will start it by itself.

However, the main driver of the product are the digital features. The oven is designed and manufactured with the aim of creating a connected device. Indeed, Explora can firstly

exchange information with many smart devices, such as smartphones and tablet, moreover, it can access a cloud system provided by Piron in which all the information is stocked and provided to maintenance services and the user itself. The possibility to interact with the oven with smart-devices permits to the user to remotely manage cooking and other functions. There are many functions that you can perform remotely: pre-set or personalize cooking phases, start and monitor the washing system, control and program different ovens, program the daily work plan, set a specific timing for multilayer cooking (setting an alarm for every tray you insert), control the ongoing cooking. Three other useful functions are the possibility to visualize records for the operations that the oven performs, a log for diagnostics and handle the maintenance, and lastly, the oven provide and visualize the HACCP (Hazard Analysis and Critical Control Points) data, useful to understand if food safety has been guaranteed during the cooking.

3.3.1 – Piron: The Supply Chain

Similarly, to what we have already seen in Carpigiani, Piron works in a traditional supply chain system. The OEM, Piron, is a BtoB company that sells its products to distributor. The end-user main interface with the product will be the distributor itself. Differently from the previous case, after-sales are not part of Piron functions inside the supply chain.

Upstream Supply Chain: Upstream the company deals with materials supplier. These are divided in two categories of supply:

1. Oven components
2. Electronic components

For what concerns the products parts, the key suppliers are those who provide steel, glass and plastic components. Steel is the most critical supply, not for the material per se, but because of the relations with suppliers are strongly contract-driven involving high switching costs. The steelmaker usually asks for a minimum quantity to be produced, and, also, co-design the specific mold to implement in the equipment to manufacture specific steel components. For a similar reason, also plastic components have high switching costs based on contracts since the manufacturer must design and implement new molds for every new component. Glass is the least problematic supply since difficulties arise mostly with increasing dimensions of the panel.

Electronic components have become critical since there is a global crisis involving chip production. There is no easy explanation for this problem, a cause could be Chinese policies that are restraining the mining of silicon, with a deep impact on raw materials supply. Another explanation could be a sort of draining effect due to a demand higher than the productivity caused by big global players' strategies. However, the first issue of this crisis is that lead times currently go up to 40 days. The other strategic supplier of electronic components is the display manufacturer. Even if the component is not customized or difficult to retrieve on the market with similar specifics, switch costs are high due to the fact that the new display would require testing again all the interaction with the other components of the oven. Especially temperature resistance and electromagnetic interferences. Beside these switching costs, the lead time of displays ranges between 12 and 18 weeks. The display also is bought from a Chinese manufacturer and this involves many supply chain problems related to Chinese holydays and policies that seasonally affect lead times.

Since the main issues involve global trends and/or typical market dynamics (such as the difficulty of retrieving scarce materials) Piron has very few levers to use to improve its value creation on the upstream part of the supply chain. However, there are also few trouble harming the supply chain that the company did not already faced. Standing this situation, we can consider the upstream environment quite stable and, currently, there are no options to introduce solutions to better integrate the supply chain.

Downstream: Piron has few customer segments that are not distributors and that manages directly. They are only four and accounts for around 21% of the revenues:

1. Other OEM: Piron sells directly its ovens to some companies that ask to add a new product to their offer. In these cases, relations and negotiations are directly held by the company in order to select the best suitably companies for their product, mostly the Explora;
2. Frozen Food distributors: many frozen food distributors sell frozen bread or similar frozen preparations for pastries. These companies usually adopt a business model in which the oven is included in the supplying contract if the customer signs for an adequate number of products;
3. Big Supermarket Retailers, that together with frozen food distributors account for 10% of the sales;

4. Group buyers: usually they are composed by many end-users that decide to ask to buy together to get a discount price. Usually they are restaurants or hotels;

The other 79% of the sales revenues come from national and international distributors that, depending on the countries, could have bigger or smaller sizes. In some countries, like US, distributors have a strong regional-based presence, so there will be fewer big players in many different regions. In other countries, like China or the South-African BCE, distributors are very big players, but they have no regional specialization. Instead, in Italy the landscape is made mainly of many little players geographically dispersed. The common feature of all distributors is that they do not sell only ovens but professional cooking equipment in general. Some distributors, working in the Contract sector, even sell kitchens already furnished with all the needed equipment; usually they work with end-users like hotel chains that need new equipment for their kitchens.

Most of the relations with distributors are well established and last since many years. In this industry there are rarely one-time relations with distributors, also because the demand, in some countries is influenced by a specific seasonality: if restaurants, for example, decide to renovate the kitchen, they will usually decide to do it during low demand periods.

> […] In our industry you will find rarely spot-sales. Restaurants buy an oven and then stop. At least for around five years. This one is a spot-relation. A distributor instead needs a constant supply of products. There is a seasonality depending on the country, but still, distributors need products. When the sales' volume gets to a critic level we usually develop our relation to a sort of partnership […]
>
> *Davide Tommasin*

IoT in the supply chain: Piron is investing a lot to introduce IoT features in all its products. As of now only the Explora model has a device able to communicate with the environment, and the other models are expected to be revamped in the next two years. Currently, the main feature of its IoT system is to produce data regarding the use of the oven. Then, the data have different uses, however, the most important for the supply chain is the possibility for maintainers to access these data. When the maintainers can access data through the platform that Piron gives them, they can intervene faster when technical issues appear.

Moreover, Piron is investing to introduce pattern recognition and neural networks to optimize the Data Analytics: these two innovations are really disrupting in terms of data management and permit to the company to better understand customer needs and behaviors.

As already said, Piron is strongly product-driven and as of now the IoT features are not meant to bypass distributors and other players. Instead, one of the main concern of introducing these solutions is to optimize the information flow between the players of the chain in order to deliver higher value to the customer. With this approach, relations with distributors and maintainers are not deteriorated and the flow of the information is freely accessible to those who need it for technical purpose.

We need to highlight how in this supply chain distributors, installers and post-sales assistance are not clearly defined (see figure 16). Depending on the country, these three steps of the supply chain can be integrated inside big players working in all three steps or may be dispersed among many different companies. However, the IT system developed by Piron provide a specific account to those entrusted with access to the data.

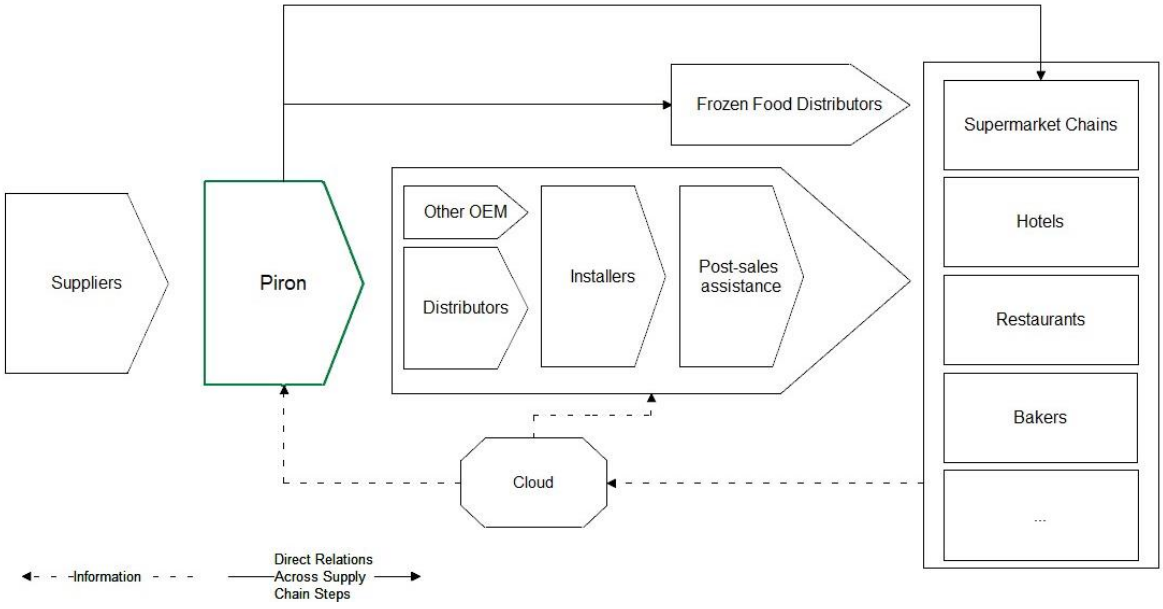

Figure 16 - Piron's Supply Chain (Source: Our elaboration)

3.3.2 – Piron: The Business Model

Piron business model is quite traditional for many small/medium OEM (see Figure 17): the focus of the company is to manufacture high quality equipment and sell it through distributors. Thus, the market is segmented in two: the first is *gastronomy*, customer segments in which customers run professional kitchens, for examples restaurant and hotels. The second segment are *bakeries*, and *supermarkets* that need an oven for frozen food regeneration. Usually those aiming to frozen food regeneration prefer low-end or basic products, while

restaurants are more probable to buy high-end equipment. Moreover, some old-style bakers still use static ovens to cook, therefore Piron ovens provide the semi-static cooking option.

Piron has a standard network made of a mix of internal and external salespeople in the countries in which its products are sold. Moreover, through their internal sales office, they take care of the relations with the direct customers, such as the group buyers or big chains. However, a special touchpoint with distributors are Piron's corporate chefs, called "traveler chef". They are trained to use Piron's ovens in the most effective way and the main activity they perform is the demo cooking, a demonstration to distributors of how an oven works. Having good corporate chefs is important for two reasons:

- They show the value of the oven, all the features implemented and the advantages of the product;
- They will provide training to distributor's chefs that, in their turn, will have to perform a demo cooking to end-users.

Also, traveler chefs perform a marketing function: they are particularly useful when it comes to organize expositions and events, even abroad.

Travelers chef, salespeople are a relevant asset to keep good relations with customers. Also, there are account managers, and even if this is an unstructured role inside the organization they play a relevant role. They work to listen to customers' need and report them to the company. In these cases, we talk about *personal assistance*: the human factor is really important when it comes to nurture relations. However, the digital transformation of many relations is evident also in Piron. They implemented many ways to add *self-services* and *automated services*. If maintainers have problem with the product, they can access an online platform where they can download specific exploded axonometric or other information. Moreover, the Big Data analytics combined with the pattern recognition can provide useful data inherent to proactive maintenance, for example if the machine will suffer a malfunctioning in short time due to overuse of certain parts, like what happens with the door's hinges.

> […] We listen to our customers. Usually just talking together, our final customer will start highlighting the issues we did not think about. When we launched Explora we did not think about the light alarm that flashes when the cooking finishes, we have it in all our ovens. It was thanks to a chat with a swiss chef that we noticed the flaw and fixed it immediately with a remote update […]
>
> *Davide Tommasin*

The company has a strong focus on the technical aspects of the product. This reflects on the decision to perform the most possible activities *in-house*. Currently, Piron manufactures ovens and provide its digital services buying only raw materials like steels and similar. Also, thanks to their R&D department they perform internally both the electronic parts assembly, and the relative software development. In the last period they also decided to internalize a simple thing as the handbooks production, printing them when they need it, just to optimize the spaces and the timing of the packaging.

Davide Tommasin is the person in charge to take decisions regarding the product development. There are two input driving the product development:

- Technology push: analyzing the market they define a technology lack to implement in the new product;
- Users input: they get in touch with end-users and through informal conversation they try to understand changing needs and behaviors;

The technical aspects of the oven are important when it comes to the cooking performance. Piron sells a *mid-range product* that provide all the main cooking feature typical of professional ovens. However, the main distinctions from its competitors are the automatic washing and the *digital features*. Going in detail, these digital features enable an almost real-time control of the oven helping the monitoring and the diagnose of problems.

Here we can see how Piron is trying to shift from a pure OEM business model in which they simply manufacture the equipment and then sell it at the distributor providing technical support to the installer.

Implementing IoT feature in their products they provide a group of parallel services that strengthen their relations with distributors and customers and create a higher value perception.

> […] One of the first things we have seen, doing some analysis, was that most customers in a specific region of France used to start the washing, and then, after a pause, they used to start the rinsing. We recognized this behaviour thanks to pattern recognition algorithms. We thought about a technical problem. We called our distributor for that region to ask for a quick survey among customers. He said to us that he already knew the answer to our problem. Chefs used to cook fish and right after, not to mix flavours with other foods, they used to do a sort of fast rinsing since they did not know the duration of the washing. This little problem was solved easily by remotely updating the software to show washing times. […]
>
> *Davide Tommasin*

Specifically, the IoT permits to the ovens to autonomously update with bug fix, new improvements or new features. It enables a customized remote assistance when needed - for example, there are many little problems that are caused by electromagnetic field that are typical of the specific customer's kitchen. Also, the IoT let Piron analyze the data regarding the use, understand specific information and providing it to distributors the data analysis can suggest more efficient ways to use the oven.

Another important feature is the cloud at disposal of both, technicians and final customer. The cloud permits to provide the data to those who have access to it with different level of information provided: technical data for maintainers, more business- or operations-oriented for end-users. The final user, especially, will have the possibility to store in the cloud specific saves, like cooking programs, working programs or new recipes, and to share it to all its connected ovens.

In our connected world this simple feature may seem just a little feature, however it opens a window to a whole new business. In fact, big food chains or supermarket chains, rarely employ professional chefs in their restaurant or bakery corners. A connected oven offers the possibility to standardize many processes through online recipe sharing between the headquarter, where corporate chefs prepare new recipe, and all the branches around the world. This permit to the operator in the branches to simply insert the ingredients in the oven and touch the recipe-related icon. Also, big chains have a strong concern about costs, so, it is critical to have the possibility to keep them monitored and accordingly implement solutions to increase efficiency.

So, the value proposition of Piron is highly enriched by implementing IoT in the product. They estimated a 30% increase of sales in 2018 thanks to this new feature that will have the double function of strengthening relations with customers and create a sort of lock-in effect. However, they do not think they are already capable to implement a real razor-and-blade model.

A critical asset at Piron are people. The human resources are one of the main asset that permit to create a performing product. The focus on the product need a lot of expertise and that's why 20% of the employees work in the R&D department. Also, Piron invest around 10% if the revenues in R&D. They managed to develop the Explora model almost entirely with internal resources and they are investing to find at least a new developer for the daily routine,

even if the expansion plans they have will need a bigger increase of R&D and technical office.

Another source of value are Piron's partners. Form both side, upstream and downstream there are key supplier or distributor. Piron need to keep close relations with them because:

- Upstream: the supplier of electronic components for the motherboards need a continuous exchange of information regarding new prototypes. In fact, the projects developed by Piron, as all the chip projects, need some adjustments. So, usually, the two companies need some time to define all the specifics of a new chip. Also, Bluewind, an IT consulting company, plays an important role in providing support in the development of the IoT system.
- Downstream: many distributors worldwide, like the mentioned BCE, are considered partners. Because of the high volume of sales Piron usually plan together with them marketing, production and expansion plans.

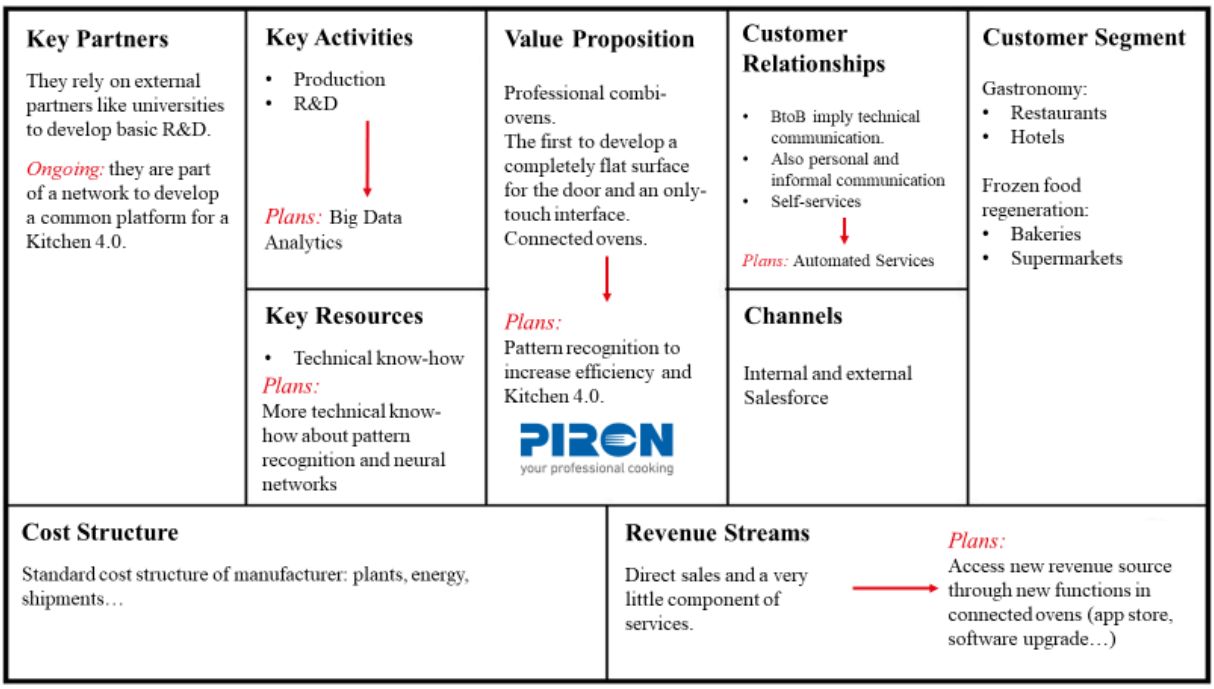

Figure 17 - Piron's Business Model (Source: Our elaboration)

3.3.3 – Piron: Plans for the Future

Piron is working hard to shift its production to all connected devices. As said, end-users are still conservative and prefer old-style models, but the market is evolving, and new digital feature will become common in the next few years.

If the oven become a smart connected device the company will have many new opportunities. Some competitor already developed some ways to generate value for end-users through digital platforms and other complementary digital services. A German competitor developed a social network where ovens' owners and technician can share problems, solutions and ideas. Also, they provide the possibility to buy new recipes already set to work with oven, like exotic or ethnic recipes. Other decided to exploit even further the possibility of managing all the information related to maintenance and provide to installers/maintainers different monitoring level with priced data packages depending on the volume of items monitored.

Piron does not think that selling data packages and different level of maintenance will be for now the road to follow. The company dimension does not permit to leverage already on this kind of contracts. Instead, they think that creating a community platform and sell recipes, with a similar model to those of some competitors, would be more effective for their business model.

Also, they are thinking to develop a proprietary app store where users will have the possibility to buy apps to improve the use experience. Examples could be an app considered as a complementary service that could help chefs to develop a daily working plan to optimize energy saving and forecast costs for the single working day. Also, it could be an app that track ingredient consumption based on recipes used and, if the restaurant keeps the ingredient list updated, it could send an alarm if reserves get down a certain level.

However, even if the idea of developing an app store is fascinating, there could be problems in implementing it. It could be easier to create a software and lever on upgrades when buying the oven.

Another innovation, to ad in future to the oven, could be the imaging mapping. This technology uses a software to recognize images captured by video sensors. It could be useful to implement this kind of sensor to make the oven "understand" what is inside the chamber. This technology is already used in many sectors and it is a topic in which many companies are

pushing also in this industry. The only limit is the economic feasibility since we talk of a sensor that need a 360° view angle inside a small chamber that reaches 300 °C. Keeping the sensor safety in such environment is not easy and for now it is costly. However, if successfully implemented it could permit to develop a strong razor-and-blade model for many distributors of frozen food, since they will have an effective method to analyze the actual volume used of their products by the user.

In the next 2 years Piron plans to revamp completely two of the three old models to upgrade them and add the digital feature that are in the Explora model. This is also a move to internalize further the IT related to the development of the ovens creating a standard for all the products. The fourth model will be cancelled in the next two years, so there will be just few improvements.

A big problem introducing these digital features is the Chinese market. The government does not allow data from inside China to exit the country, so companies need to partner with local server providers or create one brand new company in China only to manage the data generated by the product. Since for now it would be difficult to manage these aspects, China is left aside in the expansion plans of Piron.

Another issue that smart connected devices bring with them is the privacy issue. At the moment all the Explora needed a specific contract in which a clause enables Piron to handle the data, however it is costly to develop every time a specific contract. Piron is working to solve this problem trying to implement a sort of standard contract in which the final user will have to accept the terms and conditions of use at the moment of the first start with just a touch on the screen of the oven.

Beside these product-related improvements, Piron established a partnership with three other companies, a spin-off of the University of Padua, and the University itself, to develop a connected network of devices. Piron’s oven will be together with a blast chiller and a vacuum sealer. Part of the know-how will be provided by the University and the spin-off, especially regarding the processes virtualization. Moreover, a baker and a restaurant will participate as tester to the network.

The companies will develop a project for a Kitchen 4.0 in which the three devices will share data to optimize the working plan of restaurants or other customers. Why this three equipment?

- Nowadays combi ovens are fundamental in most of the professional kitchens thanks to wide range of products and recipes that they can cook;
- Blast chiller is important since many policies regarding food conservation bind food producers to blast chill food before stocking;
- Vacuum sealers are growing in use since in the last years has been discovered that cooking vacuum-packed food permits a better result in terms of flavor, nutrient and aspect.

Combining this three equipment will permit to the project to lever on the presence of two basic equipment and to make a step forward including a device that will become more and more used.

Further Opportunities: We think that developing a business-related application could be useful, especially for customers aiming to standardize processes. For restaurants and bakers could be useful an app that tries to forecast recipes and ingredient use. This could be achieved through pattern recognition algorithms that analyze food seasonality and which are the periods in which a specific preparation has higher demand. This could help planning supplies and the reserves management.

3.4 – Discussion

We think that the information we collected are useful enough to describe some tendencies that could be demonstrated with future researches.

3.4.1 – Internal Environment and External Impact

A first observation that could be done it is whether the technology adopted impacts on the internal or external environment of the company. It is well known that external and internal environments are not completely divided, and that what happens on one side influences the other side. However, to simplify our analysis we divided in two categories our first observation:

Internal Environment **(see figure 18):** Industry 4.0 compared to the Dotcom revolution impacts way more on production systems. The overview we provided in the first chapter shows a lot of new production means. Digital Transformation basically provides digital means to manage physical production. An important feature of this transformation are the Data generated by the IoT. With this in mind, we can say that the companies interviewed have in their plans to invest in IoT, not just to provide innovative features and charge a premium price, but to exploit the data in the production or the service delivery and achieve higher levels of efficiency and effectiveness. We also see the rise of Industrial Internet of Things (IIoT) in the next years, since many manufacturers will need to cut costs through connected equipment and implementing remote control for most of the operations.

The internal impacts will focus on two areas of the business model: key resources and key activities. These influence the way companies perform the internal activities and the resources needed. In our interviews all companies expressed the need to acquire new know-how to develop new projects regarding Industry 4. – in our cases, to develop IoT solutions. As we stated also in the previous chapters, Human Resources are especially linked to good performances, since investments in physical resources are no not enough to ensure efficiency, effectiveness and the overall functioning of the business model. Never, in our interviews, companies rely only on internal know-how to develop new technologies or to implement new solutions related to the manufacturing. In many fields they seek for partners or to outsource activities.

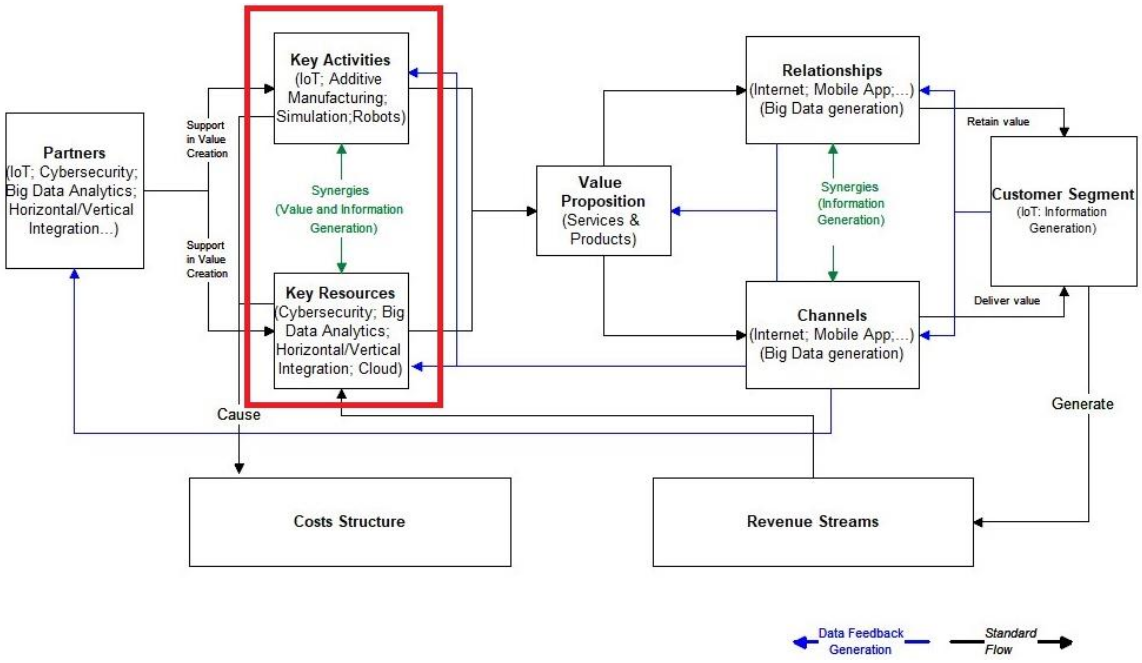

Figure 18 - Business Model Dynamics: Internal Impact (Source: Our Elaboration)

External Impact (see figure 19): Some kind of solutions implemented impact on the external environment of the company. In this case the aim of the technologies is to strengthen relations, enhance the channels through which value is delivered, and get the information from customers. In this case IoT, Cloud Computing and Machine Learning are some of the most useful: products and services are customer-oriented and play a role in capturing, retaining and upselling. Relations can be automatized, for examples with machine learning and Artificial Intelligence (AI) implemented in the customer services through instant chat. IoT can make pieces of furniture dialogue and so creating insights about specific information for the customer, like what Piron is trying to do with the network of companies, connecting kitchen equipment. New channels can be implemented, for example the Teorema system inside a Carpigiani machine can autonomously alert maintenance if a problem occurs, creating a new way of reacting to problems, in which the customer has little part and creating more efficient interventions.

Since this kind of applications impact mainly on the Relationships and Channels blocks, we think that they are highly related to customer behaviors and needs. To implement such applications, you need to understand your customer and provide a feature that could be useful to him. User Interface, User Experience, Relevance of the Information are all issues to take into account: it would not be useful for a Carpigiani machine or a Piron oven to provide

information related to technical data to the final customer, conversely, maintenance people do not need information related to the business of the customer. Also, companies working on this side of the business model will find hard to overcome some problems like privacy and public policies – like Piron that for now cannot enter China because of policies on data flow.

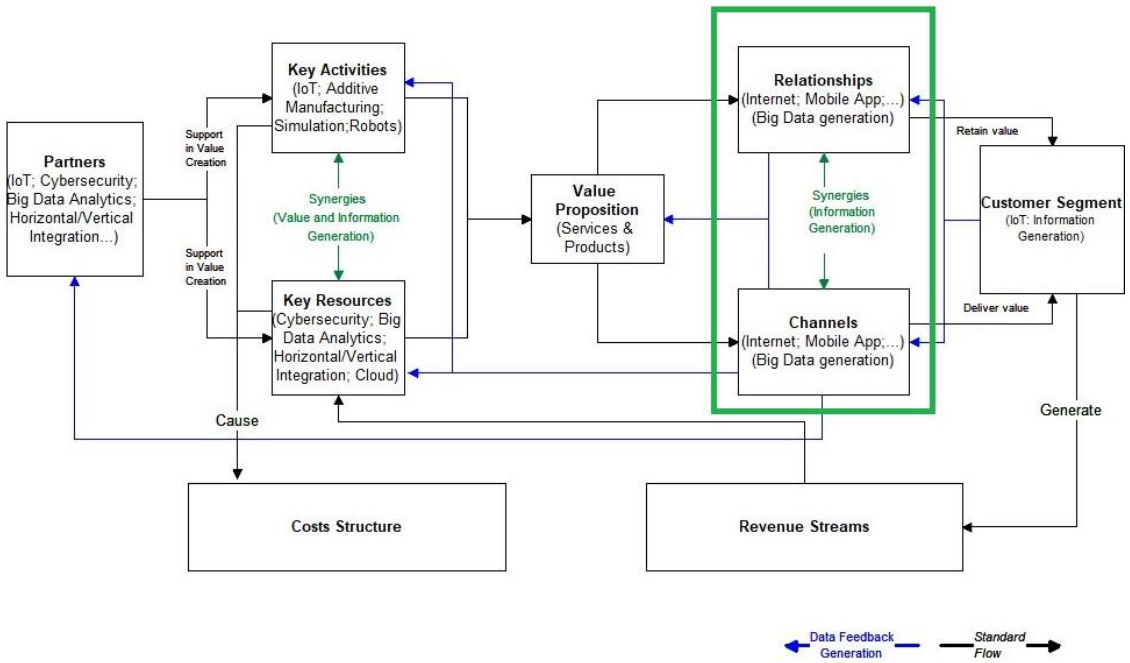

Figure 19 - Business Model Dynamics: External Impact (Source: Our Elaboration)

3.4.2 – Supply Chain Position

Another aspect that companies must take into consideration is the position on the supply chain (see figure 20). Some business models are easier to implement if you are downstream or upstream. Also, some issues arise if you are more distant from the final customer. Companies far from the final customer usually are those who provide raw materials, commodities, components and similar to manufacturer of finished goods. Conversely, the closer you get to the final customer, the more you need to implement services in your business model.

Upstream: Technologies here are more focused on efficiency. Due to global competition and costs, companies cannot lever too much on pricing if they are providing commodities. Usually the more complex is the product, higher are the margins you can generate. However, efficiency and costs cutting remain two of the most feasible ways to increase margins. The example of Carel, shows how companies working upstream in the supply chain have more difficulties implementing IoT in the products than in the very production system: due to

privacy issues it is easier to digitalize your machines and equipment than provide products and services with IoT features and manage to retain property or usage of the data. We think that trend Key Enabling Technologies (KET) that will spread more at this level of the supply chain are those related to innovative manufacturing systems and Industrial Internet of Things, than those more customer-oriented: horizontal and vertical integration, autonomous robots, 3D manufacturing.

Downstream: The closer you get to the final customer, the more you need to know him. Companies need higher levels of differentiation and price is a common lever: premium prices for premium features, discount prices for basic products. Here we think that in the future we will see an increase on Smart Connected Devices for many different purposes, from home automation (or domotics) to insurances. The cases of Piron and Carpigiani show us that OEMs of finished goods will probably invest with priority in IoT for services related to customer retention and upselling. It will become common for professional equipment manufacturer to provide digital features to connect post-sales and the equipment, in this way they would manage to automatize some processes and focus on others. For example, shifting costs from call centers to IT related activities.

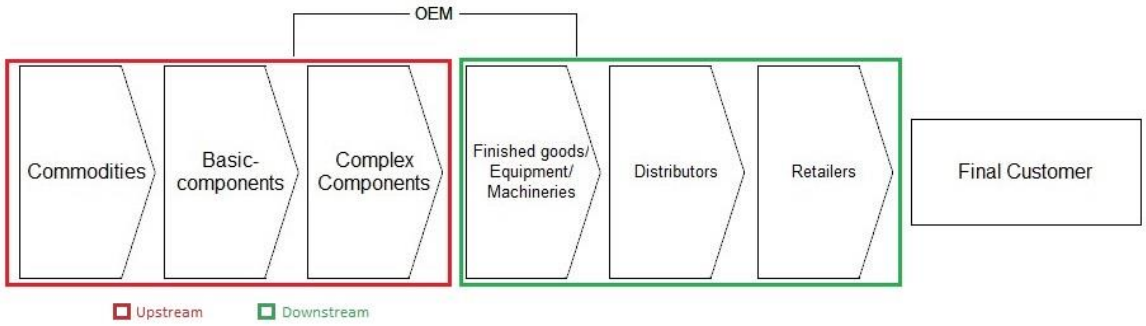

Figure 20 - Supply Chain Position (Source: Our elaboration)

3.4.3 – IT related Capabilities

There is another aspect that we analyzed previously in the work and that is connected to the impact of new technologies in the business model: IT related capabilities. Again, also in this case, there are two effects that companies must consider when introducing digital features in production systems or products: are there the needed capabilities to handle the innovation? In this case the impact takes a shape similar to the above-mentioned difference between internal and external impact (see Figure 21). Indeed, new products, services and machineries impact on humans, not just on balance sheet. The know-how is required by both, customers and

companies, and good Partners and better understanding of Customers will become relevant. So, we can separate the influence that digital transformation has in two:

Production Skills: there is no company capable to generate internally all the know-how needed to run and innovate a business. Many strategies involve decisions on whether to make in-house or buy outside, and know-how is not different from any other asset. These decisions become relevant especially when it comes to innovation. New products need new features, and the level of innovation may need to acquire new competencies outside the company. In the current environment, where companies try to invest in new technologies that started spread only few years ago, there very few players capable to develop all the needed know-how internally. Usually those are the forerunner that developed the basics for new technologies. All the second-comers at first need to watch to market and look for new competencies.

In this case, companies will need new know-how from external sources if undertaking investments for Industry 4.0. So, a specific CANVAS block that will become of extreme importance is the Partners' one. We mentioned in the other chapters that partnerships will become a key value driver for many companies, since the skills required are so specific and at the same time, so critical, that many companies will opt to partner with different companies to develop products. This is something that is already happening for years with hi-tech companies and will start to happen in many other fields. In our interviews we found that when it comes to Industry 4.0 there are many fields in which companies needed and will need partners to develop further their projects. Not just outsourcing a function but a closer relation to create ad hoc solutions and work together as time passes. For example, at Piron they worked in pairs with the university spin-offs to develop the innovative door's material for their Explora. Carpigiani too has strong relations with universities to develop innovations, as it happened with Teorema.

Customers Know-how: new products mean new features. If a company wants to deliver a product with new digital features, customers need to understand where the added value is. New smart products need, especially if consumer-oriented, that the customer understand the features and the advantages of the product. We mentioned that Piron basically betted on the introduction of the Explora, since the market has some traditional characteristics and customers are not willing to change too much the interface with the oven. Or Carpigiani that,

when talking about the adoption of the Teorema system by installers/maintainers, showed to us that the system is not adopted by everyone despite the advantages, probably because of factors like the familiarity with technology.

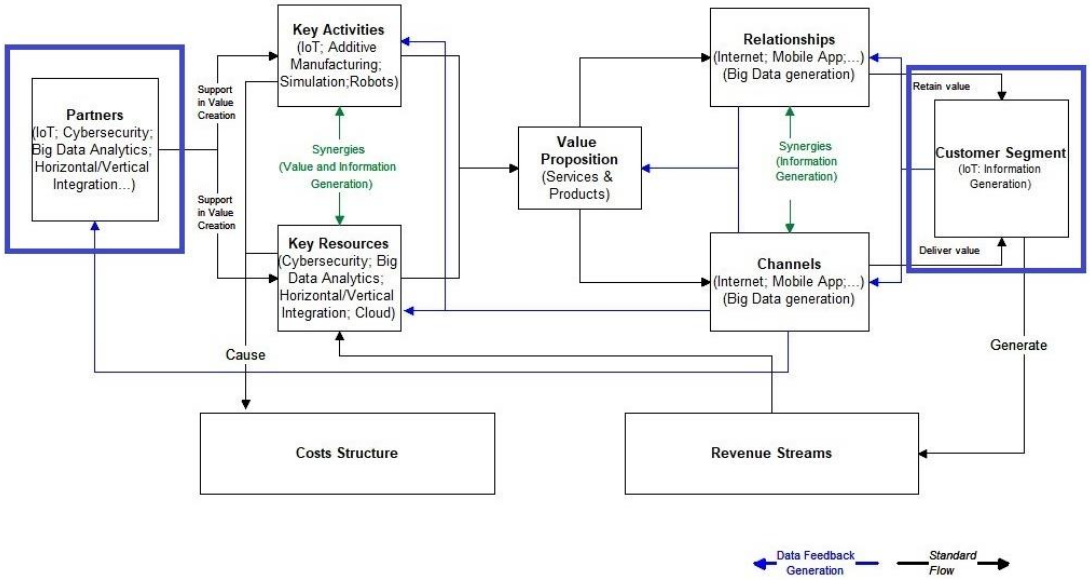

Figure 21 - Business Model Dynamics: System Capabilities (Source: Our elaboration)

So, companies will have two ways to handle the situation: 1) educate customers to the new features; 2) re-segment the customers and find those interested in new technologies and create a specific offer just for them. We could say that this is a sort of side-effect of technology introduction that companies must monitor, since developing new products is costly and if the product does no hit the market there could be problems.

4 - Conclusions

The initial aim of this work was to give an answer to the question: “How can we understand how technology innovation will hit businesses and what is the impact of the plans that companies are undergoing to exploit Industry 4.0 revolution?”. Digital Transformation and Industry 4.0 are very recent research topics and the scarcity of literature and previous works on these themes forced us to design a completely original path to find an answer. Therefore, we tried to provide an innovative perspective on how to assess the impact on business models of the new technologies related to Industry 4.0. We did not start our analysis focusing on macro-topics and we discussed briefly wide topics like Business Models or Supply Chain theories, and we approached the main topic with a point of view between a micro- and a macro-perspective.

We introduced the thesis without focusing too much on the definition of Industry 4.0 since we consider it a catchword used in some countries to define the same process that in other places is called otherwise. The focus in the first chapter has been on the technology disruptions of the Industry 4.0, the fourth industrial revolution: Digital Transformation. Firstly, we provided some examples of theories, publications and opinions that investigated our issue in the past years.

Then, we introduced a list of technologies that will play a fundamental role in many investment decisions that companies will undergo in the next years:

1. Internet of Things (IoT) and Industrial IoT;
2. Cloud Computing;
3. Simulation;
4. Horizontal and Vertical Integration;
5. Autonomous Robot;
6. Big Data and Analytics;
7. Augmented Reality;
8. Additive Manufacturing;
9. Cybersecurity.

We thought that a purely theoretical approach could not work to assess a process that is still ongoing and has no historical data to rely on. So, we discussed briefly the very physical

objects of this industrial revolution: the technologies. We described in an easy way the main functioning and the relevant aspects of each technology, trying to leave aside more engineering aspects and introducing those that belong the most to the economic field.

In the second chapter the focus shifted to the frameworks and strategic aspects that we tried to analyze. Supply Chain and Business Model CANVAS are not new concepts to the economic landscape. However, we thought that starting with simple tools would simplify the data collection and ease the analysis of a still unknown process with not so many use cases and information to base our discussion. We found two useful tools in the models provided by Berman and Bell (2011) and Paiola (2017): they built a matrix-based model in that helps visualize which are the paths that companies choose to undertake digital transformation.

In the last chapter we provide a description of our use cases: we interviewed managers from three Italian firms to understand what their plans for the future are. We discovered that, even if with different purposes and means, all of them aim to implement IoT technologies in their value proposition. After presenting the three companies we summed up the most useful insights from the six interviews we conducted between November 2017 and January 2018.

Finally, in the final paragraph we developed our analysis and tried to answer our initial question. We took into consideration the frameworks provided in the second chapter and, with reference to the technologies from the first chapter, we carried on a deconstruction of the composing parts of the CANVAS. We highlighted in which areas new technologies will impact basing our assumptions on the information we collected during the interviews and proposed a method to understand and forecast the strategies that companies will probably choose on the basis of three main factors:

1. Internal or External impact: new technologies imply that companies investing on the production-side will probably need partners to develop and implement digital transformation. On the other hand, the external impact involves problem related to privacy and data management;
2. Supply Chain Position: the higher in the supply chain, the farer from the end-customer. This implies that companies will invest accordingly to their position in new technologies for production systems or new services;

3. IT-related Capabilities: new technology must be handled by people with the right skills, both internally and externally. So, companies need to invest in skills and know-how on both Partners and Customer education.

We acknowledge that the analysis we developed inside this master thesis would need further research, especially to monitor ongoing projects and collect Key Performance Indicators (KPI) from the projects settled while we are writing. Also, we consider that a major limitation could be the number of companies which we managed to analyze.

We think that a larger sample would have been better, however, we consider the number of companies involved a sample consistent with the aim of a master's thesis. We recognize another flaw in the number of people involved. It could have been more complete, in some cases, to get contacts with people from different operating areas to widen the range of information and point of view about the matter.

Nevertheless, we think that through our work we managed to clarify some trends that companies will probably follow. We highlighted from a business point of view the technologies that will play a fundamental role in the investments of many firms in the next years. Moreover, we provided practical examples with three use cases that show how companies investing in the future are already moving and in which direction.

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