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Business and strategic impact of digitalization, new distribution channels and technologies on companies supply chain ecosystem

The De' Longhi Group experience

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ABSTRACT

New digital technologies are having and will continue to have a fundamental impact on one hand on companies' competitive, productive and innovation capabilities and operating models and on the other hand on consumer's way of exploring, choosing and purchasing products. The globalization and its consequences - namely deeply interrelated economies and increasing uncertainty and unpredictability due to recurrent pandemic or geopolitical crisis – are adding complexity to this fast changing transformation process. This thesis aim to explore in particular two areas where companies are impacted by digital and new technologies changes: the overall supply chain ecosystem, within the different steps of companies value chain, and the development of new digital distribution channels, in particular the direct to consumer channels. These two aspects are in primis investigated at the level of general systemic evolution and secondary with references to the specific experience of the De 'Longhi Group, an international group operating in the durable consumer goods market.

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INTRODUCTION

Bill Gates said «we're changing the world with technology». This is pretty accurate considering that the everyday life we are experiencing today is the result of the technological improvements made through centuries by the humanity, clearly accelerated in the last 20 years. The primary goal of research and development in this field is to improve our lives pushing the boundaries of our possibilities everyday a step further. Figuring the future is not easy, and at the same time thinking of going back to the past is impossible. We do not know what will expect us, and we ask ourselves how we could live before without these technologies. Considering the business environment, technological improvements have deeply changed the rules of the game configuring as one of the most significant competitive lever ever. Years ago, distrust was built upon the belief that the machines would have substitute people, but nowadays we are conscious of the primary role of them in using, implementing and exploiting technologies that are built to support and improve our lives. We went through digitization and digitalization to end up with the digital transformation era. In this context, technology is not only a means to complete old tasks in an easier way. It is the key to business model innovation through the redefinition of processes and the shape of a new business culture. Companies now leaders in the market were the ones who early recognized the opportunities offered by the technological development and that at the same time were able to exploit them changing the rules of the game. This resulted in a shift from the physical to the digital, from product centricity to customer centricity, from supply-driven to demand-driven, and to a fundamental role of data-driven business decisions. Keeping up with those trends – striving to drive what will be next - has already demonstrated to be a requirement for survival itself. Together with globalization – with which there is an interdependent relation – technologies have changed businesses helping them to deal with a context of deeply interrelated economies and increasing uncertainty and unpredictability due to recurrent economics and geopolitical crisis. The Covid-19 pandemic started in the late 2019 gave light to several pain points that needed urgently to be solved in order to cope with the ones that today are daily business concerns. In fact, to the pandemic followed a series of events that marked the entrance in the "era of uncertainty" which we are currently experiencing and

that brings several changes in the ecosystem in which companies have to conduct their operations.

I've spent the last six months in the De' Longhi Group headquarter in Treviso together with the team that is currently working on the Group's supply chain transformation. This experience allowed me to understand how the supply chain is a fundamental strategic and competitive asset for companies in the current market environment, and how the ability of being customer centric is highly related to the use of data and to superior performance achieved through optimization. An up-to-date supply chain - which exploit the right mix of technology in its processes - is indispensable to build and maintain market leadership. Moreover, I was interested by the recent business model change of the Group made through the investments in its direct-to-consumer e-commerce channel in 2020. The e-commerce is not a technology per se but it has been enabled by technological progress and particularly by the advent of internet, which has been the greatest game-changer. From this experience, I have gained the awareness that the digital channel is extremely important for the consumer of today, which relies on it not only for making its purchase but before that, systematically, for information purposes. For companies, this is a mean to gain valuable data to understand the market and to maximise profits and expand the business. However, they have to serve consumers segments with the highest expectations ever. Those now are more used to outstanding service levels and to an omnichannel experience, which permits them to buy everything, anywhere, at any time and from any device. For these reasons, entering the D2C dynamics for a historically B2B oriented company comprises great challenges. To unlock its real value, companies have to address those challenges to master the new competitive environment with a positive impact on the overall value chain, and they cannot do this without an effective use of the available technologies.

This thesis is structured in four different chapters. The first one provides a general overview on the supply chain management field, on its importance related to the difficult time we are experiencing and on its main processes together with the factors that can bring companies supply chains to a superior performance.

The second chapter shifts to distribution channels and particularly focuses on the direct-to-consumer e-commerce channel, providing an analysis of its benefits and challenges from the point of view of an historically B2B oriented company that approach a D2C

distribution exploiting the possibilities provided by the internet. Moreover, a general overview of the way in which this affects the operations and the mechanisms underpinning supply chain processes is provided.

The third chapter moves on considering the concept of Industry 4.0 and some of the most discussed technologies in the business landscape. After a brief definition of the perimeter of movements – being emerging technologies continuously under development and so continuously changing the boundaries of business' possibilities – a focus is provided for cloud computing, artificial intelligence, the internet of things, digital twins and the blockchain. Those have a significant potential in affecting a company's supply chain ecosystem, especially in relation to better manage the way in which it faces the difficulties generated by recurring disruptions and complex business dynamics coming from the introduction of new distribution channels.

The last chapter is dedicated to the presentation of the De' Longhi Group and of its brands – De' Longhi, Braun, Kenwood, Nutribullet and Ariete – with a particular focus on the D2C e-commerce channel of the company and a hint of the CFEx project which is revolutionizing the global supply chain of the company. The outstanding results reached by the global leader in the small domestic appliances industries together with the investments made in exploiting technologies – both emerging and less recent –have been very inspiring for me, providing food for thought on the importance of an effective planning activity and on the significance of future prediction.

With this thesis, I wanted to explore how the e-commerce and new technologies configure as great sources of competitive advantage. In particular, I wanted to identify the impact of the first on the supply chain key processes and the way in which the latter could deliver real value to supply chain management in dealing with the daily challenges results of both external and internal pressures.

CHAPTER I

Supply Chain Management as a source of competitive advantage

1.1. Supply chain and supply chain management

Martin Christopher defines the supply chain as «the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer»[1]. In particular, upstream and downstream linkages can consist of material, information and financial flows. Through the management of the relations with suppliers and customers, the company can gain meaningful competitive advantage given the possibility to increase efficiency and reduce costs. In the beginning – around 1980's - Supply Chain Management was conceived as the management of each flow and block in the chain as independent from the others. Nowadays, the end-to-end approach that contemplate an integrated system is already a sound concept. Under this vision, together with the logistics function, the supply chain is able to deliver both cost reduction and service enhancement. In subsequent years, Supply Chain Management has acquired more and more importance in organizations coming already in the early 2000s to the awareness that competition is no more against companies but against their supply chains.

Figure 1 Supply Chain Management activities.

The advent of globalization provided companies with plenty of opportunities while it has increased the complexity for their supply chains. Together with the access to new global markets, companies explored increased sourcing opportunities having the possibility to

[1] Martin Christopher, *Logistics and Supply Chain Management* (Pearson UK, 2013).

choose among plenty of suppliers for goods and services. This, together with the expansion of manufacturing plants decentralisation, allowing the proximity of production plants to critical production resources[2]. This environment permitted to companies to specialize on their core business while favouring outsourcing possibilities.

Figure 2 Globalization's impact on supply chain, opportunities and challenges.

Coming to the complex supply networks to manage, suppliers and customers from all over the world requires effort in overcoming not only language and culture barriers, but also in being compliant with several different regulations and legislations. This increase a lot the complexity of aspects that need to be managed, and for the company translates in embedding additional risk factors.

The objective of SCM is building and managing relations in a way that creates value. First, to create value the supply chain has to be effective, agile and responsive. The "3 Ts" framework provided by Richard Wilding presents three interrelated factors influencing the ability of a supply chain to create and deliver value: time, transparency and trust[3]. Considering time, velocity is fundamental especially in the environment of the e-commerce, where the capacity to fulfil and deliver orders in few hours is decisive for the success of the business. Process improvement mainly relates to the abatement of the time

[2] Raghav Jandhyala et al., *Sales and Operations Planning with SAP IBP* (Rheinwerk Publishing Incorporated, 2018).
[3] Richard Wilding, 'The 3Ts of Highly Effective Supply Chains', *Supply Chain Practice* 5 (1 September 2003): 30–39.

needed to perform a certain action, lowering the costs and improving efficiency. Time tracking is the raw material for plenty of key performance indicators monitored by the organization while assessing its performance.

Transparency has a significant weight both for internal and external stakeholders in two different meanings. At the forefront, the theme of supply chain transparency applies to the disclosure of the relationships and the warranty of consistency between the actions taken by the actors in the chain. This given the increasing importance that the environmental and social responsibility play in the market landscape. Consumers, governments, suppliers and all the other players establishing relations with the company require it, being necessary to provide and to ask for transparency along the entire chain. This enhance the previously stated concept that we moved on from the time in which the company competed as a stand-alone entity. Lack of transparency undermine the trust and the reputation of the organisation, being accountable in the eyes of stakeholders for its actions and for the ones of its suppliers too. Secondly, inside the organisation - on an operational level - transparency enables the collection of required information to identify opportunities for improvement[4]. Monitoring supply chain performance is not straight to reach in complex environment, relying heavily on visibility provided by third parties. Visibility enables to access data in a specific location, while transparency allows seeing the picture as a whole sharing data across the different positions[5]. Integrated supply chains ideally provide full transparency: but in practice, many actors work as isolated silos and lack in collaboration. This affects transparency on inventory, on the stock, on the production capacity and on lead-times. New technologies provide significant opportunities to improve in this path by making data readily available to stakeholders. This is the prerequisite for an agile, flexible, predictive and responsive supply chain. It is estimated that companies can increase profits from 2% to 10% by improving end-to-end transparency, enabling resilience and so the ability to resist and recover from disruptions[6].

[4] Alexis Bateman and Leonardo Bonanni, 'What Supply Chain Transparency Really Means', *Harvard Business Review*, 20 August 2019, https://hbr.org/2019/08/what-supply-chain-transparency-really-means.
[5] Ryder System, Inc, 'Supply Chain Transparency Creates Resilient Operations', *Forbes*, n.d., https://www.forbes.com/sites/ryder/2021/06/01/supply-chain-transparency-creates-resilient-operations/.
[6] Ryder System, Inc.

Coming to trust, this dimension is fundamental to support collaborative environments along the supply chain and to retain consumers' confidence in the business. Trust has a significant weight in the success of long-term relationships, and is gained and maintained through transparency and communication with partners. These factors are interrelated since time is a measure of performance and is strictly monitored in processes, enabling the transparency on what is happening and giving confidence that is at the base of the trust among actors. The supply chain concept is linked to the one of the value chain developed by Michael Porter, who identifies the set of activities having an impact on the organisation's competitive advantage.

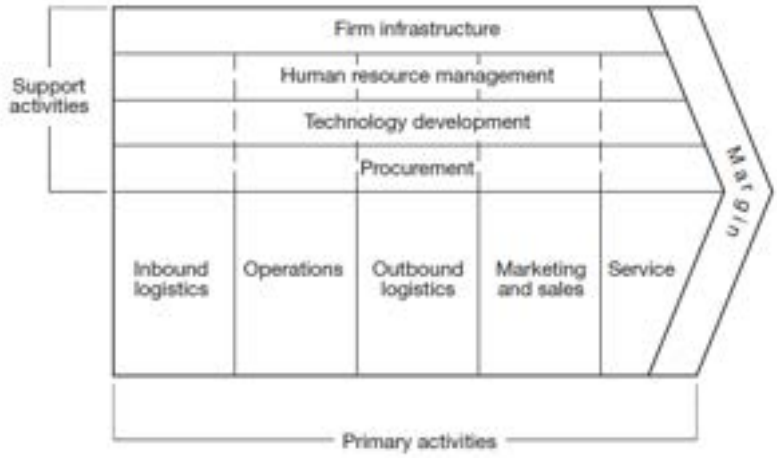

Figure 3 The value chain.

Each company has to identify its core ones - that are keys in its strategy - to focus on them, while relying on outsourcing for the others. Outsourcing – namely the situation in which some activities are performed by an external entity - is adding complexity in the supply chain, implying additional relationships to be managed, and is extending the value chain beyond the boundaries of the business overlapping with the supply chain itself[7]. Value creation and competitive advantage does not depend by the organization as a closed environment, but all the actors linked to it and the relationships among them continuously affect it. The way to build and deliver value through supply chain includes integrated business planning solutions, smart manufacturing techniques and warehousing and transportation solutions for flexible logistics[8]. We have already

[7] Christopher, *Logistics and Supply Chain Management*.
[8] Sandy Markin et al., *SAP Integrated Business Planning: Functionality and Implementation* (Rheinwerk Publishing, 2021).

discussed the importance of placing the customer at the centre of the business strategy. To make it work as a proper strategic asset, the customer's role has shifted from the final destination to the starting point. Consequently, managers have to start from the customer and work backwards, focusing on market understanding as a strategic tool to succeed with respect to competitors. Customers' expectation became dramatically high in relation to the possibilities offered by digital technologies: they enjoy omnichannel shopping experiences with several implications for supply chain management. Incrementing complexity, the only way to master the omnichannel sales and distribution is to dispose of advanced planning, forecasting and data management, as well as high logistics capabilities. This is possible only if systems are highly integrated and if the company is able to receive and translate properly the demand signals coming from the digital economy. These data are a fundamental input for R&D, manufacturing, and supply chain processes.

1.2. The era of uncertainty

Before proceeding, we have to outline the context in which companies are conducting their activities, being the market and their operations as a whole strictly connected to both local and global events. The first theme that we need to outline in this section is the coronavirus pandemic. The World Health Organization declared the outbreak of a global pandemic on the 11 of March 2020. The first case of infection was reported in China during December 2019, in the city of Wuhan that will become famous around the world to be the starting point of a difficult global crisis that is not finished yet. From that point, 6.31 million of people died due to the Covid-19 virus and 536 million cases were registered up to date[9]. The severity of the illness forced many governments to impose lockdowns and movements restrictions to their peoples, which experienced tremendous social and economic disruption caused by the fight against its rapid diffusion. In the meanwhile, hospitals where collapsing for the high number of people which needed assistance due to the serious respiratory difficulties combined with low evidences on effective treatments, and the unavailability of a vaccine for prevention which will come one year later in December 2020.

[9] Worldometer, 'Coronavirus Death Toll and Trends - Last Update 14 June 2022', 2022, https://www.worldometers.info/coronavirus/coronavirus-death-toll/.

People experienced the effect of a global "stop". While social and human costs of the last two years are immeasurable, the International Monetary Fund defined it right from the beginning the worst economic downturn since the great depression[10], which marked the gap between advanced economies and low-income countries. The Covid-19 pandemic started as a health crisis but gave rise to social, economic and political ones as well. It only overshadowed the climate crisis due to the climate change – which refers to the shift in temperatures and weather patterns caused by human activity against the environment – that is still a considerable challenge that we must address.

Some authors sustain that we are living the "era of uncertainty"[11] in which recurring crisis threaten businesses globally. One of the pandemics consequences immediately visible was the food shortage that supermarkets experienced during the lockdowns. This is nothing more than the effect of global supply chain disruptions, emerged with supply shortage of raw materials caused by the difficult period and then persisting over time, causing difficulties to companies of all the industries. Everybody has probably heard about the global chip shortage caused by the surge in the demand for electronics[12] following the diffusion of the remote working, a drought in Taiwan – were the vast majority of manufacturing of chips takes place – and the transportation blockage in the Suez Canal. From 23 to 30 of March 2021 the Ever Given - a 400 meters length water vessel - got stuck in the Canal where 12% of global trade, around one million barrels of oil and roughly 8% of liquefied natural gas pass through each day[13], causing near $10 billion in trade frozen a day[14]. These sudden events happen and upset business dynamics worldwide, requiring the ability to overcome challenges and find alternative routes.

It is not all. When it seemed we were reaching again a sort of balance, the Russian President Vladimir Putin decided to invade Ukraine on 24 February 2022 causing a significant imbalance in the geopolitical landscape of Europe. The conflict – which is result

[10] IMF, 'The Great Lockdown: Worst Economic Downturn Since the Great Depression', IMF, 2020, https://www.imf.org/en/News/Articles/2020/03/23/pr2098-imf-managing-director-statement-following-a-g20-ministerial-call-on-the-coronavirus-emergency.
[11] John E. Katsos and Jason Miklian, 'A New Crisis Playbook for an Uncertain World', *Harvard Business Review*, 2021, https://hbr.org/2021/11/a-new-crisis-playbook-for-an-uncertain-world.
[12] 'Here's What We Know about the Global Chip Shortage', *Tech Monitor* (blog), 2022, https://techmonitor.ai/technology/chip-shortage-why-global.
[13] 'The Cost of the Suez Canal Blockage', *BBC News*, 2021, sec. Business, https://www.bbc.com/news/business-56559073.
[14] Vivian Yee and James Glanz, 'How One of the World's Biggest Ships Jammed the Suez Canal', *The New York Times*, 2021, sec. World, https://www.nytimes.com/2021/07/17/world/middleeast/suez-canal-stuck-ship-ever-given.html.

of an escalation of an ongoing war in the Crimea and Donbas regions since 2014 – has caused the European fastest-growing refugee crisis since World War II[15]. The reaction of the European Union was the sanctioning of Russian oligarchs and businesses, with the attempt to discourage Russia to advance in the conflict. The war threatened the global order, causing difficulties due to the amount of resources provided by the two nations. Ukraine supply of neon gas represents 50% of the global supply[16]. Russia and Ukraine together account for more than 25% of the world's trade in wheat, for more than 60% of global sunflower oil and around 30% of global barley exports[17]. Moreover, Russia is a major exporter of some critical commodities such as mineral fuels, cereals and fertilizer. Companies which conducted business in those regions and which counted on their raw materials supply had to adapt rapidly to those changes, facing inflation in supplier and customer contracts. The war worsen logistic challenges due to port congestion, container shortages, long lead times, and record-high ocean freight rates[18].

In the meanwhile, China in March 2022 decided to implement the so-called "zero-covid policy" starting from Shanghai and prescribing severe lockdowns for tens of millions of people in order to cope with a sudden increase in the number of Covid-19 cases. This halted many productive plants - such as the ones of Toyota cars and Apple iPhones[19] - causing additional pain to businesses. The ones that exploited globalization through massive location in the 90's of productive plants there or that expanded heavily in that consumer market payed the price of a destroy in both supply and demand.

Companies have started to become aware of the importance of reducing the level of dependence from China – which accounted in 2019 for 28.7% of the global manufacturing output - for components and finished goods, and from Russia for transportation and raw materials while having more localized sourcing strategies[20].

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[15] María R. Sahuquillo and Javier G. Cuesta, 'Russia, Ukraine Agree to Humanitarian Corridors, with Possible Ceasefire during Evacuations', *EL PAÍS English Edition*, 2022, sec. International, https://english.elpais.com/international/2022-03-03/russia-ukraine-agree-to-humanitarian-corridors-with-possible-ceasefire-during-evacuations.html.

[16] David Simchi-Levi and Pierre Haren, 'How the War in Ukraine Is Further Disrupting Global Supply Chains', *Harvard Business Review*, 2022, https://hbr.org/2022/03/how-the-war-in-ukraine-is-further-disrupting-global-supply-chains.

[17] Jim Kilpatrick, 'Supply Chain Implications of the Russia-Ukraine Conflict', Deloitte Insights, 2022, https://www2.deloitte.com/xe/en/insights/focus/supply-chain/supply-chain-war-russia-ukraine.html.

[18] Simchi-Levi and Haren, 'How the War in Ukraine Is Further Disrupting Global Supply Chains'.

[19] Keith Bradsher, 'Surge of Omicron Infections Prompts Lockdowns in China', *The New York Times*, 2022, sec. World, https://www.nytimes.com/2022/03/14/world/asia/china-covid-omicron-lockdowns.html.

[20] Simchi-Levi and Haren, 'How the War in Ukraine Is Further Disrupting Global Supply Chains'.

From this global context of continuous disruptions, supply chain has emerged as a fundamental pillar of the worldwide ecosystem as well as a real source of competitive advantage to ensure the ability to pursue business objectives. In order to be able to do so, supply chain resilience and agility are fundamental, combined with the ability to predict in some way future disruptions through data-tracking and to have flexible systems which exploit possibilities offered by new technologies.

1.3. Supply chain key processes

We define as "supply network" the set of people and organizations that, with their activity, take part in the supply chain. We already mentioned that this network expands outside of the company's boundaries, including customers, suppliers, suppliers' of suppliers, customers' of customers and so on. It is possible to identify the upstream supply network that includes all the suppliers up to suppliers of raw material, which represent the origin of the network. On the other side, downstream supply network is composed of customers, up to the end consumers[21]. The supply chain as a whole includes:

- Suppliers, which are all the people or organizations that provide materials, components and finished goods.
- The manufacturing ecosystem of the company – including own plants network and third party co-manufacturers.
- Distributors, wholesalers and retailers - depending on the distribution channel's configuration – that are the company's customers.
- End-consumers.

Figure 4 Material flow along the supply chain ecosystem.

[21] Pietro Romano and Pamela Danese, *Supply chain management. La gestione di processi di fornitura e distribuzione* (McGraw-Hill Companies, 2010).

Inside the company, there are several functions involved in managing the relations with the upstream and downstream network. Those are responsible for key operative processes and value added activities that support the functioning of the network, and can be divided into three main functions:

- Demand planning
- Supply planning
- Logistics

Their objective is to bring together the demand level coming from the markets and the supply capacity of production plants, at the point that minimizes total costs. This involves manufacturing, warehousing activities, order fulfilment and finally logistics responsible for transportation and storage of goods. Before proceeding, we should clarify what is intended for "planning" and why companies face the need to use advance planning systems their flow of activities.

In general, planning is the process that deals with the identification of all the steps and measures needed in order to achieve a goal or an objective. It is a key to coordinate the huge amount of actions that need to be performed together and simultaneously. This tool supports decision-making providing alternative scenarios and enabling manager's valuations on which one would be better to perform[22]. All the organization levels and objective of different importance need planning. As we can see, it plays a central role in the complex context of supply chain. It has a conceptual difference with forecasting, which tries «to predict future developments and to explain relationships between input and output of complex systems»[23]. In this context, models that simulate reality decomposing it in simpler terms are used to simulate events. Optimization models, in addition, enables alternative's evaluation through the introduction of an objective function, decision variables and business constraints. The validity of the plans developed persists in relation to its planning horizon. Long-term planning – strategic planning – is set up at a higher level and relates to long-term objectives, considering the desired future development in some years. Mid-term planning – sometimes referred to as tactical

[22] Wolfgang Domschke and Armin Scholl, *Grundlagen Der Betriebswirtschaftslehre* (Springer Berlin, Heidelberg, 2003).
[23] Bernhard Fleischmann, Herbert Meyr, and Michael Wagner, 'Advanced Planning', in *Supply Chain Management and Advanced Planning: Concepts, Models, Software and Case Studies*, ed. Hartmut Stadtler and Christoph Kilger (Berlin, Heidelberg: Springer, 2005), 81–106, https://doi.org/10.1007/3-540-24814-5_5.

planning – considers what will happen in the range between the next 6-24 months, breaking down the overall objective into an outline of operations. Lastly, the operational planning splits into a high detailed and technical level all the actions that have to be taken in the short-term, including daily measures to be implemented[24].

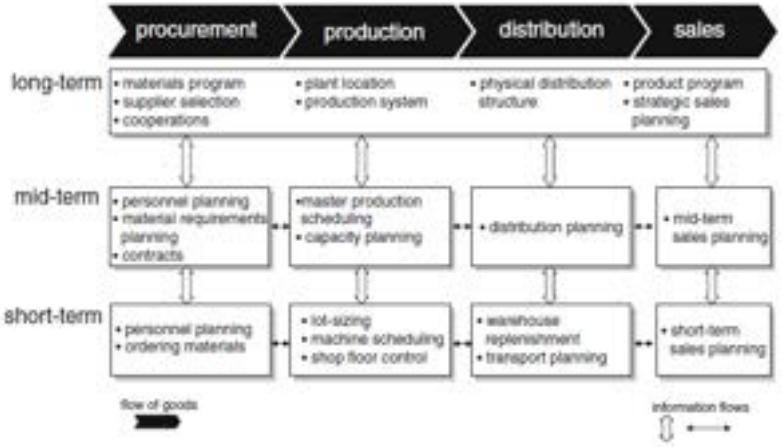

Figure 5 The Supply Chain Planning Matrix. Source: Fleischmann, Meyr, and Wagner.

Planning is important but often comprise several trade-offs, being constantly evolving together with the external and internal environments. Fleischmann et al. sustain that to select the best alternative comparing them by some criteria is not feasible, since uncertainty is the most relevant difficulty in having effective plans. Those have to continuously deal with changes in external and internal environments, and have to be revised accordingly. To mitigate the impact of uncertainty, planning is usually made on a rolling horizon basis that permits to revise the plans when needed. The planning horizon is divided into smaller periods. The first period is "frozen" in the sense that the plan cannot be revised. At the beginning of each period, the whole plan – except for the frozen part – is updated and the horizon overlaps with the previous one extending it one period further[25].

Especially in relation to the uncertain context underlined before, end-to-end planning is an imperative for companies that need to involve the entire supply chain processes from product design to after-sales customer services. Planning practices have to be effective and in order to do so they should exploit possibilities offered by new technologies. The main principles of end-to-end planning are:

[24] Fleischmann, Meyr, and Wagner.
[25] Fleischmann, Meyr, and Wagner.

1. Cross-functional integration, which brings together all the different planning activities in order to deliver the maximum value for the value chain as a whole;
2. Short planning cycles, required by the continuous changing context which calls for weekly – or even daily – cycles;
3. Advanced analytics enablement, through techniques able to translate data in valuable information for each planning process;
4. Automation, to make planners job more lean and valuable;
5. Full-visibility, to identify on-time risks and potential bottlenecks and develop proper solutions[26].

In this way, companies will be able to deliver a superior performance in line with objectives and strategies, exploiting the benefits of a functioning planning process incorporating the several different needs and points of view.

To make the most out of their planning processes, companies should rely on one service partner – such as SAP, Oracle, and IBM - to harmonize supply chain processes into a unified and collaborative network.

1.3.1. Sales and Operations Planning – S&OP

We will now consider the key process of supply chain management: the S&OP. Standing for Sales and Operations Planning, it is a fundamental cross-functional collaboration process that combines the perspectives of sales and marketing function - more customer focused and market oriented - and the one of the supply chain - responsible for procurement and production plans. It can also be referred to as Integrated Business Planning – IBP – since it combines tactical and operational planning in an integrated perspective.

The aim of the S&OP is to "develop tactical plans that provide management the ability to strategically direct its business to achieve competitive advantage on a continuous basis"[27]. This process is needed in order to strive to satisfy the total demand of the market while observing the production's constraints together with minimization of costs related to the

[26] Jérémie Ghandour et al., 'An End-to-End Transformation of Planning', *McKinsey*, 2021, https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/consumer-goods-companies-must-transform-their-planning-end-to-end.
[27] 'APICS Dictionary -The Essential Supply Chain Reference', in *APICS Dictionary, 14th Edition*, 2013.

inventory and the distribution of products. Jeff Baker suggests thinking to S&OP as the underwater part of an iceberg that enables the tip one to emerge. This includes improved forecast accuracy, faster inventory turns, better EBITDA projections and improved customer satisfaction. The potential of S&OP to provide those results relies heavily on the human capabilities of those who drives the process[28].

Figure 6 S&OP Process. Source: SAP.

We can identify different phases that constitute the process. An approach proposed by Jandhyala et al. starts with the product review phase, which takes into account the new launches of products planned in the coming 18 months – considering the complexity that derives by the lack of historical information – and the confirmation on the strategic and target alignment of existing products' performance. Following, the demand review phase is exploited by the demand planning team, which consider the output of the sales and marketing function of the organization for what concerns their expectations on what will be the potential market request. This demand is considered "unconstrained" because it does not take into account the production capacity, and should be evaluated both on the product level and on the customer level. Once the demand review has been completed, its output serves as an input to the supply review phase. The role of supply planners is to produce detailed production plans, components requirement plans and capacity utilization plans. These have to consider the unconstrained demand reviewing it with constraint parameters in accordance with supply and production capacity. The outcome is the "propagated demand", a version of what required by the market adjusted considering factors such as plants' capacity, shortage of components and possible delays due to external forces. Following, the operational S&OP meeting put together representative of each function and try to solve issues emerged by the previous phases. This cross-functional meeting involves different perspectives inside the organization, in order to get out with the best possible trade-off. Lastly, the executive S&OP – an executive

[28] Jeff Baker, 'Solving Dysfunction in Your S&OP Process', *The Journal of Business Forecasting* 38, no. 3 (2019): 11–14.

decision-making meeting - starts from the problems emerged and the possible solutions provided by the operational meeting and flows in sign-off on plans to be followed[29].

Each company has to customize its own S&OP process depending on factors such as the industry dynamics and product lifecycle. The plan frequency and horizon can be diverse too. An efficient S&OP process leads to a higher ability of the company to satisfy the demand level while optimizing assets' utilization. The consequences of out-of-stock enhance the importance of this planning process: the situation in which products are not available to consumers when they intend to purchase them can be destructive both for manufacturers and for retailers. Out-of-stock situations can emerge due to the inability of the company to produce and deliver the right quantity, or due to the bad order and stock practices of its customers. Supply chain management intervene in this context planning on its own process and educating, monitoring and assisting distributers in order to prevent such situations. A survey conducted on Indian consumers in October 2021 highlighted that 41% of them decided to buy a different product when they found it not available[30]. When result of the inability of the manufacturer to provide its products, out-of-stock brings difficulty for its customers that may face the inability to satisfy consumers. However, retailers can still extract benefit from this situation through category management[31]. It has to be specified that for some products, the out of stock situation can affect the product's desirability in consumer's mind. However, this heavily depend by the context and does not have to be confused with the manufacturer inability to provide the required level of stock due to operational inefficiencies.

Summarizing, this process is a value creation opportunity that brings together the two side of the supply chain - the demand side and the supply side – integrating all the other function of the organization – sales, marketing, production, inventory management, R&D and finance. Generally, the expected output of the process is an updated forecast declined into sales plan, production plan, inventory plan, new product development plan, strategic initiative plan and a financial plan.

[29] Jandhyala et al., *Sales and Operations Planning with SAP IBP*.
[30] McKinsey. "Consumer response when products were out of stock in India as of October 2021." Chart. December 3, 2021. Statista. Accessed April 28, 2022. https://www.statista.com/statistics/1294041/india-consumer-reaction-to-out-of-stock-products/
[31] Yunhui Huang and Y. Charles Zhang, 'The Out-of-Stock (OOS) Effect on Choice Shares of Available Options', *Journal of Retailing* 92, no. 1 (1 March 2016): 13–24, https://doi.org/10.1016/j.jretai.2015.07.001.

Other than improving financial performance, the S&OP process:

- Improves utilization of capacity and improves return on assets.
- Increases visibility across the entire supply chain enabling better business decisions and quicker reaction to issues.
- Improves communications and teamwork across regions and functions leading to more balanced trade-offs in decisions resulting in improved bottom line.

Internally, it increases transparency and integration between departments.

1.3.2. Demand planning

The process of demand planning can be different in companies depending mainly on which strategy they want to pursue. In particular, companies can decide to follow a make-to-stock logic or a make-to-order one. In the case of MTS, the production of goods is placed in advance with respect to the onset of the demand itself, while the production takes place only after the demand signal and - theoretically – there should be no stock for the products in the MTO strategy. In both cases, planning is important, but the underpinning logic differs[32].

The demand planning team is responsible for the demand review phase. Starting from its forecast, the objective is to predict the quantity and the quality of demand that the market will provide in the future. The reason why forecasting is needed is to allow the organization to ensure that it will dispose of the right resources at the right time to satisfy the market, avoiding lost sales due to unavailability of products. The ability to provide a high forecast quality is a key driver to growth, necessary to monitor and keep low the inventory level – that is a significant cost for the company – while satisfying the actual demand level. However, the only certainty about forecasts is that they are always wrong. Anyway, the objective of demand planning is to improve accuracy, starting from the forecast, correcting and balancing it through important considerations on external and internal factors – which in some cases are not easy to include in algorithms.

[32] Jandhyala et al., *Sales and Operations Planning with SAP IBP*.

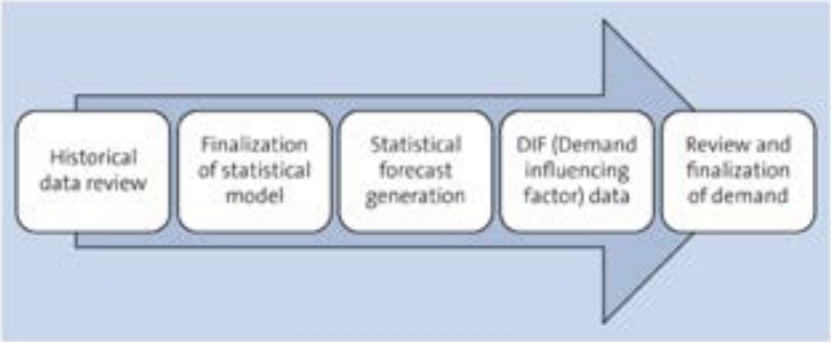

Figure 7 Demand Planning Process Steps. Source: SAP.

As we can observe in the above figure, the demand planning process begins with historical data review, complemented with both quantitative and qualitative approaches to consider factors that could cause complexities: external environment, product lifecycle, new launches, marketing strategies and promotion plans. The role of the demand planning team is important especially with respect to the aggregate number: in the situation of a company operating in multiple geographical areas and with multiple distribution channels, multiple actors will provide the forecast. Simply speaking, each actor will provide an optimistic forecast to ensure itself a portion of stock in order to be able to satisfy an unexpected excess of demand. This becomes a problem when the total aggregated demand – to which a priori the supply planning team will add a safety stock level to ensure an adequate inventory level – presents the sum of each excess of demand. This excess get unsustainable when sums tens or hundreds of isolated number, resulting in the risk of an excess of inventory. The phenomenon is referred to as "bullwhip effect", also known as "Forrester effect". The bullwhip effect can be described as the propagation of a small operational inefficiency that amplifies while going upstream along the supply chain. To mitigate those effect – which characterize itself for being an operational recurrent risk[33] - synchronization of the supply chain and end-to-end visibility are necessary[34]. There are several ways to measure the accuracy of the demand planning process: the forecast error measures the discrepancy between the actual and the predicted value. The lower is the forecast error the higher is the forecast quality. The goal

[33] Dmitry Ivanov, Alexandre Dolgui, and Boris Sokolov, 'Ripple Effect in the Supply Chain: Definitions, Frameworks and Future Research Perspectives', in *International Series in Operations Research and Management Science*, 2019, 1–33, https://doi.org/10.1007/978-3-030-14302-2_1.
[34] 'APICS Dictionary -The Essential Supply Chain Reference'.

is to figure out a level that will be as close as possible to the actual one – to minimize the two opposite situations of shortages or surplus of stock.

A concept that deserves a mention is the one of demand shaping. It refers to a series of actions conducted with the aim to influence the demand and makes it converge towards the supply. It inverts the cycle for which supply is aligned to demand inferred from market signals with the supply level adjusted accordingly. This approach can pose several limits given the ignorance from the market side about the inventory quality and of the stock quantity already present. Once identified necessities in term of stock abatement, these data are used to communicate with the market that should adjust its sales plan in order to shape the demand. Dynamic pricing, promotions, special sales and other aggressive marketing strategies are methods used by companies in their attempt to influence customers. Analyses used for determining how to exploit the demand shaping are an integral part of the S&OP process, and the relevance of this bidirectional flow of information is one of the core concept underlying the collaboration concept in supply chains.

Collaboration is namely the action to working together with someone to produce something. In supply chains, collaboration expresses coordination with «internal departments and external partners to sustain an optimized flow through the supply chain in order to efficiently meet demand and ensure on-time, in-full delivery»[35]. In practice, it occurs trough real-time shared visibility among supply chain partners on aspects such as raw material availability and inventory level, permitted by integrated systems sharing data, transactions and material flows. Clearly only the ones useful to reach common objectives. Through collaboration, a smooth-running supply chain could be achieved especially with reference to the difficulties emerging by global shortages of components. Supply order collaboration permits to companies to know directly from the system the information they need to be aware of their order status, integrating those details in their own planning. Vendor-managed inventory maximise the potential of stock in warehouse while alleviating the production[36]. Collaborative forecasting would benefit of all the

[35] GEP, 'Supply Chain Collaboration - What, Why and How', 2022, https://www.gep.com/blog/technology/complete-guide-to-supply-chain-collaboration-what-why-and-how.

[36] GEP, 'Top Five Supply Chain Processes That Need Collaboration Right Now', Whitepaper, 2020, https://www.gep.com/white-papers/top-5-supply-chain-processes-that-need-better-collaboration-right-now.

different point of view of supply chain actors, providing more reliable and realistic numbers. Finally, convenience would come from collaborative capacity too – in other words «knowing whether the supplier's materials are allocated to you as a customer in time for it to produce supplies to meet your production schedule»[37]. Many companies are still suspicious about sharing or do not have proper systems to engage in this yet. However, it is a common opinion that collaboration will bring several operational efficiencies and outstanding performance to companies that will be able to effectively implement it[38].

1.3.3. Supply Planning and Inventory Management

After the release of an agreed demand plan results of the two phases of product review and demand review, the supply planning process begins. In this step, unconstrained demand is aligned with the organization's ability to meet that demand considering the organization's capabilities. Thus, supply planners have to come up with a supply plan that satisfies the higher possible amount of demand taking into consideration supply constraints and costs. Supply planning in manufacturing firms is fundamental to predict in advance how the current capacity can support and sustain the estimated demand level in the future: this enables evaluation on the possibilities of expanding production plants, changing the management of the stock or the distribution footprint.

Figure 8 Inputs for the Supply Plan. Source: SAP.

[37] GEP.
[38] Paul Martyn, 'Supply Chain And Manufacturing Collaboration Is Now Common Sense', *Forbes*, 2017, https://www.forbes.com/sites/paulmartyn/2017/06/28/the-case-for-collaboration-is-now-common-sense/.

The key stakeholders in this process are manufacturing, procurement, logistics, and distribution. Evaluations have to be made considering the plants' capacity, the feasibility of receiving enough raw materials and components from suppliers – considering in this way supplier's capacity too – the warehouse capacity, the transportation possibilities and lastly the consistency of the plan with the organization's financial objectives[39]. In this process, demand is propagated in the sense that it is defined «the path for a given product from a customer to its ultimate supply source through the internal distribution network, up to exploding the bills of material for production processes, resulting in raw material requirements coming from suppliers»[40]. This permits to make assessments on the ability to meet the level of demand required, and to evaluate if there are other feasible ways – such as outsourcing or different inventory policies. Following, the supply propagation gives the feedback on the quantity and the quality of demand that can be satisfied. The two information flows are described in the following figure.

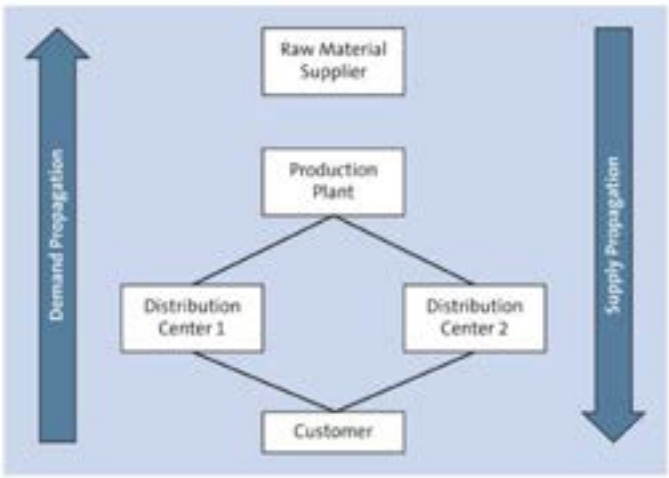

Figure 9 Demand and Supply Propagation. Source: SAP.

Something that has to be strictly monitored when planning the production is the inventory level. Inventory is «materials held for use in the future, either for sales or in the production process»[41]. There are several classification of inventory depending on its purpose, such as finished products inventory, raw materials inventory, or even work in progress and inventory for maintenance and repairs. Buffer inventory – also known as safety stock - is a certain quantity of products usually expressed in a percentage of the

[39] Jandhyala et al., *Sales and Operations Planning with SAP IBP*.
[40] Jandhyala et al.
[41] Lei Wang et al., *Inventory Planning and Optimization with SAP IBP* (Rheinwerk Publishing, 2019).

confirmed demand forecast, which is added to the forecast in order to mitigate the possibility of occurring into stock outs caused by impediments in production or lack of raw materials and components. It should protect the companies from sudden changes in demand or supply. Even though inventory is essential for supply chain processes, its level needs to be carefully managed given that it represents a significant cost beared by companies financial statements, composed by the holding cost – the capital tied-up in inventory and the warehouse cost for storing it - and the risk associated to obsolescence and accidental damages. An effective inventory planning and optimization aims at:

- Meeting customer needs through an optimal strategic distribution of inventory along the supply chain, in the way in which will provide capabilities to reach a high service level – for example in the right warehouses, hubs and distribution centres or at the right production facility in the case of raw materials[42].
- Minimize the working capital level, which is the difference between a company's current assets – which include inventory - and current liabilities. Working capital ensures liquidity but at the same time ties-up capital that could be invested in other activities. Minimizing inventory level brings more operational efficiency and higher the availability of funds for long-term undertakings[43].

Inventory management has to address the risk of having a bimodal distribution with too much of the wrong products and too less of the right ones. This threat is diffused especially in companies that has a elevate number of SKUs and products with a short lifecycle.

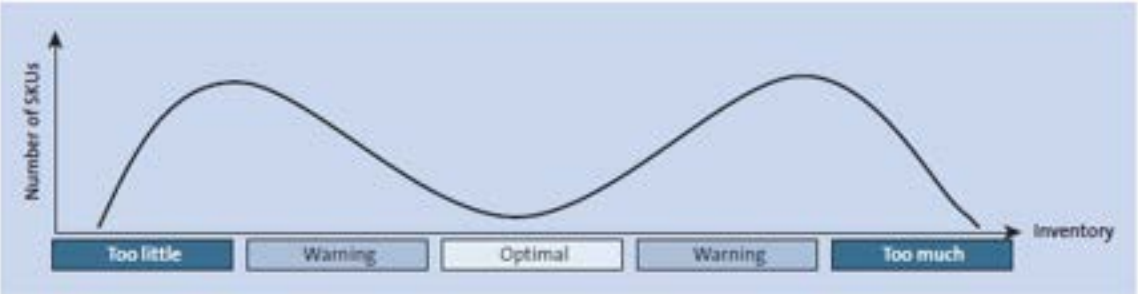

Figure 10 Bimodal Inventory Distribution. Source: SAP.

[42] Wang et al.
[43] Wang et al.

1.3.4. Logistics

Logistics is the «means whereby the needs of customers are satisfied through the co-ordination of the materials and information flows that extend from the marketplace, through the firm and its operations and beyond that to suppliers»[44].

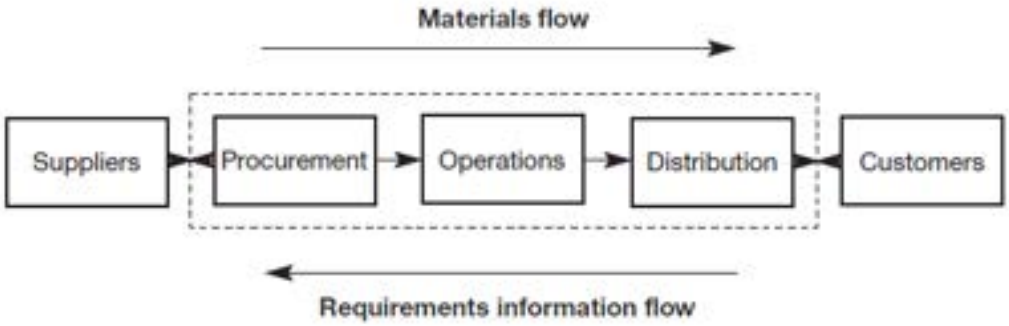

Figure 11 Logistics management process.

In other words, the logistic function provides a plan that manage together all the different thousands of flow of products and information to enable a smooth execution of business operations. The logistics function is fundamental for an effective supply chain management, since it takes into account also the external entities part of the supply network. Moreover, it has an impact on cash flows too, given agreements that contemplate payments starting from the date in which the goods are received[45].

Logistic efficiency enhance competitive advantage and profitability through effective orders fulfilment, especially in relation to the growing importance placed by consumers to the speed of the service.

Two of the primary activities in the value chain are inbound and outbound logistics: the first refers to material management that enables manufacturing activities, while the latter deals with all the actions needed to bring products in consumer's hands through distribution. Both manage the flow of goods, but the first focuses on acquisition of resources and on the supply side, while the latter with delivery coherently with what required by the demand side.

[44] Christopher, *Logistics and Supply Chain Management*.
[45] C. John Langley et al., *Supply Chain Management: A Logistics Perspective* (Cengage Learning, 2020).

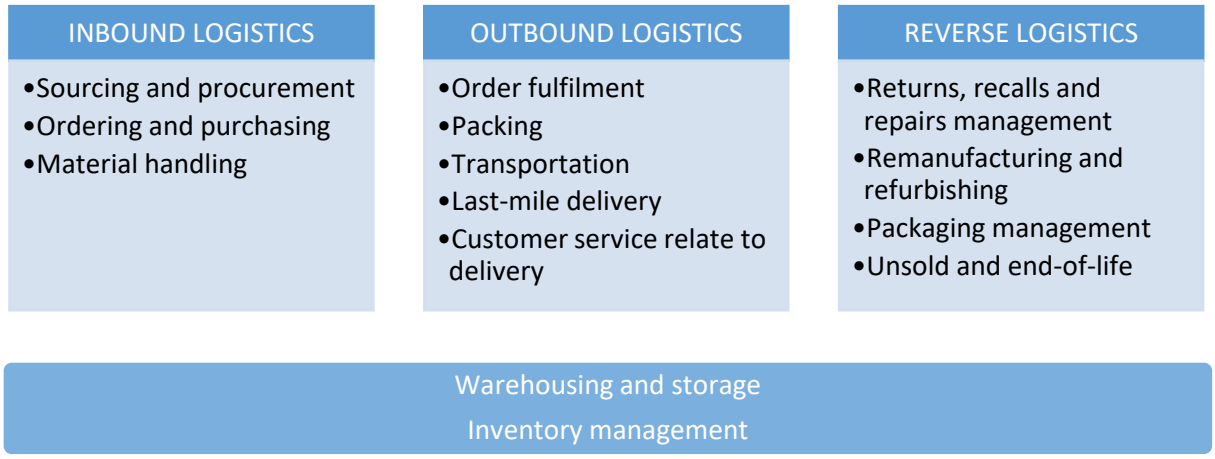

Figure 12 Logistics and reverse logistics activities.

Reverse logistics is responsible for the flow of goods that are moved back from the customers to the manufacturer. This includes e-commerce returns made in the scope of the consumer's rights, recycling opportunities and all the other situations that involve the goods' ascent through the supply chain. Reverse logistics' processes are key in supply chain efficiency and in the economic and environmental sustainability pattern of the company. While return management is essential to deal with the current trend – especially related to the omnichannel distribution – others permits to exploit the circular economy's benefits.

1.4. Supply chain management critical success factors

Successfully managing supply chain networks – and consequently achieving outstanding performance and competitive advantage – requires a deep understanding of both internal and external environments. Something that has recently gained attention due to latest events – such as the COVID-19 pandemic or the geopolitical crisis due to the war in Ukraine – is the concept of resilience of the supply chain. Supply chain disruptions represent a cost for worldwide organizations estimated to an average of 228 million dollars per years in the United States[46]. Disruptions are high-impact and low-frequency events which affect the supply chain structure and performance, and whose propagation along the chain is identified as the "ripple effect"[47]. The inability to contain and limit the

[46] Interos. "Estimated average annual cost to respondents' organizations as a result of global supply chain disruptions in 2021, by region or country (in million U.S. dollars)." Chart. June 30, 2021. Statista. Accessed April 23, 2022. https://www.statista.com/statistics/1259125/cost-supply-chain-disruption-country/
[47] Ivanov, Dolgui, and Sokolov, 'Ripple Effect in the Supply Chain'.

impact to a confined area brings severe consequences. For instance, Ivanov et al. (2019) and Cochrane (2005) say everything you need to know on this topic. In order to prevent the ripple effect and overcome challenges provided by an increasingly uncertain and unpredictable context, flexibility and effectiveness of systems is a fundamental requisite. Resilience relates to the ability to recover quickly from difficulties, and a resilient supply chain is the one that is able to «persist, adapt, or transform in the face of change»[48]. Holling described two different perspectives on supply chain resilience present in the literature: an engineering and a social-ecological one. The engineering resilience concept is valuable in a short-term approach that considers the supply chain as a machine with a steady state. When this steady state is altered, the equilibrium moves and resilience can be measured through the two indicators of the time-to-recovery and time-to-survive. Respectively, they identify the time needed to go back to the equilibrium, and the time left until the disruption will stop the system. However, some argued that considering the system as rigid is misleading, while adaptability and flexibility in relation to the changing environment is a prerequisite for value creation. The environment we refer to is characterized by high volatility, which indicates the ability to change rapidly and unpredictably. Applied to the supply chain context, this result in unexpected changes in upstream and downstream flows that have an impact on the ability of the organization to match supply and demand level, resulting in sticky situations. In this context, supply chain management intervenes exactly in order to overcome difficulties related to increased customer's expectations, demand volatility and supply volatility[49]. To this purpose, authors that have embraced the social-ecological resilience sustain that the supply chain ecosystem should adapt itself to external environment, measuring resilience as the amount of disruption that can be absorbed before the supply chain changes structure[50]. It is reasonable to assume that both the perspectives are important and should be considered in combination with each other.

According to a 2021 survey among global supply chain leaders, 73% of them encountered problems on their supplier footprint that require changes in the future, while 75% of them

[48] Andreas Wieland and Christian F. Durach, 'Two Perspectives on Supply Chain Resilience', *Journal of Business Logistics* 42, no. 3 (2021): 315–22, https://doi.org/10.1111/jbl.12271.
[49] Jandhyala et al., *Sales and Operations Planning with SAP IBP*.
[50] C. S. Holling, 'Engineering Resilience versus Ecological Resilience', in *Engineering Within Ecological Constraints*, 1996, https://www.semanticscholar.org/paper/Engineering-Resilience-versus-Ecological-Resilience-Holling/ab0dc6785ebbae3904aace0cb9e243d5379acd75.

found gaps in the production and distribution footprints. The 85% stated that have had several struggles due to insufficient digital technologies[51]. Companies can improve their supply chain resiliency through a combination of measures aimed at:

- anticipate challenges through predictive models that are able to depict events;
- diversify of the supply and distribution networks;
- improve communication and live information sharing among parties;
- implement lean and agile logistic management.

Diversification plays a key role in relation to resilience. Companies who have already engaged in multichannel distribution had the chance to be resilient in the pandemic's movement restriction period relying on online sales. Diversification of the production footprint makes acceptable the impossibility of a plant to operate due to unexpected wars or geographical limitations, relying on other factories to go on with the business in the rest of the world. In the same way, diversification of suppliers increases the possibility to overtake delays that cause impossibility to complete the production of finished goods.

New technologies embed a great potential for applications in supply chains too, in order to improve not only resilience but also visibility. Many scholars have conduct studies in the field of digital twins – firstly defined by the NASA as «an integrated multi-physics, multi-scale, probabilistic simulation of a vehicle or system that uses the best available physical models, sensor updates, fleet history, etc., to mirror the life of its flying twin»[52]. Burgos and Ivanov conducted an interesting study in which they implemented a supply chain digital twin model for a disruption analysis on the food retail's supply chain resilience during the pandemic. Through this tool, companies can figure out how to solve problems regarding shortages or bottlenecks easily, automatically and in advance. Given its potential, it can be an important partner for data-driven decision-making towards optimization and end-to-end visibility[53]. Several factors and are calling for this end-to-end

[51] Knut Alicke, Richa Gupta, and Vera Trautwein, 'Resetting Supply Chains for the next Normal', *McKinsey*, 2020, https://www.mckinsey.com/business-functions/operations/our-insights/resetting-supply-chains-for-the-next-normal.

[52] Edward Glaessgen and David Stargel, 'The Digital Twin Paradigm for Future NASA and U.S. Air Force Vehicles', in *53rd AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference* (American Institute of Aeronautics and Astronautics), accessed 28 April 2022, https://doi.org/10.2514/6.2012-1818.

[53] Diana Burgos and Dmitry Ivanov, 'Food Retail Supply Chain Resilience and the COVID-19 Pandemic: A Digital Twin-Based Impact Analysis and Improvement Directions', *Transportation Research Part E: Logistics and Transportation Review* 152 (1 August 2021): 102412, https://doi.org/10.1016/j.tre.2021.102412.

approach in supply chain optimization. Production cycles are complex especially in relation to the increase in size and variety of production portfolio. Coordination of activities is often hindered by not-on-time delivery of raw materials and shortage in critical components. The market demand scenario is characterized by the highest uncertainty and volatility ever seen. Moreover, companies have to pay plenty of attention to stakeholders' sustainability requirements, while being compliant with stringent regulations[54].

Together with resilience, the other three important factors that supply chain managers should keep in mind are responsiveness, reliability and relationship. Together, they define the 4Rs framework provided by Christopher (2013). In achieving those objectives, we should keep in mind the customer centricity concept discussed in the previous chapter. In supply chains, it may start by the definition of the different customer segments - based on the three elements mentioned right before – and followed by the identification of each one's priorities and expectations. After that, it is possible to tailor and draw supply chain processes to promote efficiency, while continuously calibrating them accordingly to customer's expectations.

It may sound obvious that information technology capabilities are critical for end-to-end visibility and communication among parties, but it is important to underline the extent of the value that these firm-specific capabilities bring. Moreover, new technologies enables analytics possibilities that can offer scalable solutions.

The collaborative approach – already mentioned before - owes its popularity to its connection with the circular economy, environmental sustainability and resources optimization. It exploit the benefits of information sharing among actors on the inventory and stock level to eliminate buffers between organizations providing them with information needed to pursue their sustainable goals. A sustainable supply chain ensures ethical and environmentally responsible actions taken by all the actors participating, ensuring transparency both among those actors and to external stakeholders through appropriate levels of disclosure, and companies need to ensure its effectiveness.

[54] Rainer Schuster et al., 'Real-World Supply Chain Resilience', *BCG Global*, 26 July 2021, https://www.bcg.com/publications/2021/building-resilience-strategies-to-improve-supply-chain-resilience.

CHAPTER II

The e-commerce era: considerations on the launch of a D2C e-commerce channel for a B2B traditionally oriented company

2.1. The distribution strategy relevance for the business

Once a company has identified its value proposition, its products and its customers, the stage goes to the channels through which the product will get to its final destination. The design of these processes is a fundamental element in the complex structure of a company's strategy, in order to pursue not only revenues and profit maximization, but also maintaining, while striving to increase, the market share that competitors would otherwise gain in a while if the company lose control. An appropriate distribution strategy literally makes the business work, and is necessary but not sufficient likewise all the other business functions. Imagine having a warehouse full of pallets assorted with the whole product catalogue, coherently with what the demand planning forecasted after accurate market researches and coordination with the marketing department effort. Given this forecasts, the production planning team gives the input to the production plant, which is able to fulfil its production capacity given the hard work of continuous implementation of the manufacturing processes. The output is an outstanding performing product, results of months of research and development combined with the claim of top quality. The sales team has already sold the product to a wholesaler that is waiting to receive it in order to make it move along the chain to reach its final destination. You do very little of all this effort if the distribution does not work. If the wholesaler does not receive its order, you have potentially lost one of your clients and one of your distribution channels. Meaning that some end-consumers will not find your product on shelves and consequently will likely to move to the ones of your competitors. You lost market share simply because you were not able to physically deliver your value proposition to the market. The point is that to recover from a damage that can happen in a while it takes months. This is an oversimplification used to give the idea of how much effort a manufacturer company has to pay, not limiting its attention to one activity but instead focusing on the whole cycle – from the R&D to when the product is in the hands of consumer, continuing later with post-

purchase services. The pandemic has given the demonstration of how managing distribution lies on a precarious equilibrium that is affected by so many external factors, on which you cannot have the complete control, that you need to be prepared to get around the obstacles before knowing which are those obstacles. No matter if they relate to unexpected events such as restrictions of movements due to a pandemic, or a vessel wedged across the waterway in the Suez Canal, the supply chain has to get over it and recover as quickly as possible with the cooperation of the other business functions.

A clear distribution strategy defines which are the objectives and the priorities that serve as a solid baseline to calibrate critical decisions, frequent to take in the everyday business by supply chain managers. The design process has to consider several factors, to suits the business model of the company and the overall strategic plan. On a broad distinction, the choice is to pursue one of the following distribution strategies: intensive, selective or exclusive. It can differs for each product type in relation to its specific features and intrinsic value, the customer segments that it wants to serve and the positioning that we want to achieve. The intensive strategy aims to market saturation with an aggressive penetration that makes the product available in all the possible stores. It is used mostly for goods that are not highly differentiated from competitors, for which the absence from the shelves would immediately translate in lost sales. With the selective strategy, the company concentrate its efforts only on selected location and stores, chosen through defined criteria. This allows to match the product values with the ones of the stores chosen. Benefits related are better insights gained on the customer base that helps in taking actions to increase customer's satisfaction. Lastly, the exclusive strategy represents an extremization of selection, since products are sold only in few stores in designated areas. This could enhance the product value by the scarcity principle, gaining better control on the price and the related image.

2.1.1. Distribution channels configuration

Right after the definition of the business strategy, a key importance is played by distribution channel's design. On its way to the end-consumer, products have to follow a path that can be made of more steps depending on whether the channel is direct, indirect and on its peculiar configuration. Each step contemplates a series of processes that involve the work of multiple actors in the organization. We define direct channels as «a

route to market that involves the supplier in dealing directly with its customers and not going to market through intermediaries»[55]. Conversely, when the supplier takes advantage of intermediaries that stands in its distance to the end-consumer, this configures an indirect channel, in which agents, wholesalers, retailers or a combination of these figures compose the chain. Indirect channels can be short or long depending on the number of intermediaries present. The academic literature makes a distinction among channels depending on the characteristics of the transaction's parties. Distribution channels in private companies can be defined:

1. B2B (business-to-business) when transactions are between two companies. This happens among all the actors involved in the indirect distribution channel until the retailer level. Looking a bit ahead of distribution, all the supply chain transactions with suppliers configures as B2B too;
2. B2C (business-to-consumer) when the transaction is taking place between a business and the end-user of the product, such as in retailers and marketplaces serving as retailers;
3. D2C (direct-to-consumer) when the manufacturer is selling its products directly to the end-consumer in physical or digital environments, without intermediaries in the transaction.

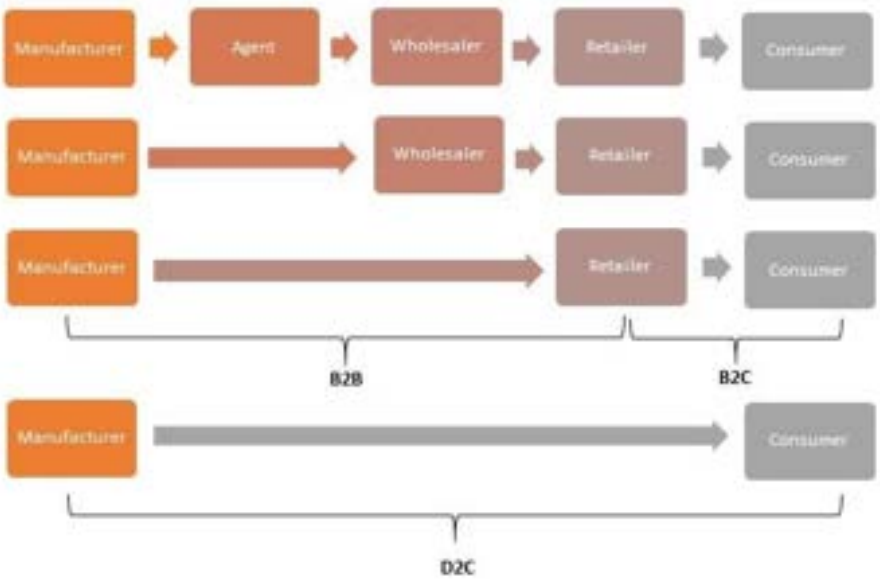

Figure 13 Basic distribution structures.

[55] Julian Dent, *Distribution Channels: Understanding and Managing Channels to Market* (Kogan Page Publishers, 2011).

The configuration of the distribution routes has to take into account several factors. The decisions about where to sell have a significant impact on the positioning of the product and of the brand in consumer's minds. Through wholesalers, the company can achieve a higher market coverage and distribute in multiple geographical areas without having to manage the retail's dynamics. Demo or flagship stores directly managed by the company deliver a full-immersion experience to consumers and a strong brand image, but require additional effort due to the characteristics of physical direct distribution and the specific retail know-how needed to operate effectively. The online channel is an important strategic lever – over 80% of western consumers across the globe shopped online in 2020[56] - but managing an e-commerce and selling on marketplaces require strong skills and elasticity due to the high competition levels. In addition, the complexity deriving by the management of the selected distribution channels has an impact on costs and consequently on the profit. With indirect channels, the company can take advantage of the third parties logistics and sales experience, reducing the risk of purchase uncertainty. However, complex systems with multiple parties lead to higher difficulties and lower margin to the manufacturer. The e-commerce needs significant initial investments but scalability, once achieved, provides considerable tangible benefits.

In reality, the distribution strategy of companies contemplates a system where multiple types of distribution channels operate together. This is of primary importance given that in the current context - results of the combination of the globalization and the progresses made in the technology field – customers can easily switch from one company to another in their purchase, accomplice the spread of marketplaces.

2.1.2. The influence of the digital transformation

The term "multichannel distribution" refers to the situation in which companies articulate their distribution using more than one channel to reach the market. It can be a combination of selling through wholesaler, directly managed shops and on marketplaces too, giving customers multiple choice for their purchase decision. It gained importance especially in relation to the success of the digital commerce – which we refer to as e-

[56] Sponsorpulse. "Total global share of consumers who shopped online in 2020, by region." Chart. December 3, 2020. Statista. Accessed March 30, 2022. https://www.statista.com/statistics/1192578/worldwide-share-of-consumers-that-shop-online/

commerce – that enabled the sell and purchase of goods and services on the web, without the need of a physical interaction among parties. The possibilities offered by the digital allow the previous seen configuration – B2B, B2C and D2C – to take place in the online environment too. This opened up emerging businesses to the possibility of breaking through new business models, and to already consolidated ones to innovate their organization and aim to leadership in the market. The digital is a "use it or lose it" opportunity, where losing it can be fatal in the ability to survive in the competitive context. This because the ongoing environment has already surpassed the digitalization concept – meaning the use of digital technologies to change business operations – directing attention to the digital transformation that is defined as the «customer-driven strategic business transformation that requires cross-cutting organizational change as well as the implementation of digital technologies»[57]. This concept broadly relates to the business model innovation where companies use technology to make disruptions and strive to build the dynamics that will dominate the market in the future. Digital transformation includes a technological change, faster to implement, and an organisational change, that depends more on the change management skills of people in the organization and is consequently more difficult to accomplish.

To understand how the digital transformation concept is affecting the distribution channels we have to go back to the concept of customer centricity - to which we will devote more time later - that has gained popularity in the last decades distinguishing the most profitable business of these days. The convergence towards the new focus has an impact on all business functions, including the supply chain and the logistics ones, affecting the configuration of the routes that brings the product to consumers. Before proceeding, we have to specify that the terms "customer" and "consumer" differs in the meaning that identifies in the first the individual/business that purchase the products, in the latter the one who makes use of them. In the literature they are often used interchangeably and it seems appropriate to assume that, for the purpose of the customer centricity, we refer to customers intending both the B2B customers – for example wholesalers and retailers – and the end users that can be both the ones of the B2B2C relation or the ones of the D2C. Consumer Goods' manufacturers operating B2B need to

[57] Jason Bloomberg, 'Digitization, Digitalization, And Digital Transformation: Confuse Them At Your Peril', *Forbes*, 2018, https://www.forbes.com/sites/jasonbloomberg/2018/04/29/digitization-digitalization-and-digital-transformation-confuse-them-at-your-peril/.

apply this customer centricity concept to their strategy thinking both to their business clients, which are their primary revenue's source, and in turn to their clients too. If end users expect to find products in the retailer shop, on the marketplace and on a www.companyname.com e-commerce too, the challenge is in the fulfilment of both the requirements of the indirect distribution and the ones of the online direct one without run into conflicts between them.

In the digital world we are experiencing today, being customer centric and operate as digital sellers are close related concepts. E-commerce's numbers highlights its importance in customer's minds: 67.8% of manufacturing shipments in the United States in 2019 have been ordered through the web[58]. On a B2B perspective, businesses purchase online more than ever: e-commerce B2B transactions accounted for most e-commerce sales value in 2019[59]. While its implementation is a big step into the digital transformation, this is not sufficient to strive to achieve the "Digital Champion" label. Geissbauer et al. explain how companies have to go far beyond the mere concept of automation while mastering the four critical business layers reported in Figure 2:

- Customer Solutions, that includes the e-commerce, marketplaces and all the products and services offered to customers that distinguish the company from competitors;
- Operations, where stands all the activities in support of the other ecosystems;
- Technology, which include the digital infrastructures that together with new technologies enables the company to fully exploit its digital capabilities;
- People, the human capital that is the primary driver of every change and progress[60].

These layers are interconnected and have to be managed in an integrated way. Meaning that the e-commerce is affected by technology and people, and relies on an efficient

[58] US Census Bureau. "E-commerce as percentage of total manufacturing shipments in the United States from 2010 to 2019." Chart. August 5, 2021. Statista. Accessed March 28, 2022. https://www.statista.com/statistics/185329/share-of-e-commerce-in-total-value-of-us-manufacturing-shipments-since-2000/

[59] UNCTAD. "Share of e-commerce sales held by B2B e-commerce in selected countries in 2019 ." Chart. May 3, 2021. Statista. Accessed March 28, 2022. https://www.statista.com/statistics/1242150/b2b-ecommerce-share-in-total-ecommerce-sales/

[60] Reinhard Geissbauer et al., 'Global Digital Operations Study 2018, Digital Champions - How Industry Leaders Build Integrated Operations Ecosystems to Deliver End-to-End Customer Solutions' (Pwc Strategy &, 2018).

operations ecosystem, at the same time having a significant impact on processes and activities. It affects the entire value chain requiring the struggle to look beyond organizational boundaries.

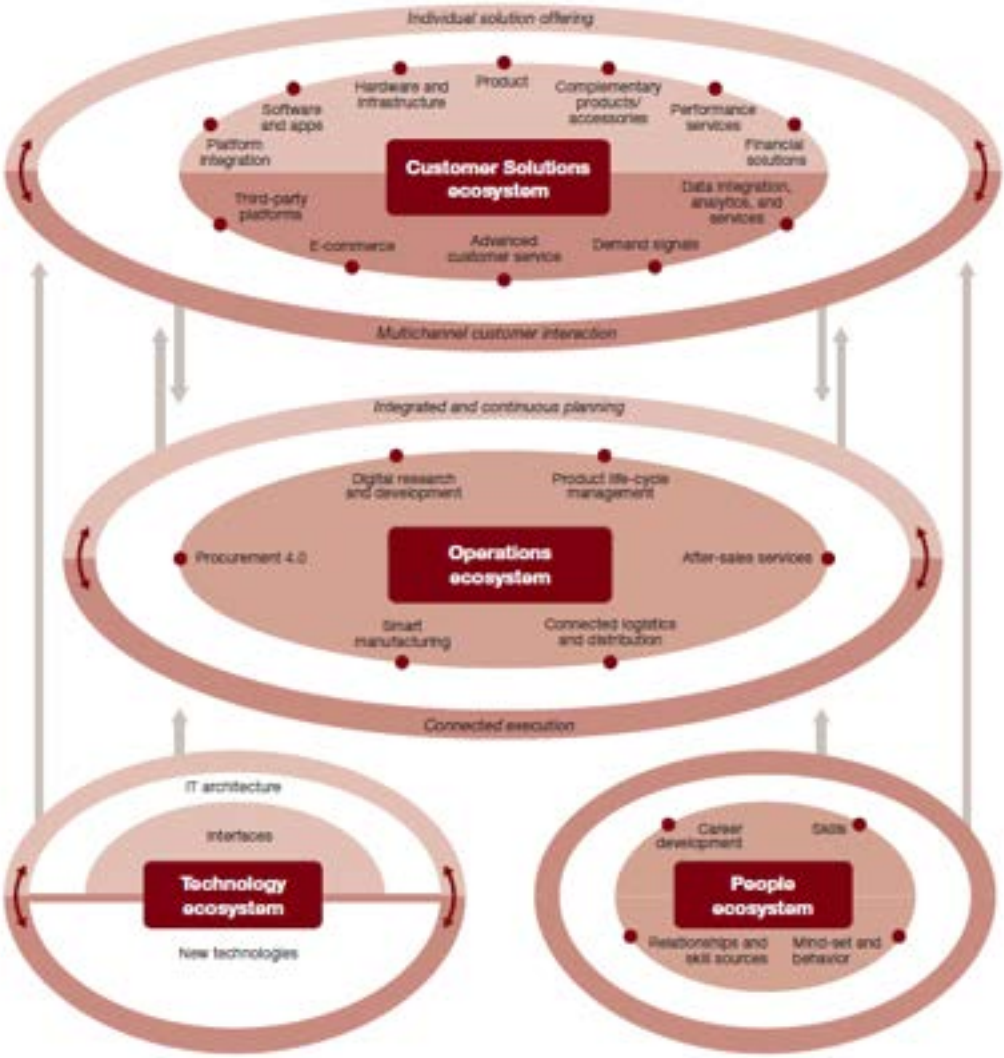

Figure 14 The four digital ecosystem layers. Source: PwC's Strategy& Global Digital Operations Study 2018.

2.1.3. The role of marketplaces

Online marketplaces have played as leading actors in the evolvement of the e-commerce era, given the success of some of them that gained the reputation of "web giants". Being the online correspondent of shopping mall or department stores, they are various in their features. It is discussed in the literature if marketplaces can be included in the perimeter of direct-to-consumer distribution, given the role that the third party provider of the platform is playing. It seems appropriate to consider marketplaces as direct channels only

when the company can sell its product independently and self-determined in a D2C relation[61]. Considering Amazon as an example, this is the case of the Amazon Business Seller Program where the company sells through the platform having the responsibility on listing, pricing and advertising, and directly collecting data on its consumers. On the contrary, this is not the situation for products sold by Amazon itself, in the scope of the Amazon Vendor Program. Here the manufacturer act as a supplier to Amazon that buy the product in a channel that configures as a B2B2C, and the company has no power on the pricing decisions and loses visibility on the end-consumer. Another leader of the sector is Alibaba – sometimes referred to as the "Chinese Amazon" – but there are many other popular marketplaces such as eBay, used mainly for B2C, Etsy for homemade and vintage items, and Zalando for fashion. Even Facebook has implemented a marketplace function.

In the same way as in physical distribution, also online marketplaces have their pros and cons. For sure, they enable companies to benefit of the intensive traffic - over 2.7 billion of visits in June 2021 for Amazon.com[62] - to increase product's visibility giving a big opportunity to businesses to enhance sales and brand awareness. The possibility to compare multiple products, the perception of price convenience, the reliability gained through the excellent customer service, and the efficiency in delivery and returns make online marketplaces attractive for customers. While reaching new target groups - the marketplaces-addicted - the company can devote its effort to develop loyalty with the consumer and attempt to direct some traffic gained through the platform to its own physical or online shops. On the other side, there are strict conditions to respect in order to be eligible to sell on the website and fees generates lower the margin gained by the seller.

2.2. Why a D2C e-commerce: benefits and challenges

In this section we will devote specific attention to the D2C e-commerce, namely the situation in which a manufacturer sell its product directly to consumers from its web-

[61] Uwe Leimstoll and Ralf Wölfle, 'Direct to Consumer (D2C) E-Commerce: Goals and Strategies of Brand Manufacturers', in *New Trends in Business Information Systems and Technology: Digital Innovation and Digital Business Transformation*, ed. Rolf Dornberger, Studies in Systems, Decision and Control (Cham: Springer International Publishing, 2021), 237–50, https://doi.org/10.1007/978-3-030-48332-6_16.
[62] SimilarWeb. "Worldwide visits to Amazon.com from September 2021 to February 2022 (in billions)." Chart. March 30, 2022. Statista. Accessed March 25, 2022. https://www.statista.com/statistics/623566/web-visits-to-amazoncom/

store. The digitalization provided an easy access to global distribution and direct commerce to manufacturers, thanks to the possibility of selling directly in online stores without the necessity to manage a physical shop. It has also driven, on the other side, the changes in buying habits and raised consumers' expectations, giving all the businesses an urgent need to shift to a customer-oriented focus in all their processes. In this evolving context, for many manufacturer companies the presence in the market with owned e-commerce has become, more than a choice, a necessity in order to exploit their full potential and to remain competitive in the market. Far beyond, going "multichannel", and consequently giving consumers the possibility to shop across multiple channels, is an already outdated concept considering the emerging importance of a new distribution approach that has gained ground in the last years: the "omnichannel" business model, to which we will devote attention later.

Going back to the D2C e-commerce, all the forecasts asserts the increasing importance that this channel will cover in the near future: the 2025 expected global e-commerce revenue is $4,198.5 billion, with an average annual growth rate of +8% (CAGR) per year from 2020 onwards. A substantial increase compared to the 2020 result of $2,854.8 billion. Particularly, this estimated market development interests the Household Appliances segment for $174.7 billion, compared to the $138.8 billion realised in 2020[63].

Considering the differences with the indirect distribution, these relates especially to the size and volume of orders, combined with the timeliness expected by customers. E-commerce orders usually are composed of one or a few different types of products, that have to be picked from the pallets and included in the same box with a dedicate packing-process. The orders' fulfilment takes place in the next 24 hours and is delivered to the courier as soon as possible – it is a race against the clock given the importance that online customers give to same-day delivery that will soon converge to "before-time-delivery". In B2B, wholesaler and retailers place months in advance orders of standard quantities of pallets, for which there is an accurate organization of production in compliance with the plant's capacity, a careful planning of the warehouse storage and long transit-time shipping with containers and truckload. In this business, seasonality is known and easier to foresee, while in the e-commerce peaks are often influenced by not-programmable

[63] Statista, 'ECommerce Report 2021' (Statista Digital Market Outlook, 2021), https://www.statista.com/study/42335/ecommerce-report/.

market trends that may send the specific product out-of-stock before the demand is exhausted. Moreover, it can be difficult to predict the demand of holidays and critical events - such as the Black-Friday - without sound experience and series of historical data processed by a sophisticated algorithm.

From a survey conducted by the Marketing Association of Spain in 2020 it emerged how the most perceived opportunities of D2C e-commerce are the control of data - knowledge of the user profile, retargeting, CRM strategy - and the personalization of the customer's journey[64]. Together with increased profitability opportunities and enhanced brand's value, these are the main benefits that that configure this type of expansion as a growth-driver that enhance the company's leadership in the industry. We will now take a look to the "lights and shadows" observable in a B2B context enriched with a D2C channel introduction, keeping in mind that this step is a valuable source for the company but entail some difficulties to overcome.

Table 1 Benefits and challenges of D2C e-commerce implementation in a B2B oriented company.

Benefits	Challenges
Higher margin for the manufacturer and new customer segments.	Cost of implementation and management of a new channel linked to under scale operations at least for a channel build-up phase.
Data gain.	Higher volatility and difficulties in implementing ways to interpreting data.
Possibility to gain new markets and of widening the customer base.	Risk of conflicts with retailer, competition among channels in particular in pricing levels.
Enhanced brand value.	Compete with higher standards in the market.

2.2.1. Economic and data gains and costs

The first factor that comes to mind when dealing with the opportunity for a B2B traditionally oriented business to implement a D2C channel is the impact on profitability and value generation. We already mentioned that the use of intermediaries in indirect

[64] Wunderman Thompson. "Leading factors that would motivate online shoppers worldwide to buy directly from brands as of April 2021." Chart. March 23, 2021. Statista. Accessed May 02, 2022. https://www.statista.com/statistics/1274958/motivating-factors-for-purchasing-d2c-sites-worldwide/

channels leads to a lower margin for the manufacturer compared to the price paid by the end-consumer – considering that this has to include a revenue for all the actors along the chain. The elimination of these actors can flow in one of the following situations: a higher margin for the producer or a lower price for the consumer. Both situations can be favourable to the company since on one side, it is increasing its profitability and on the other side, it is likely to gain market share if competing on a price level – i.e. if price elasticity is a relevant factor. We must specify that the latter situation could be valuable in segments in which, for their products' and market's characteristics, competitive dynamics are based on price strategies. However it is not that viable for the contest of our analysis - a B2B company increasing, not substituting, its business with a D2C – because price competition in this sense opens up to conflicts with retailers that will be discussed further on. Focusing on the profitability opportunity, this is not limited to the margins but it broadly relates to the expansion to other customer segments combined with the potential to increase loyalty and the monetization of the already existing customer base through repeated purchases[65]. The higher margin on sales cannot configure as a decisional factor per se in evaluating pros and cons, given the fact that the introduction of the new channel entails costs and additional effort – especially in the first phase that requires high change management skills. The cost of introducing a structured e-commerce with a large product catalogue, dedicated marketing, customer service as a value creator and well-planned stock necessity is not limited to building the online platform – that has to be easy-to-use and desirable given its graphics and functions. It requires a dedicated cross-functional team full-time focused on the dynamics of this stand-alone environment, since this business calls for specific knowledge and skills. The e-commerce enables the company to improve both the range and the quality of services offered, but only as long as there is the capability to effectively deliver this higher value. Nestlé – the Swiss food and drink corporation – achieved great results from its digital transformation journey. The e-commerce channel accounted in 2021 for 14.3% of total sales, growing by 15.1% from the previous year[66]. For this reason, the company plans to increase the investments in digital marketing by 50% and almost double the size of the e-commerce platform by 2025.

[65] Dave Chaffey, *Digital Business and E-Commerce Management* (Pearson Education, Limited, 2014).
[66] 'Transforming through Digitalization | Nestlé Annual Report', Nestlé Global, 2022, https://www.nestle.com/investors/annual-report/digitalization.

An immediately tangible gain is the amount of data – commonly referred to as "the new gold" – on consumers gathered through the e-commerce platform. The rarity of data collected, meaning that no other company can have access to the exact same quality and quantity of the others – configure them as a proper strategic asset. This refers to both internally generated data and external user-generated content, the latter being useful especially for service differentiation purposes[67]. The e-commerce is the fastest adopter of big data analytics, dealing with both:

- Structured data, such as name, age, gender, nationality, address and the other psychographic variables of users; and
- Unstructured data, that are clicks, likes, links, tweets and similar[68].

Data analytics in general enables companies to take data-driven business decisions, gaining a knowledge applicable in multiple fields related to business process improvement, product and service innovation and marketing. Data-driven business decisions' benefits are widely discussed in the literature and their size depends on the accuracy and ability of the company in predictive analytics that generates true business value. Big data represent the raw material that enables machine learning and artificial intelligence, technologies that has become crucial in gaining advantage beside competitors. Moreover, they are widely used in the most advanced supply chains in demand forecasting through sophisticated algorithms that can include information about numbers of clicks, the wish lists or left-in-basket products to predict consumers' decisions.

The capacity to foretell events is one of the factors that, among the others, distinguish top players in the market. With reference to the D2C e-commerce, an advantage of its implementation is that data are directly collected by the company, which no longer needs to rely on its third party's brokerage and can immediately use its business data analytics' capabilities to calibrate its future moves. With this in mind, the e-commerce is both a source and an application of big data analytics: data gained on the company's online customers are the primary requirement for customized approaches that lead to an

[67] Varun Grover et al., 'Creating Strategic Business Value from Big Data Analytics: A Research Framework', *Journal of Management Information Systems* 35, no. 2 (3 April 2018): 388–423, https://doi.org/10.1080/07421222.2018.1451951.
[68] Shahriar Akter and Samuel Fosso Wamba, 'Big Data Analytics in E-Commerce: A Systematic Review and Agenda for Future Research', *Electronic Markets* 26, no. 2 (1 May 2016): 173–94, https://doi.org/10.1007/s12525-016-0219-0.

improved customer journey, increased loyalty, and that will likely influence future purchase decisions that translate in further economic gains. This is more than ever needed since the customer groups accessible through the e-commerce are very heterogeneous, and not limited to – as we could expect - younger generation: in Germany the highest share of e-commerce users is between 45 and 54 years old, while in Spain between 35 and 44[69].

On the other hand, data are as powerful as challenging to manage, since they are meaningful only if put in correlation to other factors. As already mentioned, their analysis require analytics capabilities that can take time to be properly developed, and human resources that can be difficult to recruit and to retain. Their collection and storage process needs appropriate systems and technologies, which entail costs of implementation and management. Data quality – or non-quality – can lead to misleading interpretations, and a factor that increases complexity is the fact that consumer's data, especially those coming from the e-commerce which gives the deepest knowledge on customers, are subject to several data protection regulations all over the world. This combined with the effort needed for data security, in order to prevent data breaches[70].

2.2.2. Win-win across channels, if conflicts are properly managed

A BCG's survey showed how 38% of corporate e-commerce channel managers interviewed have "conflicts" as their primary business concern, and 44% expect its complexity to increase in the future[71]. Possible conflicts with retailers and among channels is an aspect to consider and monitor continuously along the way, since it is a considerable threat for the manufacturer too – which has however the power to mitigate this risk. For this reason, it does not configure as a deterrent to the new channel's implementation, but just calls for attention and meticulous planning of pricing strategies and market presence. The strategic plan for the e-commerce implementation requires engaging a global vision of the channel integrated in the already-existing business context, since the company would not benefit of a retailer's default caused by the internal environment. We have to keep in mind that the e-commerce implementation – in the

[69] Statista, 'ECommerce Report 2021'.
[70] Grover et al., 'Creating Strategic Business Value from Big Data Analytics'.
[71] Alex Baxter et al., 'Don't Let Channel Conflicts Limit E-Commerce Sales', *BCG Global*, 2021, https://www.bcg.com/publications/2021/mitigating-e-commerce-channel-conflicts.

context of this study - should aim at reaching new customer's groups therefore incrementing, not replacing, the everyday business. Moreover, it contribute as a source of added value to the customer's experience that has an influence on loyalty and customer retention, of which all the channels benefits – including those of retailers selling the product on their physical or online shops. A suggested five-step approach with the key actions to be taken in order to minimize conflicts is the one that contemplate:

1. An "as is" analysis categorizing the existing customer segments;
2. Matching of each channel with its own customer segments;
3. Adjustments related to product mix and pricing;
4. Development of different customer's journeys based on channel's specific features;
5. Strategy communication and key stakeholders' management[72].

In the new environment made of multiple actors collaborating while competing, the marketing team plays a fundamental role. It has to devote additional effort to activities aimed at leading customers to purchase on both the physical and online channels - rather than giving place to a substitution effect that makes them choose only one way other than using them as complementary. In this way, retailers are benefitting "for free" of the marketing effort that increase brand awareness and that can result in rise in sales for the physical channel too. Indeed, not all consumers enjoy online shopping, but the most of them is subject to advertising campaign on the social media and is likely to make research on the internet in the various stage of the purchasing decision process. The online channel is an easy and fast way to have access to information crucial for the purchasing decision, such as product's features, instruction manual and, in most cases, the list of retailers too. The Statista Global Consumer Survey of 2020 highlighted that 63% of U.S. participants always do some researches online first when planning a major purchase and that the Household Appliances are among the highest products researched online with no following online purchase.

A cautious pricing strategy is fundamental, and requires that the D2C channel does not aspire to price leadership against its retailers. On the contrary, it has to work focusing on three other objectives, that mixed define its strategy:

[72] Baxter et al.

1. Product customization, that for segments as the one of small household appliances is not viable through traditional channels such as brick-and-mortar stores;
2. Value-added activities, such as improved customer journey, information availability and customer care services;
3. Brand awareness strengthening.

While directing the effort towards these activities, the D2C gives place to a business model innovation capable to strengthen the position of the company in the industry environment. An adequate channel's management leads more to cooperation than to a collision, configuring as a win-win situation. This goal's achievement requires a mind-set shift and is complemented by actions directed to cross-channel principle alignment, a high cross-functional awareness of objectives and strategies, and the definition of different centres of growth for each channel[73].

2.2.3. Enhanced brand value with the right marketing capabilities

To grab the e-commerce potential, it is fundamental to look at it from all the different perspectives that it influences. Meaning that a D2C channel does not only serves as an online shop to increase sales and consequently revenues. At the same time, it is a powerful marketing tool that allows to spread messages in a while and that gives back direct and faster feedbacks on the effectiveness of marketing campaigns. This enables quick movements on the learning curve and related adjustments[74]. Moreover, the online presence allows operating targeted marketing discriminating – when possible - from users' information collected by interactions with the platform and given the outcome of big data analytics. Moreover, the e-commerce serves as a showcase and a dictionary, providing all the necessary information on the products, the possibilities offered to the consumer and more in general about the value proposition that the brand wants to deliver. It configures as an important point of reference for existing customers and a fishing net for the new ones, creating a value for the products and the brand's name of which all the channels benefit. Then the consumer is left to decide the way in which will

[73] Yuval Atsmon et al., 'The Six Must-Haves to Achieve Breakthrough Growth in e-Commerce D2C', *McKinsey*, 2021, https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/the-six-must-haves-to-achieve-breakthrough-growth-in-e-commerce-d2c.
[74] 'How Does D2C Become a Key Profit Driver?' (Spryker, 2020), https://spryker.com/en/insights/d2c-study/.

conclude the purchase, in any case enhancing the probability that the experience will come out with an emotional attachment.

The basket of possibilities needs however to be considered and contextualized in the current saturated market environment, in which marketers have to be more aggressive than ever since competition with large already consolidated platforms is combined with demand volatility[75]. Digital marketing evolution has made every action critical: the speed and impact of diffusion work both for successful marketing campaigns – able to deliver correctly the positive message and producing related positive outcomes – and for undesired misunderstanding too, that go viral as well – or even faster.

The digital era provided another powerful tool for companies to interact with customers: social media. In 2021, over 4.26 billion people were using social media worldwide[76] giving companies the possibility to exploit low cost analytics tools to understand better than ever before their consumers' behaviour, tastes and desires. Instagram, Facebook, Tik Tok, Twitter and others are the easiest way to connect and engage with consumers through social media marketing. Those platforms provide companies with built-in data analytics tools that easily and fast provide them with valuable feedbacks on track the engagement reached by their campaigns by checking the number of views, interactions and consequently the success of communication. Moreover, a particular form of social media marketing has reshaped the way of making product placement of many companies: influencer marketing. Influencers are users with a broad and active range of followers, which buying decisions can be influenced by recommendation or promotion of items made through the influencer's profile. This often is the result of a trust relation established between the influencer and its followers, which market value was estimated for 2021 to $13.8 billion[77].

[75] 'How Does D2C Become a Key Profit Driver?'
[76] Statista. "Number of social media users worldwide from 2018 to 2027 (in billions)." Chart. June 15, 2022. Statista. Accessed June 18, 2022. https://www.statista.com/statistics/278414/number-of-worldwide-social-network-users/
[77] Influencer Marketing Hub. "Influencer marketing market size worldwide from 2016 to 2021 (in billion U.S. dollars)." Chart. February 10, 2021. Statista. Accessed June 18, 2022. https://www.statista.com/statistics/1092819/global-influencer-market-size/

2.3. The D2C e-commerce critical success factors

To achieve success and growth not only in the short but also in the long-term, the e-commerce business requires considerable effort in its planning and implementation phases. The ability of the online channel to create real value for the business depends on the occurrence of certain conditions, commonly defined as Critical Success Factors or Key Success Factors/Key Results Area. According to the Cambridge Dictionary, a CSF is «one of the most important things that a company or organization must do well in order for its business or work to be successful». We can classify critical success factors in D2C e-commerce by three basic elements: leadership commitment, customer-centricity and digital talent.

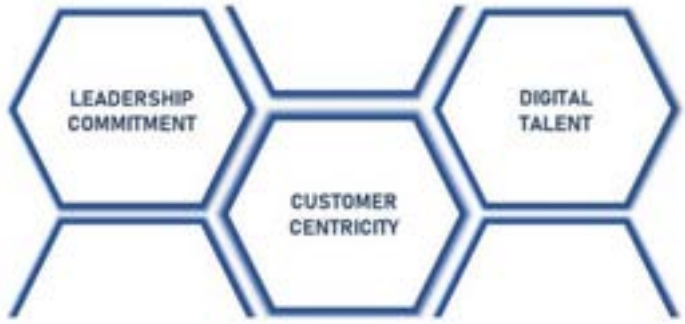

Figure 15 D2C e-commerce CSF.

Leadership commitment is a key element in the success of any business model innovation or change. It relates to the ability of managers and leaders to focus on the long-term goals while looking over the first-time difficulties. These relate both to the ones of the new business perimeter, and to those deriving from the integration of the new D2C dynamics with the B2B ones. Despite the intrinsic potential of the e-commerce, manufacturers still generate the vast majority of their sales through their intermediaries in traditional distribution channels, meaning that the B2B will continue to cover a central role absorbing lot of energies in the continuation of the business[78]. However, this does not mean that the e-commerce should come in second position. On the contrary, managers have to fully understand and embrace its role in the future development and in the strategy of the company. If they do not believe in its potential they will for sure prevent from the success, since an e-commerce channel require collaboration both on a cross-

[78] Leimstoll and Wölfle, 'Direct to Consumer (D2C) E-Commerce'.

functional and on a cross-channel levels. In order to strive to achieve the maximum commitment and effort of people – first the ones in top position and then all the others - communication is a factor of primary importance. Leaders will prioritize the new channel only if they have clear in mind its strategic role and ambitions, combined with a continuous alignment on the current situation[79].

Customer centricity is a key concept for the business as a whole and plays a central role for the e-commerce organization too. It is not a recent discussion the one on the general shift from a focus on the product to a focus on the customers: with the ease of information accessibility, customers are well informed and extremely exigent in choosing among companies while purchasing. This awareness has noticeably driven the development of the way of doing business in the last decades, calling for a greater attention to consumer's requirements to be in line with their value and expectations, offering them solutions and not only products: the mind-set has shifted from "selling products" to "fulfilling customer's needs". This requires a significant effort and high capabilities level, which is why many companies struggle to reach the goal, but is one of the major competitive advantage's sources. Collecting data to gain insights on the end-consumer is easier than ever with an e-commerce platform. However, some authors sustain that many firms face the "customer centricity paradox": there are plenty of information but a lack of causality, with the risk to reduce what should be the focus to a "means to an end"[80]. Others sustain that customer centricity requires to focus only on the most valuable customers rather than on all of them[81]. In all the possible direction, what drives the success of an e-commerce is its orientation toward consumers translated into an outstanding customer journey and improved customer satisfaction, in order to try to increase their lifetime value.

Digital talent is a crucial theme given the scarcity of this resource in the market. Despite the technological progress, human skills and expertise are still fundamental factors in both decision-making and executing. The lack of sufficiently equipped people configures

[79] Atsmon et al., 'The Six Must-Haves to Achieve Breakthrough Growth in e-Commerce D2C'.
[80] Christine Riedmann-Streitz, 'Redefining the Customer Centricity Approach in the Digital Age', in *Design, User Experience, and Usability: Theory and Practice*, ed. Aaron Marcus and Wentao Wang, Lecture Notes in Computer Science (Cham: Springer International Publishing, 2018), 203–22, https://doi.org/10.1007/978-3-319-91797-9_15.
[81] Peter Fader, *Customer Centricity: Focus on the Right Customers for Strategic Advantage* (University of Pennsylvania Press, 2020).

as a barrier to companies' growth and innovation, which is increasingly related to their ability to manage new technologies and software development. According to Forbes, 59% of employers interviewed reported shortage of skilled employees that have a major or moderate impact on their businesses. This situation is flattening the digital transformation progress, influencing the organization's ability to upgrade to the next level[82]. The e-commerce success relies heavily on the digital talent that the company is able to both build and retain or to acquire from the market, given that an online platform needs highly specialized competencies to work well managing high traffic. Given that more or less everybody can own an e-commerce website, differentiation with respect to competitors requires to be flawless and to provide users with a first-class experience. Two components contribute to a positive experience for users: stimulating contents and easiness-to-use. An interesting contribution is the e-commerce service failure framework proposed by Tan et al., that describe failures as «negative event that occurs whenever the e-commerce website is incapable of offering the necessary technological capabilities essential for a consumer to accomplish his/her transactional activities and/or objectives»[83]. It classifies failures in three different groups:

- Information failures, regarding situations in which the information provided through the platform are not accurate, complete and relevant;
- Functional failures, for what concerns all the different functionalities of which a consumer can benefit before, during and after the purchase process;
- System failures, when the platform is not accessible, adaptable, navigable. They refer also to situations regarding the response time and the security of the transactions[84].

When failures occur, customer experience difficulties can lead to dissatisfaction and to a possible loss of sales if the purchase is not concluded yet, resulting in loss of loyalty due to the poor service level. Moreover, proceeding with recovery actions can be expensive and not all consumers would respond positively. For these reasons, digital talent is a critical success factor because it is the only mean to prevent and manage those situations.

[82] Jack Kelly, 'The Lack Of Digital Tech Talent Is An "Existential Threat" To Business Growth And Innovation', *Forbes*, 2022, https://www.forbes.com/sites/jackkelly/2022/03/02/the-lack-of-digital-tech-talent-is-an-existential-threat-to-business-growth-and-innovation/.
[83] Chee-Wee Tan, Izak Benbasat, and Ronald T. Cenfetelli, 'An Exploratory Study of the Formation and Impact of Electronic Service Failures', *MIS Quarterly* 40, no. 1 (2016): 1–30.
[84] Tan, Benbasat, and Cenfetelli.

To summarize, the three elements of leadership commitment, customer centricity and digital talent are prerequisites that enable the success of the shift to a new business model, and that configure as critical success areas to achieve a breakthrough e-commerce. However, they are not enough. A worldwide research conducted by Censuswide on April 2021, while investigating the leading factors that mostly motivate online shoppers to buy directly from brands found out that the most relevant are: price reasons, delivery and return conditions, loyalty program and exclusive products[85]. Excluding the price reasons that, as already explained, is not the most convenient way for a manufacturer to reach success in D2C, we can move further in our analysis of critical success factors.

Figure 16 D2C e-commerce CSF.

The e-commerce platform makes a lot in an e-commerce business: in the same way as everything in a physical store is planned in order to deliver feelings, emotions and sensations to a visitor, the e-commerce wants to provide users with the highest shopping experience possible. Giving that it has some disadvantages compared to the traditional way, such as the impossibility to touch with hand the product or to be assisted face to face by salesperson, it needs to bridge this gap with its own means. Going to the origin, nothing counts if the platform is not accessible, user-friendly and actually working. It has to allow customers to find easily the website and understand without difficulties the functionalities offered and how to conclude the purchase. Consumers have to be able to reach all the information necessary, being them related to the products, or to the post purchase possibilities - such as the order status, customer care, return instructions and so on. They need to understand offers without being bothered by them, and the purchase

[85] Wunderman Thompson. "Leading factors that would motivate online shoppers worldwide to buy directly from brands as of April 2021." Chart. March 23, 2021. Statista. Accessed May 02, 2022. https://www.statista.com/statistics/1274958/motivating-factors-for-purchasing-d2c-sites-worldwide/

path has to be clear and easy-to-accomplish while providing shipment/billing/payment information. Website crashes or slow operations are likely to frustrate the customer, causing dissatisfaction.

Given high expectations of consumers on the company's ability to teleport goods to their homes, warehouse, logistics and distribution management stands definitely among key success factors. Consumer's standard is the "Amazon Business Model", based on low price, fast delivery and a wide selection of products, and this translates in a lot of effort required for companies to reach the performance necessary to be competitive. Moreover, reverse logistic is requiring attention too, since the possibility to make the return of product purchased on online sales is first required by law, second consolidated in practice with many e-commerce offerings long time and free return shipping. The graph below shows the average return rate of products purchased online among consumers in some European countries, by age group. As we can see, there is an average of product returns that goes around 10/15%, for which companies have to work on to improve customer satisfaction also in this phase. A study on factors affecting customer satisfaction in China highlighted that the return policy is among the most important perceived benefit by customers, and affect their re-purchase intention in online stores, since this possibility reduces their risk perception related to the online channel[86].

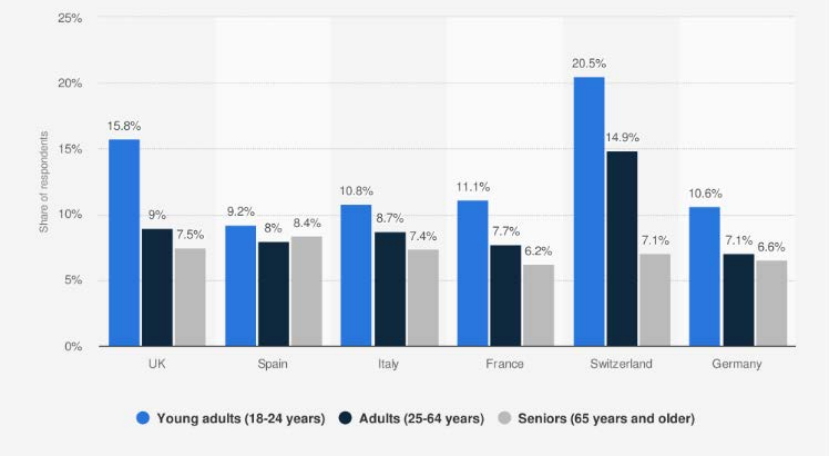

Figure 17 Average return rate of products purchased online among consumers in Europe in 2021. Source: Statista.

Customer Care plays a crucial role in enhancing the customer journey through the platform, both in its declination of customer support and of customer service. It is

[86] Shahzad Ahmad Khan, Yan Liang, and Sumaira Shahzad, 'An Empirical Study of Perceived Factors Affecting Customer Satisfaction to Re-Purchase Intention in Online Stores in China', *Journal of Service Science and Management* 08, no. 03 (7 May 2015): 291, https://doi.org/10.4236/jssm.2015.83032.

beneficial for new clients who need information and assistance, placing side-by-side and adding value in their decision process. For the already consolidated customer base, it enhances customer retention while giving the perception of a quality service included in the price of the good purchased.

Finally yet importantly, Customer Relation Management is a strategic activity that concretely enables the company to drive the business in a customer-centric direction. CRM manage interactions of the company with customers accordingly to data gained and elaborated through information technologies. While the e-commerce serves as an important source of raw material for customer relationship management, the CRM allows it to grow, to acquire new clients and to manage effectively relationships with the existing ones through data-driven actions' implementation. The e-commerce bring CRM to the next level, requiring real-time interactivity, personalized technical solutions, on site services with speed, accuracy and efficiency. In this context, CRM should be designed in order to be scalable, secure and to work in an integrated environment across the organization's departments[87].

2.4. Looking to an omnichannel strategy

The omnichannel distribution is a concept that has gained lot of attention in the last years, characterizing the business model innovation of many successful companies. Omnichannel is the answer to the customer's demand of a seamless experience, which integrates traditional and online channels with free-of-boundaries interactions. While many companies work to adapt their structures to satisfy the needs of e-commerce, omnichannel has already become the normal outside and is confirming the importance of both physical and online sales working together. Nowadays 80% of consumers exploit the online channel for their purchasing decisions, and is estimated that omnichannel customers buy 70% more often compared to the offline-only ones[88].

Nowadays customers not only are used to order from any device, anytime and anywhere. They look for same day delivery and they expect to buy and return products with free

[87] Feng Guo, 'Research on Customer Relationship Management in E-Commerce Environment', *IOP Conference Series: Earth and Environmental Science* 693, no. 1 (1 March 2021): 012072, https://doi.org/10.1088/1755-1315/693/1/012072.
[88] McKinsey, 'Apparel Omnichannel Survey', 2019.

shipments and multiple choices on the place of delivery. This affects a lot the operations and logistics teams in manufacturing companies that have seen several changes to their way of working, revealing how in these functions resides a huge potential for gaining competitive advantage.

Figure 18 Cross-channel services. Source: Statista.

The reason why growing towards integration is fundamental is that thinking that one channel will completely replace the other is completely misleading. The following graph, showing the revenue share of retailers worldwide in 2020 by channel, shows that traditional channel still plays a primary role in retail, accounting for over the 70% of retailer's sales in a year[89]. However cross-channel services, such as ship from store, buy online pick up in-store and local delivery, accounted for 16.4% of the total.

Figure 19 Revenue share of retailers worldwide in 2020, by channel. Source: Statista.

Click and Collect – defined as BOPIS or buy online pick up in store - is the omnichannel service being more popular in Western markets with 64% of retailers offering this

[89] IHL Group. "Revenue share of retailers worldwide in 2020, by channel." Chart. January 8, 2020. Statista. Accessed April 03, 2022. https://www.statista.com/statistics/1139136/revenue-share-of-retailers-by-channel-worldwide/

seamless experience in the UK and 50.5% in France, compared to the 27.5% in the United States[90]. Traditional retailers have incentives to engage in online sales to cope with stagnation in offline sales and to «capitalize on transactional capabilities afforded by digital environments»[91], while online pure player lack of the possibility for consumers to touch with hand their products and miss the offer of in-store pick-up and servicing. Given the general tendency of consumers to acquire information through one channel and then complete the purchase on another – the so-called "cross-channel free riding" behaviour – offering a 360° experience can be the key to growth.

Omnichannel is not interesting only B2C or D2C transactions: B2B companies moved to integrate their systems and platforms to establish omnichannel with their customers too. A worldwide survey among B2B companies in February 2021 revealed that the interactions between suppliers and sales representatives involved equal amounts of traditional interactions, remote human interactions, and digital self-serve[92].

As an example, Alibaba in 2015 acquired a stake in one of the largest consumer electronics retail chains in China with the aim to implement synergies. Later in 2020 it partnered with an international e-freight marketplace to enhance air and sea shipments[93]. Alibaba's success is mainly due to its massive supplier base, but the e-giant strategy is clearly moving integrating offline sales with online ones posing the base to emerge in the omnichannel layout.

IKEA – the Swedish furniture company – engaged in an omnichannel expansion to increase customer engagement and satisfaction though a complete holistic experience. Despite the complexities arising from the integration of the new channel and in particular

[90] Retail TouchPoints. "Share of retailers implementing buy online, pick up in store (BOPIS) services worldwide in 2018, by country." Chart. January 7, 2019. Statista. Accessed April 03, 2022. https://www.statista.com/statistics/1115508/share-of-retailers-implementing-bopis-by-selected-country-worldwide/

[91] Yang Chen, Christy M. K. Cheung, and Chee-Wee Tan, 'Omnichannel Business Research: Opportunities and Challenges', *Decision Support Systems*, Omnichannel Business Research: Opportunities and Challenges, 109 (1 May 2018): 1–4, https://doi.org/10.1016/j.dss.2018.03.007.

[92] McKinsey. "Share of sales representatives interacting with suppliers during order process in 2020 and 2021." Chart. February 23, 2022. Statista. Accessed April 03, 2022. https://www.statista.com/statistics/1238333/omnichannel-interactions-in-b2b-ordering/

[93] Statista, 'In-Depth Report: B2B e-Commerce 2021' (ecommerceDB.com, 2021), https://www.statista.com/study/44442/statista-report-b2b-e-commerce/.

with returns management, the results were outstanding. The UK subsidiary reported that after making its products accessible across retailing channels, customers increasingly used both channels to complete their purchasing journey, which resulted in a 31% rise in online sales[94].

However, the path to an omnichannel business model is not easy. The upgrade to omnichannel distribution is risky and costly. It needs to be preceded by multichannel implementation and by a deep understanding of markets and industry dynamics. To work, it requires high level of integration across the supply chain's functions, with transparent and consistent information sharing. The delivery of personalized experiences in purchasing journey requires companies to shift the focus from internal processes to collaboration, in order to pursue customer-centricity.

2.5. E-commerce channel impact on supply chain key processes

Companies must tailor supply chain processes on their specific needs, taking into account the peculiarities of all the different channels through which they serve markets. Each one has its specific requirements in terms of business operation and processes. It is fundamental to weight the costs of those requirements to appreciate whether new economies of scale actually enhance profitability.

The figure below shows a simple representation of:

- a single channel distribution system on the left, where the manufacturer sells its product to the retailer that act as an intermediate with the end-consumer;
- a dual channel distribution system on the right side, in which the manufacturer sells both to the retailer and through the e-commerce channel – which can be both directly managed by the manufacturer itself or by a third party electronic retailer such as the different marketplaces.

[94] Zach W. Y. Lee et al., 'Customer Engagement through Omnichannel Retailing: The Effects of Channel Integration Quality', *Industrial Marketing Management* 77 (2019): 90–101, https://doi.org/10.1016/j.indmarman.2018.12.004.

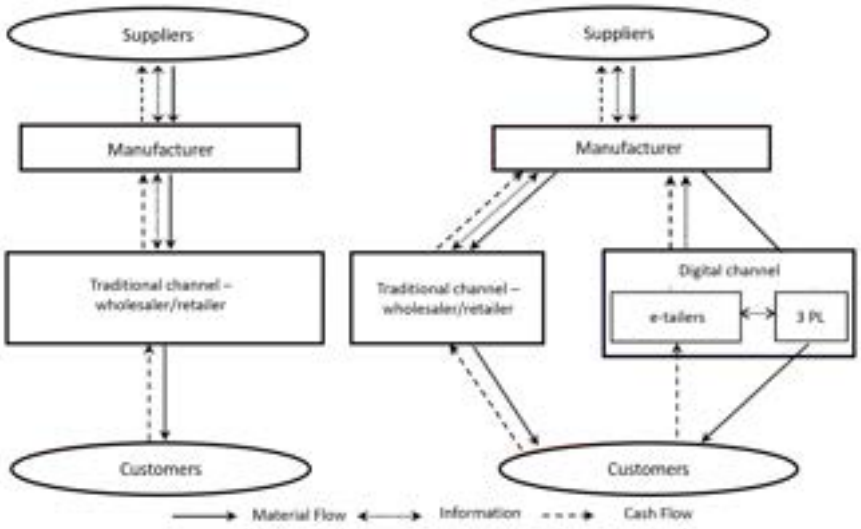

Figure 20 Single channel and dual-channel distribution systems.

In reality, the higher the number of customers – intended as both wholesaler and retailers of B2B distribution and the different online channels – the more complexity arises in planning and maintaining an outstanding service level. If we consider a manufacturing company with an already consolidated business, it is reasonable to assume that it has gained its market share through the indirect or physical distribution. We can assume this considered that the e-commerce is not that easy to implement and manage, depending heavily on the physical characteristics of the product – weight, size, fragility, perishability that affect transportation logistics and costs - and on the need of mass quantities to be worth it. E-commerce giants - which have made of logistics their excellence - are a big threat for companies that want to explore this segment, facing consumers that does not require a superior service, rather they expect it by default.

Considering the process flow of an e-commerce, the figure below[95] identifies the major steps of the online customer order cycle showing the typical product, information and financial flows. The process starts with the consumers placing the order through the website. This order goes up to the "e-tailer" – which is the owner of the online shop – that have two choices: locate the order in the warehouse or send it to a supplier, depending on its inventory level and quality. Once warehouse activities of picking and packing are

[95] Sameer Kumar, Maryellen Tiffany, and Salil Vaidya, 'Supply Chain Analysis of E-Tailing versus Retailing Operation – a Case Study', *Enterprise Information Systems* 10, no. 6 (23 July 2016): 639–65, https://doi.org/10.1080/17517575.2014.986218.

completed, the order is consigned to the shipper that deliver it to the consumer. In the case of a D2C e-commerce, the supplier and the e-tailer coincide.

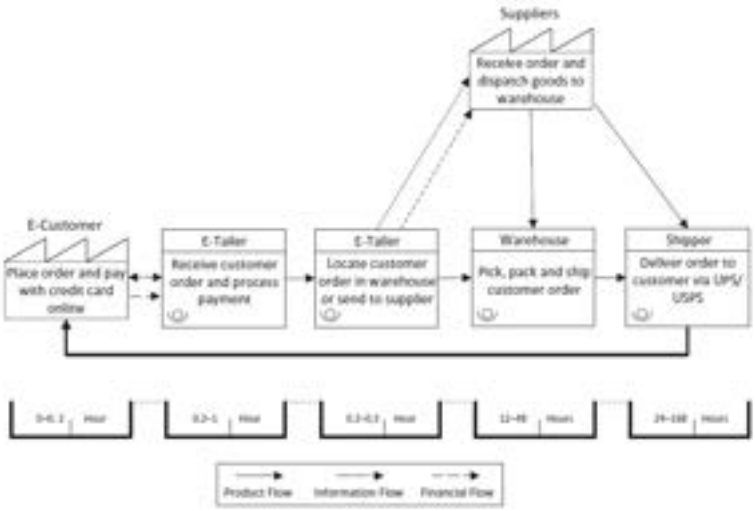

Figure 21 E-tailing supply chain process flow.

As we can expect, the process differs when considering a traditional retailing channel. Here the product is in the consumer's hands right after it has selected the items at the store. The time frame between the purchasing decision and the physical ownership of the good is much smaller, and the supplier does not have to care about shipping and the transfer of product to the customer.

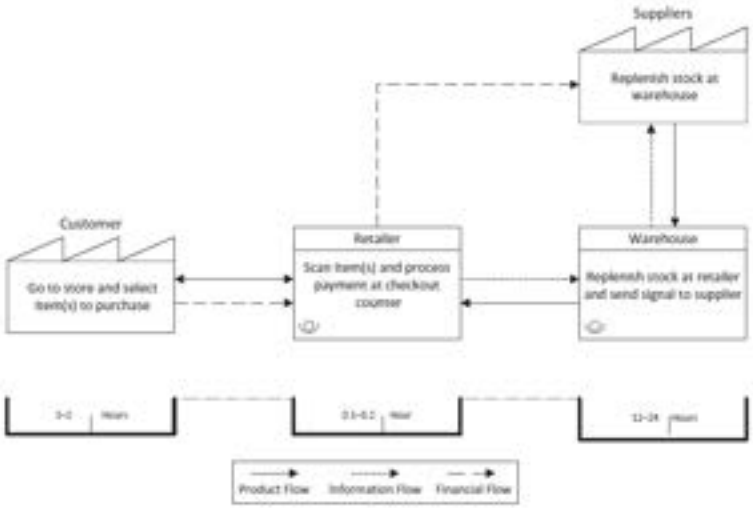

Figure 22 Traditional retailing supply chain process flow.

Considering the importance for businesses to be multichannel – being this the first requisite towards the omnichannel business model – we have to assume that supply chain process flow are hybrid, managing the dynamics of both ones[96].

In order to understand which are key supply chain processes mostly affected by the D2C e-commerce distribution channel, we have to summarize some highlights. The main differences between the online and the offline channel relate to customer types, availability of information on consumers, priority in the distribution of scarce products, operations of order fulfilment, logistics and transportation requirements, return policies and reverse logistics, expectations of service quality and related fatality of bad performance[97].

In the online shop, consumers have visibility on the overall product portfolio – included the out of stock – and not only on what is available in the store. This is both an opportunity to show the whole catalogue and the various possibilities offered, and a threat if the consumer is not willing to delay its purchase when facing unavailability, having the possibility to choose the available substitute product of a competitor.

While the demand planning process in B2B considers the insight, experience and closeness to the markets of customers which place their estimation, in the D2C e-commerce demand is more volatile and become difficult for companies with a complex product-market matrix. However, the e-commerce website provide plenty of data on consumers that could be included in predictive algorithms and in indirectly influencing their movements.

Timing is crucial: consumers order today and pretend to receive tomorrow. The last mile is a great challenge for logistics and cost management. Planning transportation is possible only right after the order is received and logistics has to be reactive and fast to avoid delays that could cause dissatisfaction. Having this a fundamental role in the success of this business, the D2C channel often have a sort of priority on the other orders influencing continuously and dynamically warehouse activities. Moreover, reverse logistics is an activity that highly intensifies when coming to the direct relation with the end-consumer that has the right to give back products bought online receiving the refund. If the company

[96] Kumar, Tiffany, and Vaidya.
[97] Prabuddha De, Yu (Jeffrey) Hu, and Mohammad S. Rahman, 'Product-Oriented Web Technologies and Product Returns: An Exploratory Study', *Information Systems Research* 24, no. 4 (2013): 998–1010.

is not able to offer this for free - owning the expense of transportation – consumers could be biased due to the risk to have to carry this expense. If on the other side this service is granted, warehouses have to be managed coherently with the size of products returned – that have to be unpacked, inspected and prepared to be sold again – implying more complexities and additional costs to be taken into account.

Moreover, warehouse management is affected in the picking process too since it concerns only few pieces at a time. The packaging of the product – that need a dedicated packing station - has to optimize the size of orders that contain more products of different dimensions while ensuring a safe delivery of products that could be ruined in transportation.

Coming to the possibility to offer customized products through the e-commerce channel, this require a change in the production site and organization - which has to quickly satisfy the make-to-order logic.

Coherently with the value chain concept expressed before in this chapter, companies does not have to manage all the supply chain aspects alone. They can consider other option such as relying on third parties to manage their logistics, the warehouse or even some aspect of the e-commerce platforms. Since the goal is to focus on value-added activities, they can look to strategic partnerships to rely on their expertise until they will be able to master the activities needed.

CHAPTER III

Industry 4.0: how new technologies have shaped the business landscape

We generally define technology as the results of scientific knowledge applied to the practice, which in some way provide a different way of doing things compared to before or the possibility to do new ones that were not possible otherwise. It is a very broad concept for which we can include almost every discover that the human has made through decades, included the invention of the wheel. However, we are now far beyond this simplistic idea and the unstoppable human desire to discover and to expand the horizon of possibilities brought us to the Fourth Industrial Revolution –also known as "Industry 4.0". At its different level of sophistication, technology has been the protagonist of all the previous ones. The First Industrial Revolution took place with the shift to mechanization in productive processes thanks to steam engine in years 1760-1860. Then, assembly lines and mass production together with electricity were spread across industries together with the development of the first big economies of scale, in the Second Industrial Revolution that concluded in 1914. After the gap due to the world wars and the difficult global context, we can date back to 1984 the begin of the third one known as the Digital Revolution in which electronics made possible the use of computer and automation not only in productive processes but also in everyday lives. Then, the great disruption came with the Fourth Industrial Revolution - commonly referred to as Industry 4.0. This concept was first launched in Germany in 2011 at the Hannover Fair[98] in which the federal government together with universities and private companies presented a «strategic program to develop advanced production systems with the aim of increasing productivity and efficiency of the national industry»[99]. Integration and data-driven business decisions are two fundamental concepts in this new business landscape, both relying on the collection and processing of real-time data to gain useful insight and enable to take no

[98] Guilherme F. Frederico et al., 'Supply Chain 4.0: Concepts, Maturity and Research Agenda', *Supply Chain Management: An International Journal* 25, no. 2 (1 January 2019): 262–82, https://doi.org/10.1108/SCM-09-2018-0339.

[99] Alejandro Germán Frank, Lucas Santos Dalenogare, and Néstor Fabián Ayala, 'Industry 4.0 Technologies: Implementation Patterns in Manufacturing Companies', *International Journal of Production Economics* 210 (2019): 4, https://doi.org/10.1016/j.ijpe.2019.01.004.

actions without direction. Protagonists are emerging technologies – defined "emerging" since under constant development and still largely unrealized – which upset the way of doing business opening up to new possibilities and horizons. Those provide the possibility to make everything smart.

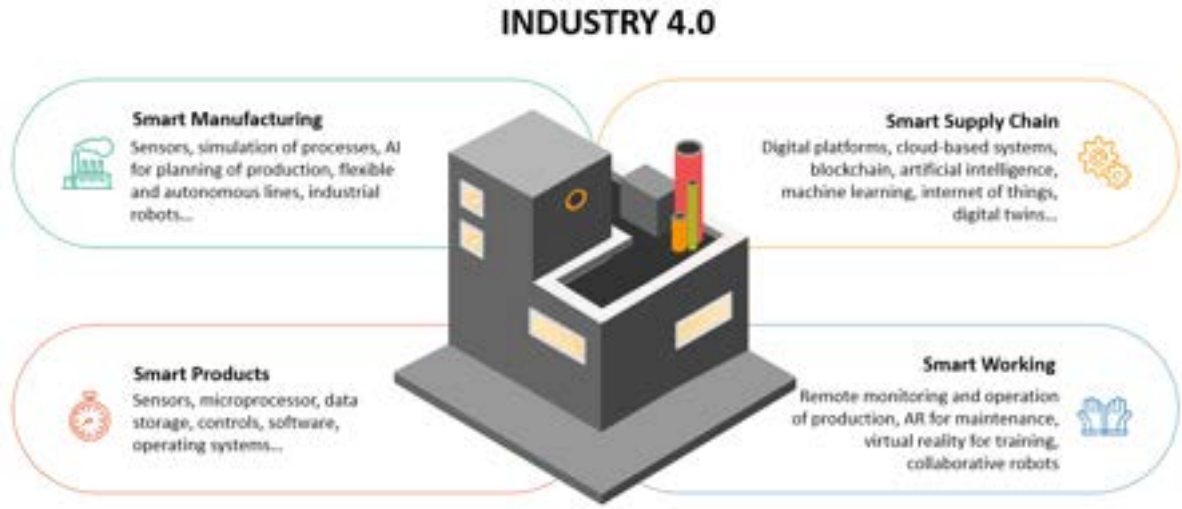

Figure 23 Theoretical framework for Industry 4.0 technologies.

Frank et al. provide an interesting framework of four areas that are impacted by new technologies: manufacturing, products, supply chain and human working. Smart manufacturing is at the core of the Industry 4.0 concept, addressing the internal operations responsible for productive processes. Those are now conceived in a way that makes production lines extremely flexible and adaptable, having an impact on their productivity and efficiency. Smart Products refer to the new generation of value-added offer for which products can be digital, connected, responsive and intelligent. While providing the consumer with an enriched experience, smart products are relevant for companies for the opportunity to gather accurate data and feedbacks from their usage. Smart supply chain relates to the new concept of horizontal integration among actors along the chain – which can share real-time information – and to the new idea of collaboration with external partners to share information and resources. The resulting supply chain 4.0 enhances the company's competitive advantage through products availability, cost reduction and increase in market share[100]. Finally, smart working

[100] Frederico et al., 'Supply Chain 4.0', 4.

considers the coherent socio-technical evolution of the human role in production systems, which has to be conducted with smart approaches.

Industry 4.0 provides a set of possibilities but the impact of the value unlocked through them compared to the cost of implementation has many variables among industry, organization size and structure, market characteristics and so on.

For completeness, we have to say that we are already catching a glimpse of the next shift: the Industry 5.0 «provides a vison of industry that aims beyond efficiency and productivity as the sole goals, and reinforces the role and the contribution of industry to society»[101]. Its keywords are human-centricity, sustainability and resilience, in coherence with the values and the direction that the society is increasingly embedding that brought to the current relevance of corporate social responsibility. In the Industry 5.0, technologies are used to pursue a sustainable development. Sustainable development means a «development which meets the needs of the present without compromising the ability of future generations to meet their own needs»[102]. This makes the organization socially accountable to its stakeholders and to the society, showing how it is enhancing the environment and the society itself. This concept makes the organization's boundaries meaningless, since it has to report and to be accountable not only for what happens inside the organization but also along its supply chain responding to its stakeholders for suppliers actions too. Companies have to consider sustainability in their decisions and leverage on technologies putting sustainable development in the spotlight, knowing that this effort will pay back especially in the long-term.

As a premise to what will follow, we have to specify that what is fundamental for businesses is the ability to capture the opportunities offered by technologies and translate them in something valuable. This express the important focus that companies have to maintain: create value, measured by the point of view of stakeholders. They do not have to engage in technology because it is revolutionary per se. No action without direction means that they have to perform activities and engage in projects that are oriented to value-creation. We will now go through some of the most discussed technologies - some emerging and others more consolidated - that have the potential to increase operational

[101] 'Industry 5.0', Text, European Commission, accessed 13 May 2022, https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation/industry-50_en.
[102] United Nations, *Our Common Future* (Oxford University Press, 1987).

efficiency through the benefits provided by transparency, connectivity of parties and an upper level of automation. It is fundamental to keep in mind what just said above to maintain a critical view and a fixed focus on value creation – that is the most various in the different circumstances. Meaning that, application of technologies inside the business is not a solution or a success factor per se: companies have to find the processes and the business area where this enhance the value creation and deliver effectively this value to its stakeholders. Industry 4.0 offers a wide range of possibilities, of which Mahdavisharif et al. present an interesting summary in their work that is reported in the table below[103].

Table 2 List of Industry 4.0 technologies.

Industry 4.0 Technology	**Brief definition**
Augmented Reality	Interactive experience enhanced by computer-generated sensations, used to assist employees enlarging real-world with information coming from multiple sources.
Cloud Computing	Storage, sharing, and easy access to the data remotely and on-demand based on the competitive costs and according to the customer requirements.
Robotics	Machines that can assist humans or even substitute to complete tasks automatically in the manufacturing process to increase productivity or safety of employees.
Sensors Technology	Use of sensors to acquire information that permits the check, monitor and control of internal and external activities of products and assets.
Internet of Things	Sensors, software and other smart technologies included in physical objects that permits their connection and exchange of data with other systems through the internet.
Self-Driving Vehicles	Vehicles able to move autonomously exploiting technologies that gather information on the external environment.
Unmanned Aerial Vehicles	Flying platforms or aircrafts that can be drive remotely or that function autonomously.

[103] Mahsa Mahdavisharif, Anna Corinna Cagliano, and Carlo Rafele, 'Investigating the Integration of Industry 4.0 and Lean Principles on Supply Chain: A Multi-Perspective Systematic Literature Review', *Applied Sciences* 12, no. 2 (2022): 586, https://doi.org/10.3390/app12020586.

3D printing	Production of a physical object from a three-dimensional digital model and a layer-upon-layer technique that does not need assembly of parts.
Blockchain	Certified archive based on the distributed ledger technology that exploits cryptography to provide transparency, automation, immutability and decentralization.
Big Data Analytics	Advanced analytic techniques used to extract knowledge from a large and complex amount of data to support the decision-making process.
Artificial Intelligence	Computer systems able to perform tasks usually requiring human intelligence, simulating the latter through the ability to learn and adapt by algorithms and statistical models. This includes the machine learning, particularly used in forecasting.
Simulation	Imitation of process and system behaviour over time through the use of models for different purposes, such as education, design, process improvement or future prediction.

In this chapter, we will narrow the scope of our analysis to the following:

- Cloud Computing, which ensure business continuity, enhance flexibility, collaboration and scalability while providing significant cost savings and permitting the effective storage of big data as well as the ground for many other technologic applications to work;
- Artificial Intelligence, which gives sense to the big data providing businesses with the potential to gain insight and to learn from them, while to develop sophisticated algorithms to perform a superior decision-making process and strategic design;
- Internet of Things, that unlocks the value of other technologies providing the necessary data;
- Digital twins, providing end-to-end visibility on the prediction of future events and optimization of logistics, production, quality and scheduling
- Blockchains, the revolutionary technology that is finding plenty of applications in the supply chain environment.

For each one we will present some use cases to provide a general overview of the business landscape, focusing on the implications for supply chain management and related fields. Emerging technologies can play a significant role in enhancing the supply chain as a source of competitive advantage. The "bionic supply chain" concept presented by the Boston Consulting Group outlines a supply chain that integrates seamlessly human and technology capabilities. Through an end-to-end digital transformation process, companies could benefit of a boost in revenues by 4% to 6%, customer service levels enhanced by 5% to 30%, and EBITDA by 2% to 4%, combined with a reduction in costs connected to manufacturing, warehousing and distribution by 10% to 20% and of working capital by 15% to 30%[104].

We have to underline that achieving those results is not that easy, being not sufficient to include technologies in business operations. A holistic transformation mindset is at the core of the success, involving the whole organization firstly on the human capital side. Organizations have to make significant investments in providing the new technical skills too[105]. Moreover, we know that collaboration across enterprises brings tangible benefits but companies are still too wary and this brings limits in new technologies applications. The following figure outlines the different technological evolutions that companies supply chains went through in the past decades.

Figure 24 Evolution of the Supply Chain Operating Model. Source: BCG Analysis.

[104] Pepe Rodriguez et al., 'Building the Bionic Supply Chain', *BCG Global*, 2020, https://www.bcg.com/publications/2020/building-bionic-supply-chain.
[105] Jonathan Van Wyck et al., 'The How-To Guide to Digital Operations', *BCG Global*, 2019, https://www.bcg.com/publications/2019/how-to-guide-digital-operations.

It is straight to see how technology has reduced the level of human decision making enhancing on the other side visibility and automation of activities. To take the next step and actually make that visibility worth, companies have to embrace the potential of collaboration across function and across companies. There are three types of collaboration: among machines through artificial intelligence, sensors and connectors, among humans to solve urgent issues and lastly among machines and humans in the form of co-working – and not of just using them as a tool[106]. The outcomes of the bionic operations model are end-to-end transparency, prediction and smart scenarios, data-driven optimization and full system control. In the bionic supply chain, integrated decision-making takes into account the impact of actions on the entire supply chain. This overcomes the old approach of sequential decision making optimized only for one silo at a time. Digital native companies find it easier to exploit technologies, while the other enterprises have to start by gaining a deep understanding of their operations pain points and areas for improvement. The first step consists in identifying where technology can fits the best, in which measure and mix. The results of a BCG survey of digital maturities in manufacturing operations brought out that more than 80% of companies are actively investing in digital operations with the aim to promote resilience and achieve cost efficiency while enhancing productivity[107]. In the operations field, companies feel that production is the value chain steps in which they achieved the highest cost savings and growth probably because in the other areas investments are for the majority of the cases at an early-stage.

3.1. Cloud computing

Cloud computing is defined as «a model for enabling convenient, on demand network access to a shared pool of configurable computing resources (…) that can be rapidly provisioned and released with minimal management effort or service provider interaction»[108]. This opposes to traditional IT where companies purchase, install, manage and maintain their own data centres trough hardware, software and applications and

[106] Rodriguez et al., 'Building the Bionic Supply Chain'.
[107] Van Wyck et al., 'The How-To Guide to Digital Operations'.
[108] Tharam Dillon, Chen Wu, and Elizabeth Chang, 'Cloud Computing: Issues and Challenges', in *2010 24th IEEE International Conference on Advanced Information Networking and Applications*, 2010, 27–33, https://doi.org/10.1109/AINA.2010.187.

consume their assets while using them[109]. In the cloud ecosystem those are offered as a service by the provider who owns and maintain them, while the consumer pays for the service of which it benefits. Giving that this is the only cost it bears, this solutions confer significant economic advantages. Considered the high scalability levels reached - since a single software from a provider serves multiple customers, which shares the costs related to the hardware, facilities, configuration and maintenance of the technology.

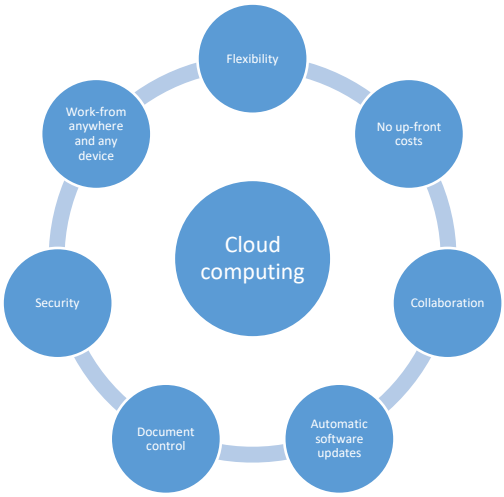

Figure 25 Cloud computing advantages for companies.

This information technology revolution permitted the shift to rapid data collection and analysis, a more flexible work structure and easier integration across functions[110]. Uber – the American provider of services for mobility - attributed to its cloud model its constant uptime with an indivisible relationship between product development and deployment, relying on mobile software, large-scale data analysis, mapping, and social networking[111] to provide the virtual fleet of its cars.

The environment configured is defined "multi-tenant", referring the word "tenant" to a group of users that shares the same access to the software. Each tenant has a customized application and the exclusivity on the access to that specific configuration granting privacy and security of data, sharing with the others the operating system, hardware and data storage mechanism. The main features of cloud computing are:

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[109] IBM Cloud Education, 'IaaS versus PaaS versus SaaS', 13 May 2022, https://www.ibm.com/cloud/learn/iaas-paas-saas.
[110] Quentin Hardy, 'How Cloud Computing Is Changing Management', *Harvard Business Review*, 8 February 2018, https://hbr.org/2018/02/how-cloud-computing-is-changing-management.
[111] Hardy.

- ❖ On demand self-service, meaning that when users need something they can operate autonomously without third party mediation;
- ❖ Broad network access, since the applications can be accessed through multiple devices;
- ❖ Resource pooling, indicating the fact that the provider offer its service to multiple parties which are not able to identify the place in which their data are stored, giving that they are continuously moved according to the ones of the other tenants in the system;
- ❖ Rapid elasticity for providers that can scale up or down depending on their workload needs and in an immediate way;
- ❖ Measured service, being the infrastructure able to measure the effective usage of each tenant[112].

The main classification of cloud services splits them in three categories. Software as a service – SaaS – is a business model in which the provider delivers software and databases on the internet usually referred to as web services[113]. Users can access ready-to-use applications while not having the possibility to modify the cloud infrastructure. They pay a fee for the use and bear additional costs if they want to upgrade the service. SaaS are widely used in everyday lives by employees even outside of their job perimeter, and are a great tool for companies to smooth activities with low investments and risks.

Platform as a service – PaaS – provides on the other side development tools to users, which can develop their own SaaS directly on the PaaS cloud. Exploiting the in-cloud platform, companies can quickly and conveniently run and test their own applications without having to manage the whole infrastructure needed, with the possibility to test new technologies, operating systems and other tools with a low investment.

Last but absolutely not least, infrastructure as a service – IaaS – offers directly the IT infrastructure and so processing, storage, networks, and other fundamental computing resources that are located in a central place called data centre but that can be accessed by users on the internet[114]. There are two options for clients approaching an IaaS: virtual machines hosted on shared physical hardware or bare metal servers on private physical

[112] Dillon, Wu, and Chang, 'Cloud Computing'.
[113] 'What Is Cloud Computing? Everything You Need to Know', SearchCloudComputing, 2022, https://www.techtarget.com/searchcloudcomputing/definition/cloud-computing.
[114] Dillon, Wu, and Chang, 'Cloud Computing'.

hardware[115]. The use of IaaS is widespread among businesses especially in relation to the e-commerce, since they benefit of the ability to scale-up when peak in traffic occurs improving their responsiveness to market movements. Moreover, IaaS can have a central role in the implementation of other technologies such as the internet of things and artificial intelligence that needs big data storage and computation.

In the three options, we can identify a different mix of management responsibilities, which in traditional IT systems are all managed by companies.

Figure 26 Management responsibilities for Traditional IT, IaaS, PaaS and SaaS. Source: IBM.

Amazon Web Services, Google Suite and Google Cloud, Microsoft 365 and Microsoft Azure, Salesforce and even Slack are some examples of cloud computing.

The impact of cloud computing on businesses can be underestimated with respect to the other emerging technologies that we will go through later on. However, it still has a primary role in permitting businesses to achieve optimization of their resources – being them people, materials or data – and laying the foundations for building a bionic company.

American Airlines have become more responsive to its customer's needs through cloud computing. The migration of its key legacy customer facing applications on IBM Cloud let the company perform better in their response time to changing customers' needs. They can perform app changes based on feedbacks easily and fast, thanks to the open and flexible cloud structure. They provide to customers an application that gives them vital

[115] IBM Cloud Education, 'IaaS versus PaaS versus SaaS'.

information and control on their travel plans with relation to changes in bookings due to the impossibility to fly, combined with a dynamic rebooking tool[116].

3.2. Artificial Intelligence

Another form of computer science that is widely used by companies to advance their business is the AI - artificial intelligence. John McCarthy – which is recognized as its father – gave in 2004 the following definition of artificial intelligence: «the science and engineering of making intelligent machines, especially intelligent computer programs. (…) Intelligence is the computational part of the ability to achieve goals in the world. Varying kinds and degrees of intelligence occur in people, many animals and some machines»[117]. Recommendation algorithms in e-commerce that gives customized suggestions to users are the result of artificial intelligence. Messaging bots on e-commerce websites that reply to customers automatically identifying their problems and providing answers with suggestions are artificial intelligence too. In this way, technology has the ability to influence consumers' purchasing decisions and provides added value to the service offered.

Companies not only use recommendation, association, location and classification algorithms to direct and assist consumers, but also to power their decision-making process by improving their predictions[118]. The effectiveness of AI is based on the amount of data that it can process, the bigger they are the more precise predictions will be. Here emerge the importance of mastering the ability to collect and manage huge amount of quality data, disposing of the right systems – building an appropriate IT architecture relying on technologies such as the previous seen cloud computing. Organised data sets are in particular the gold raw material for a sub-field of AI named machine learning. Machine learning focuses on the ability of machines to learn from the past through data

[116] IBM, 'American Airlines - The Route to Customer Experience Transformation Is through the Cloud', 2021, https://www.ibm.com/case-studies/american-airlines.
[117] John McCarthy, 'What Is Artificial Intelligence?', 2004.
[118] Victor Antonio, 'How AI Is Changing Sales', *Harvard Business Review*, 2018, https://hbr.org/2018/07/how-ai-is-changing-sales.

processing – evaluating and categorizing them - and improve by experience through inference techniques[119] providing as a result an insight, decision or conclusion[120].

A sub-field of machine learning is the so-called deep learning. While machine learning relies on structured and labelled data to make predictions[121], deep learning use unstructured data like text and images too, automating the feature extraction. In the first one algorithms learn from data, while in the latter they learn through an artificial neural network that attempts to mimic the human brain and do not need instructions on how to learn from data.

In its different form, artificial intelligence is widely used by companies to enhance the customer experience assisting customers along their journey. It is the technology at the base of autonomous vehicles and allows facial identification[122]. AI should be an integral component of every business strategy, companies have to engage an approach that goes beyond its implementation in order to see tangible benefits. They have to establish a sort of inverse relation in which human learns from machines too in a mutual learning environment[123]. According to a BCG study conducted in 2020, companies that engage in significant process changes are five times more likely to emerge with a significant financial benefit.

We can distinguish through three types of learning:

- Supervised learning, in which humans directly inform systems[124] and consequently supervise their learning mechanism directing it with labelled datasets;
- Unsupervised learning, when «an AI-enabled system is able to identify clusters or dimensions in the data itself without additional guidance from human data or

[119] IBM Cloud Education, 'What Is Machine Learning?', 2020, https://www.ibm.com/cloud/learn/machine-learning.
[120] Ben Gesing, Steve J. Peterson, and Dirk Michelsen, 'Artificial Intelligence in Logistics' (DHL Customer Solutions & Innovation, 2018), https://www.dhl.com/global-en/home/insights-and-innovation/insights/artificial-intelligence.html.
[121] IBM Cloud Education, 'What Is Deep Learning?', 2020, https://www.ibm.com/cloud/learn/deep-learning.
[122] Bernard Marr, '10 Amazing Examples Of How Deep Learning AI Is Used In Practice?', *Forbes*, 2018, https://www.forbes.com/sites/bernardmarr/2018/08/20/10-amazing-examples-of-how-deep-learning-ai-is-used-in-practice/.
[123] Sam Ransbotham et al., 'Are You Making the Most of Your Relationship with AI?', *BCG Global*, 2020, https://www.bcg.com/publications/2020/is-your-company-embracing-full-potential-of-artificial-intelligence.
[124] Gesing, Peterson, and Michelsen, 'Artificial Intelligence in Logistics'.

computer scientist»[125]. The system automatically detects patterns in data while clustering those identifying similarities.

- ❖ Reinforcement learning, when the model learns from the feedbacks received form the environment that gives back responses to the system, becoming more accurate as more feedbacks it receives.

Artificial intelligence has plenty of applications in supply chain, being a powerful tool that is year-by-year gaining ground and trust in companies proving to be a game changer. The figure below represents an interesting classification of machine learning use cases where companies applied the technology to the supply chain, result of a study conducted by BCG.

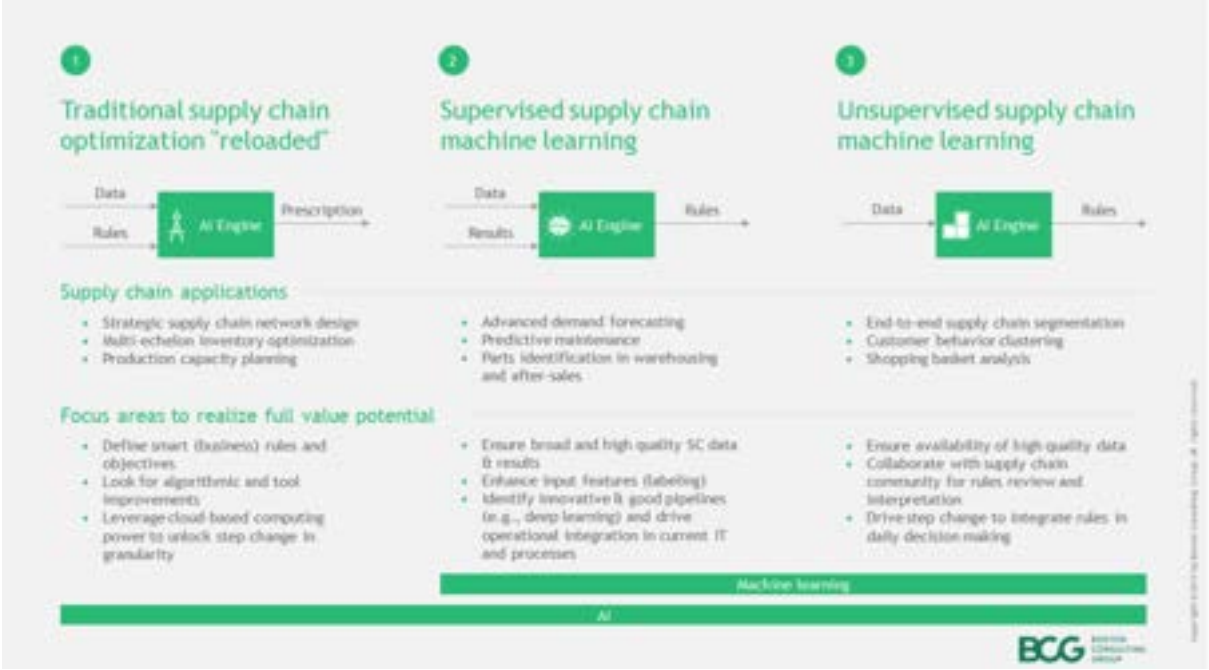

Figure 27 AI use cases in supply chain. Source: BCG.

Applications are grouped into three categories. Traditional supply chain optimization is based on the use of artificial intelligence to take decisions depending on the outcome of the application of specific rules to a set of data. This approach can bring value for inventory optimization and capacity planning, where taking data-driven business decisions could bring more than 20% of cost savings[126]. To achieve results, companies have to define the right decision rules and embrace the cloud based computing power.

[125] Gesing, Peterson, and Michelsen.
[126] Marcel Sieke, 'Managing the Supply Chain AI', *BCG*, 2020, https://www.linkedin.com/pulse/managing-supply-chain-ai-marcel-sieke.

Supervised supply chain machine learning artificial intelligence works to extract from data and results a set of rules. With the human intervention, organizations can improve forecast accuracy and predict other significant events such as assets maintenance – something that will be touched later when approaching the digital twin technology. A 2020 research shows how in a retail company machine learning provided a more accurate forecast than a statistical method in 71% of the stock quality, the remaining 29% having closer results with the traditional method[127]. In this case the amount of data and the knowledge on how to use them is fundamental to success.

Lastly, the rarer implemented unsupervised supply chain machine learning interprets data highlighting the connection between them. This can be helpful in understanding consumer behaviour analysing the relation between items purchased.

Omitting technicalities and the debate on ethics especially with relation to super AI – the attempt to use artificial intelligence to develop machines that are smarter than humans – let's focus now on some ways in which AI could bring value to businesses.

As we have just seen, demand forecasting is an activity that can be highly impacted by the predictive abilities of machine learning. IKEA – the Swedish furniture and home accessories leader – uses artificial intelligence in its Norway subsidiary to exploit data to gain insight useful for the forecasting process. This includes historical data on previous years that were the primary raw material for demand forecasting before, but combines them with up to 200 data sources for each product taking into account several consumer behaviour influencing factors such as weather forecasts and influence of seasonal changes[128]. Ikea Norway stated that thanks to AI they had an increase to 98% accepted forecast from the previous level of 92%. To this contributes the fact that the advanced algorithms starts from a local view taking into account the specificity of each market, reversing the process building first the local store forecast and then the market, country, region and global ones. This permits to have better resources allocation not only in the same region but also among channels, being variation in the demand level immediately

[127] Cornelius Herzog, Fabian Jost, and Nicolas Greiner, 'Machine Learning Has Revolutionized Forecasting During COVID-19', *Oliver Wyman*, 2021, https://www.oliverwyman.com/our-expertise/insights/2020/nov/machine-learning-will-revolutionize-forecasting.html.

[128] IKEA, 'Using Artificial Intelligence for Smarter Demand Forecasting', 2021, https://about.ikea.comhttps://about.ikea.com/en/behind-scenes/innovation-technology/2021/05/26/using-artificial-intelligence-for-smarter-demand-forecasting.

caught to adjust the forecast on a day-to-day basis. In this way, the demand forecasting transforms through artificial intelligence into what is referred to as "demand sensing".

Electrolux – a global leader in the home appliances sector – has adopted AI-driven automation capabilities to its IT operations, relying on IBM cloud computing solutions offering. This permits to the company to automate what is known in IT as "event correlation". The result is to gain critical efficiency providing the IT team with instances instead of events – considered that tens of events could be brought back to a single problem – letting them to be faster in delivering solutions. In this way, the company reduced the time needed for resolution from three weeks to one hour[129]. This use case is probably the one that brings the fastest return on investments in self-learning technologies[130]. Moreover, the company has created an Industry 4.0 application for monitoring tools connected to sensors applied to production line machineries and equipment, which easily detect frequent failures. Moreover, the artificial intelligence for IT operations – AIOps – is a powerful tool for increasing the sustainability performance too. The reduced power consumption enabled by proper utilization and functioning of data centre and hardware result in fact in lower carbon emissions.

Electrolux has applied AI to enhance its customer experience too, with the provision of real-time weather and environmental data such as air pollution, humidity, and temperature changes in the app connected to smart household appliances. The app is able to give suggestions based on weather forecasts to have not only the best usage of devices but also increase energy efficiency and reduce environmental impact[131]. This is enabled by artificial intelligence and analytics.

In January 2022, the same company launched an AI feature named CamCook®, a smartphone food-recognition tool to make consumers life easier in the kitchen. The app is able to set automatically the oven with the right mode and temperature by information processed from a picture of the food, among 20 predefined dishes[132]

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[129] IBM, 'A Legendary Innovator Brings AIOps to Its Global Enterprise', IBM, 2022, https://www.ibm.com/case-studies/electrolux.
[130] IBM.
[131] IBM, 'Electrolux and IBM Collaborate to Use AI to Enhance Customer Experiences', *IBM Newsroom*, n.d., https://newsroom.ibm.com/2020-12-14-Electrolux-and-IBM-collaborate-to-use-AI-to-enhance-customer-experiences.
[132] 'Electrolux Launches AI Feature CamCook® for Smartphones', Electrolux Group, 2022, https://www.electroluxgroup.com/en/electrolux-launches-ai-feature-camcook-for-smartphones-33735.

Nestlé has speeded up operations with its strategic revenue management program driven by an AI-powered sales team that easily optimize sales price and promotional activities. This capability is directly connected to the amount of data gained through the e-commerce platform that permits the company to be more strategic and predictive thanks to the actionable insights gained. AI is used to define go-to-market strategies and the evolution of brand value propositions, product formats and pricing structures[133].

UNOX – an Italian company famous for its self-cleaning professional ovens for the food service equipment industry – provides intelligent ovens with data, information, and artificial intelligence–generated ideas. They can autonomously adapt temperature and humidity to optimize the cooking process thanks to the so called data-driven cooking. Artificial intelligence transforms the consumption data collected by sensors in useful information for the consumer, and the technological innovation that UNOX took to the market is the strategic lever used by the company to achieve success, being AI an integral part of their product offer.

AI drives the product recommendation algorithms of e-commerce websites, and the Amazon's tool accounts for up to 30% of the revenue of the marketplace[134]. In brick and mortar stores, Lowe's – an American retail company focused on home improvements – provides customer services robot named OSHbot. OSHbot has two tablet screens where customers can ask for product information and is able to bring them nearby the shelf where to find that product[135]. It can do real-time checks of inventory levels and automatically call humans when not able to understand customer's requests. This technology exploits deep learning algorithms in order to help employees to focus on more complex task.

In logistics, DHL developed for its supply chain network an artificial intelligence based solution to optimize packaging of shipments in order to save costs and lower emissions deriving from it. Eliminating unnecessary transport, the "OptiCarton" solution can make DHL customers save around 35% of shipping costs. AI deliver suggestions on which

[133] 'Transforming through Digitalization | Nestlé Annual Report'.
[134] Gesing, Peterson, and Michelsen, 'Artificial Intelligence in Logistics'.
[135] Gesing, Peterson, and Michelsen.

carton best fits the items volume and suggest the splitting of an order into several consignments when this optimize volumes[136].

3.3. Internet of Things

The Internet of Things – IoT- represents the convergence of the physical and the digital world realised through sensors, software and technologies installed in ordinary physical objects – things – and able to connect them with devices and systems while exchanging information through the internet[137]. The industry is expected to account for $1.100 billion worldwide in 2023, compared to the $686 billion of 2019[138]. The following graph shows the projected installed base of IoT connected devices worldwide until 2025 compared to the level of the non-IoT devices. The latter include smartphones, computers and laptops while connected devices refer to smart home devices, connected cars and connected industrial equipment[139].

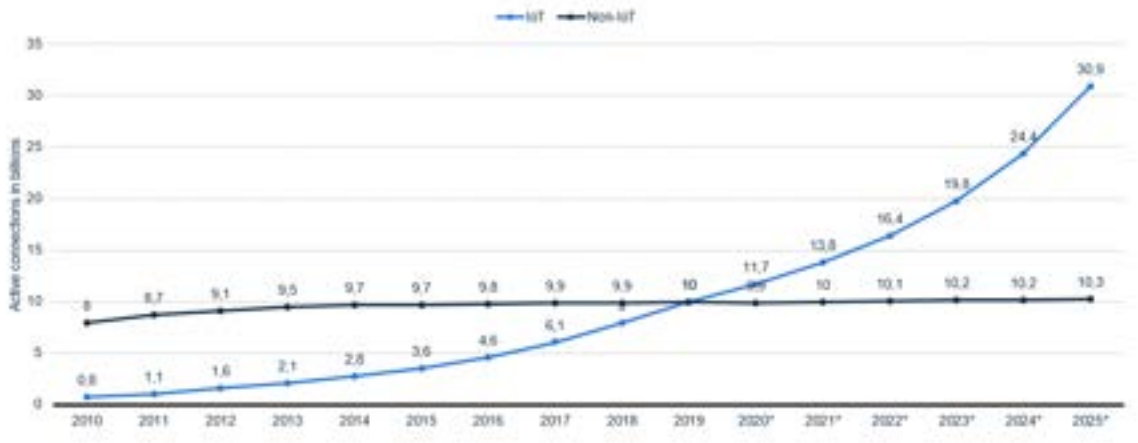

Figure 28 IoT and non-IoT connections worldwide 2010-2025. Source: Statista.

[136] 'Artificial Intelligence Saves Costs and Emissions by Optimizing Packaging of Shipments for DHL Supply Chain Customers', DHL Global, 2022, https://www.dhl.com/global-en/home/press/press-archive/2022/artificial-intelligence-saves-costs-and-emissions-by-optimizing-packaging-of-shipments-for-dhl-supply-chain-customers.html.
[137] Oracle, 'What Is the Internet of Things (IoT)?', 2022, https://www.oracle.com/internet-of-things/what-is-iot/.
[138] IDC. "Prognosis of worldwide spending on the Internet of Things (IoT) from 2018 to 2023 (in billion U.S. dollars)." Chart. June 18, 2020. Statista. Accessed June 13, 2022. https://www.statista.com/statistics/668996/worldwide-expenditures-for-the-internet-of-things/
[139] IoT Analytics. "Internet of Things (IoT) and non-IoT active device connections worldwide from 2010 to 2025 (in billions)." Chart. November 19, 2020. Statista. Accessed June 13, 2022. https://www.statista.com/statistics/1101442/iot-number-of-connected-devices-worldwide/

The growing trend towards the diffusion of this technology depends by some conditions that favoured it. First, the increasing affordability of sensors available in the market that permits to companies to introduce them at a low cost. Then, the growing use of cloud computing platforms that permits to both businesses and consumers an easy access to the infrastructures needed to scale up[140]. Lastly, there are some enabler technologies such as wireless local - Bluetooth, RFID, Wi-Fi connection -, wide area connections - 4G, LTE, 5G - and wired connections – Ethernet cables[141]. Together with the performance achieved in combination with other emerging technologies, such as the use of machine learning and other advanced analytic techniques that permits to extract powerful insight from data collected and transmitted by IoT sensors. Producing in this way potential business value, the demand of sensors increases to feed algorithms that will give sense to those data. The integration of IoT with blockchain is undergoing in many projects too. It seems that benefits of such interactions are cost savings, revenue enhancements and risk mitigation[142].

Figure 29 AI in the Internet of Things. Source: DHL (2018).

For what concerns artificial intelligence – as seen in the previous paragraph –, this technology makes sense of the information collected and can learn from Internet of

[140] Oracle, 'What Is the Internet of Things (IoT)?'
[141] Ben Gesing, Markus Kückelhaus, and James Macaulay, 'Internet of Things in Logistics' (DHL Customer Solutions & Innovation, 2015), https://www.dhl.com/global-en/home/insights-and-innovation/thought-leadership/trend-reports/internet-of-things-in-logistics.html.
[142] Zia Yusuf et al., 'Are Blockchain and the Internet of Things Made for Each Other?', *BCG*, 2018, https://www.bcg.com/it-it/publications/2018/blockchain-internet-of-things-made-for-each-other.

Things. The figure above represent the five key components of the combination between the two technologies[143].

From an industrial point of view, we can identify the vast majority of IoT sensors installed in those businesses that are characterized by easy connection of industrial assets, higher cost of replacement compared to the installation of sensors, significant maintenance costs, presence of critical equipment and potential improvement of operational efficiency[144]. A research found out that the factories setting – including all the standardized production environments – accounts for the most potential economic value from IoT in 2030[145]. This includes the field of manufacturing operations management and predictive maintenance. Following, we find the human health setting – with monitoring and treatment of illness and improving general wellness – and the city setting – with centralized and adaptive traffic control, autonomous vehicles and congestion lanes.

IoT includes consumer-oriented services – when an action performed in the digital environment corresponds to an action in the physical one. As an example, the intelligent vacuum cleaner Roomba® produced by the iRobot company uses IoT provided by Amazon Web Services to share its current state as well as its cleaning schedule and status on the mobile application.

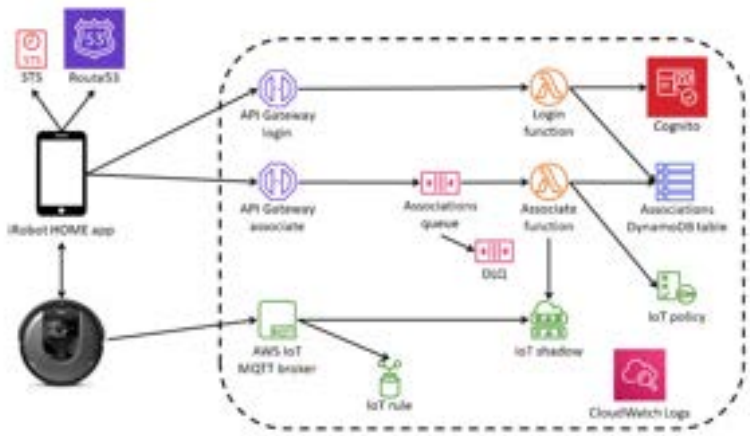

Figure 30 iRobot's architecture. Source: AWS.

[143] Timothy Chou, *Precision: Principles, Practices and Solutions for the Internet of Things* (CrowdStory Publishing, 2016).
[144] Massimo Russo and Gary Wang, 'The Incumbent's Advantage in the Internet of Things', *Italy - IT*, 2019, https://www.bcg.com/it-it/publications/2019/incumbent-advantage-internet-of-things-iot.
[145] Michael Chui, Mark Collins, and Mark Patel, 'Where and How to Capture Accelerating IoT Value' (McKinsey & Company, 2021), https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/iot-value-set-to-accelerate-through-2030-where-and-how-to-capture-it#.

In the same way, some coffee machines produced by BSH Home Appliances – the Group result of the joint venture between Bosch and Siemens – uses the "Home Connect" protocol to provide consumers with the possibility to start their coffee machine from their smartphones, or ordering a coffee to the virtual assistants Amazon Alexa or Ok Google. The possibility to control remotely domestic appliances is extended to a series of other products, which exploit the IoT technology to makes it work and which build differentiated consumer products with enhanced functionalities.

RFID – acronym for radio-frequency identification – are low-cost, miniscule identification devices that can be useful for many purposes such as IoT driven smart inventory management. When products get to inbound gateways a wireless reader captures data transmitted from each RFID gaining useful information on the product – such as weight and volume – automatically sending them to the system. The same devices provide real-time visibility of inventory levels and can send other information – such as temperature or humidity – that can help in quality management. The same tracking capabilities can ensure the authenticity of the products purchased, relevant for luxury products and artworks. The National Gallery of Singapore is actually attaching RFID tags in a non-invasive way enclosing artworks collection data.

Back in 2013, Burberry – a British luxury fashion house – used RFID technology to enhance the customers experience in its physical store in London's Regent Street. The smart sensors were attached to the products to enable the vision of multimedia content through 100 digital mirrors and 500 loudspeakers presents in the store[146] just passing with the item nearby the mirror.

The Volkswagen Group is working on the Industrial Cloud, a digital production platform for its 122 factories that collect data in one and only cloud that makes data from all over the world available to the whole Group. Cloud computing, machine learning and artificial intelligence are protagonists of the project, but at the core we have IoT sensors that enable to increase plant efficiency thanks to the collection of data coming from machineries, plants and systems. The Group is moreover opening its platform to some partner

[146] 'Omnichannel Logistics' (DHL Trend Research, 2015), https://www.dhl.com/global-en/home/insights-and-innovation/thought-leadership/trend-reports/omni-channel-logistics.html.

companies that will be able to scale and further develop their applications in one of the world's largest automobile production networks[147].

3.4. Digital Twin

The digital twin technology is not that recent, considered that in the NASA Apollo 13 mission of 1970 there was already something similar in the air. It is an evolution of computer-driven simulation, which concept was first voiced by the computer scientists David Gelernter in 1991. Michael Grieves in 2003 applied it to manufacturing and specifically in the product-lifecycle management, presenting digital twin as a virtual representation of a product containing information and data on that product[148]. At its core, digital twins are virtual model faithfully replicating an existing object or system, composed by the physical product, its virtual representation and a bi-directional data connection among them[149]. Through complex simulation algorithms, digital twins are able to span the object/system reaction to an event. Despite its relative distant introduction, the progresses made in technological development have broaden its possibilities of application particularly with reference to the raw data used by the model and the machine learning capabilities of today. Digital twins are frequently used in the automotive industry, aircraft production, building constructions and more in general in manufacturing processes.

While control towers and predictive planning are the first step in achieving a data-driven supply chain, digital twins takes it to the next level thanks to the predictive insight gained through the use of advanced simulation techniques. While control towers are useful into operations, digital twins are powerful in strategic planning enabling what-if analysis and scenario planning[150]. Moreover, what differentiate the digital twins with the other simulation methods is a matter of scale: the first can run multiple processes together[151], through real-time data received from sensors applied to the physical objects, making a

[147] Volkswagen Group, 'News - Volkswagen Brings Additional Partners to Industrial Cloud', 2022, https://www.volkswagenag.com/en/news/2020/07/Industrial_Cloud.html#.
[148] David Jones et al., 'Characterising the Digital Twin: A Systematic Literature Review', *CIRP Journal of Manufacturing Science and Technology* 29 (2020): 36–52, https://doi.org/10.1016/j.cirpj.2020.02.002.
[149] Jones et al.
[150] Sachin Lulla and Dheera Anand, 'Can a Supply Chain Digital Twin Make You Twice as Agile?', *EY*, 2021, https://www.ey.com/en_us/advanced-manufacturing/can-a-supply-chain-digital-twin-make-you-twice-as-agile.
[151] IBM, 'What Is a Digital Twin?', 2022, https://www.ibm.com/topics/what-is-a-digital-twin.

prediction on the reaction of the overall system no matter its complexity. Once fed with the right data, the virtual model can release performance issues, generate improvements, develop reliable indicators of risk exposure and recovery time[152]. This alternative to simulation models have found application in practice to products – widening the possibilities already offered by the product life-cycle management systems –, manufacturing processes and even to more complex systems such as supply chains.

We can outline the following characteristics of digital twins:

1. A digital twin is a unique virtual representation of a specific physical assets, on which the model is tailored;
2. Using diverse sensors, the digital twin gathers continuously data that feed the model allowing it to run correctly. It represents both the current state of the asset/system and how it behaves consequently to an event.
3. It enables data-driven business decision given its ability to visualize, analyse, predict and optimize.

Being digital, this tool can exist even before the physical existence of the object represented.

IBM classify digital twins depending on the complexity of the system represented into four core groups, listed in the table below.

Table 3 Types of digital twins. Source: IBM.

Component/part twins	Basic unit, repeating a component or a part of an object or a system.
Asset twins	Composition of more components/parts, simulating the behavior of the interaction among them.
System/unit twins	Provide visibility on the result of interaction among more assets in the same system, proposing suggestions on performance enhancements.
Process twins	Replicates an entire production facility composed by multiple systems, simulating how they work together.

This classification transmits the idea that this powerful technology have a wide range of application among industries, functions and for different scopes being highly customized

[152] Rodriguez et al., 'Building the Bionic Supply Chain'.

and tailored on the specific needs. Companies have to identify three dimensions when considering to embrace this possibility in their business. The first one relates to which areas in the value chain will be covered by the digital twin[153], such as product engeenering and design, supply chain, production and/or distribution. Secondly, they have to identify its scope, positioning in one of the four groups presented above. Component digital twin will reach easier precise results, while system and process twins have higher requirements and are more difficult to manage. Lastly, it has to be clear the desired degree of sophistication from which will depend the quality of the raw data needed by the model to operate. The most simple form is data foundational, providing as an output reliable data to make informed business decision. The technology can be enriched through traditional simulation tools or through predictive and prescryptive analytics and machine learning technology to gain more insight. At the highest level of sophistication, it can manipulate the real-world counterpart in a closed-loop setup[154].

To make this possible, digital twins exploit a series of technologies that enables its effective working. Cloud computing primarily – which is namely the shift from physical data centers which enabled only users connected to a specific limited network to servers hosted on the internet, granting speed, efficiency and cost reduction – permits the storage and availability of huge amount of data in digital twins. APIs – acronym of Application Programming Interface – are mechanisms that enable two software components to communicate with each other using a set of definitions and protocols[155]. They permits to combine data from multiple sources in a fast and reliable way. AI – Artificial Intelligence – enables the automatic predictive outcomes without the need to explicit programming. Machine learning in particular leverage the historical series of data to take autonomous decisions. IoT – the Internet of Things – makes it feasible to continuously collect real time data in a scalable way, through smart sensors that communicate among devices through the internet connection. Lastly, AR and VR – agumented reality and virtual reality – let users gain a realistic representation of attributes contained in the prediction, and in some cases even an interaction with it.

[153] Mickael Brossard et al., 'Digital Twins: The Art of the Possible in Product Development and Beyond', *McKinsey*, 2022, https://www.mckinsey.com/business-functions/operations/our-insights/digital-twins-the-art-of-the-possible-in-product-development-and-beyond.
[154] Brossard et al.
[155] 'What Is an API? - API Beginner's Guide - AWS', Amazon Web Services, Inc., 2022, https://aws.amazon.com/what-is/api/.

Among benefits of digital twins for product companies we find reductions in costs and in time-to-market, optimization in design and functionality and more flexibility in responding to the critical events affecting supply of components and raw material. Moreover, at a high level they open up to new business models for companies that can offer services such as remote mainteinance for software-integrated products. On the business side, predictive mainteinance with regard to assets and machineries is something of high interest, giving the impact that a broken line has on production capabilities. Digital twins could predict when and where mainteinance is needed, in order to properly take time-sensitive decisions.

In the context of supply chain management, digital twins have been embraced as a powerful solution to achieve agile and resilient supply chains, gaining full control of the whole system. Complexity in supply chain is determined by the number of production plants, warehouses, distribution centers, suppliers, customers, other assets and by the volume of inventory, information and material flows. This combined with volatility in demand, uncertainty of supply, significant delays in transportation and interconnected constraints among logistic limitations and product portfolio requirements[156]. Supply chains have to cope daily with sourcing, manufacturing and transportation issues that makes companies vulnerable to cost escalation and poor customer satisfaction. Digital twins can help them in moving from being reactive to events, to be prescriptive and predictive. Simulation of the whole systems reaction to an event makes it possible to test and optimize alternative production scenarios in an extremely fast way, having the advantage to do it on a virtual basis without disturbing the physical production. Process simulation can be related to decisions of new facilities loading, integration of other manufacturing partners in the outsourcing decision, change of the product mix or change in the capacity. For all these events, the digital twin will provide a simulation of the process and of the outcome. Implementation can be costly. Moreover, to work properly the system needs a rich and constant flow of sensor data, meaning an appropriate ability of the company to collect, store and manage big data in a right and meaningful way through a proper data governance framework and process.

[156] Rainer Schuster, Gaurav Nath, and Llorenç Mitjavila, 'Conquering Complexity in Supply Chains with Digital Twins', *BCG Global*, 2020, https://www.bcg.com/it-it/capabilities/operations/conquering-complexity-supply-chains-digital-twins.

In particular, digital twins in supply chains have wide applications. They could detect shifting demand patterns analysing orders cancellation trends activating an alarm bell for preventively adjusting production levels. On the contrary, if the production has unexpected impediments the digital twin is able to timely capture it through signals coming from IoT sensors automatically planning alternative production sources and estimating the total impact on it. They can catch shipment delays by examining signals from GPS devices comparing them with what was expected and scheduled as times of arrival[157]. Potentially, they can suggest alternative solutions to bypass obstacles. A logistic-network twin using satellite analytics to monitor key ports can aim to achieve a higher service level[158] thanks to the possibility of analytics to predict the potential impacts on cost to serve and lead times of different alternatives. Burgos and Ivanov provide a schematic representation of a digital supply chain twin for a disruption analysis, which takes into consideration the end-to-end supply chain and is represented in the figure below[159].

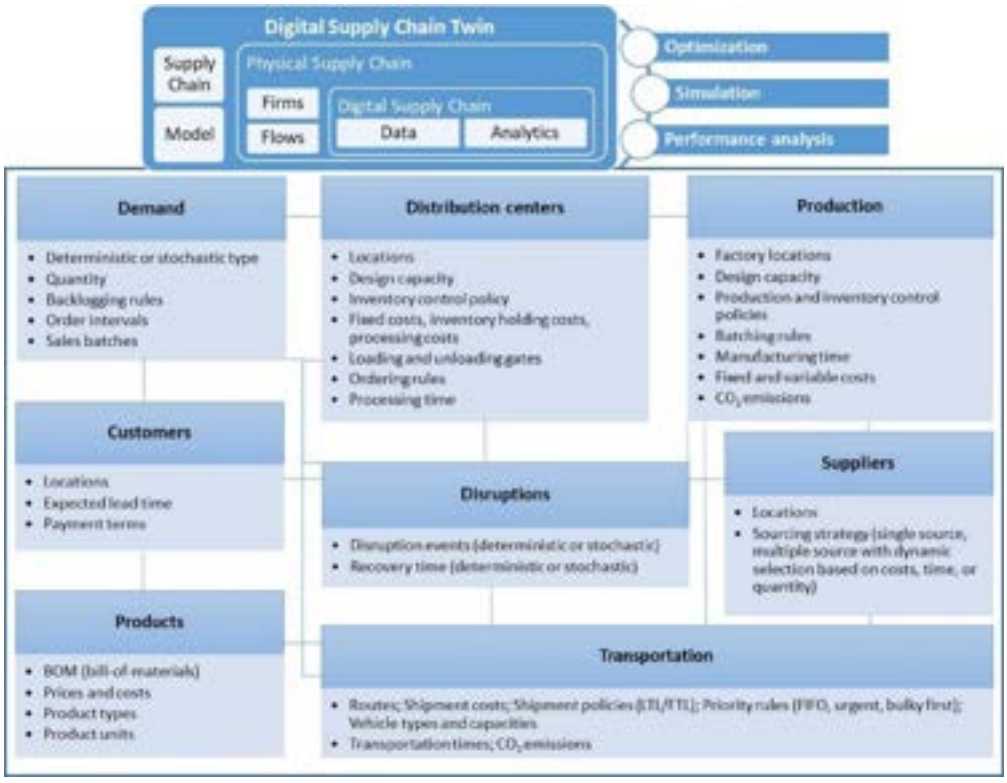

Figure 31 Digital supply chain design for disruption analysis. Source: Burgos and Ivanov.

[157] Lulla and Anand, 'Can a Supply Chain Digital Twin Make You Twice as Agile?'
[158] Service level is a key performance indicator estimating the quality of service provided considering factors such as the on-time delivery.
[159] Burgos and Ivanov, 'Food Retail Supply Chain Resilience and the COVID-19 Pandemic'.

Coming to real use-cases, an important actor in the global supply chain, the Singapore port - one of the world's leading hub for maritime transportation –, is the protagonists of a project named Next Generation Ports which exploits digital technologies to manage the complex and multi-stakeholder environment and to integrate easily new facilities. The Maritime and Port Authority of Singapore is working together with the National University of Singapore and other partners to develop a digital twin to perform simulation and optimization studies. The success of this project is highly depending on the contribution played by the participants to the network, which should embrace the digital twin technology for their assets too.

We can find strong applications of digital twins across many industries[160]. In the manufacturing sector, CNH Industrial – a capital goods company managing, among the others, the Iveco brand of transport vehicle – applied the digital twin concept to its maintenance processes of manufacturing lines. The objective was to apply simulation in order to achieve a better decision-making process on which policy to apply, among scheduled maintenance, condition-based maintenance depending on usage status and predictive maintenance to prevent difficult situations. They set on a digital twin to control and forecast the health of a specific critical component in the productive line, an electrical conductor that flex during operations[161].

The German engineering and technology company Bosch developed a software that is able to connect the data streams coming from its more than 60.000 sensors in the production plant of Blaichach in Germany. It automatically programs the designated production line with the required data, which then processes each job order accordingly[162], contributing in the improvement of manufacturing operations through predictive maintenance. The Industrial Application System Nexeed – the Bosch digital twin - interfaces with all connected manufacturing industry applications through one dashboard and one user interface boosting productivity by up to 25% and reducing inventories by as much as 30%[163]. Among the demonstrated benefits, we find the

[160] Matthias Heutger and Markus Kueckelhaus, 'Digital Twins in Logistics - A DHL Perspective on the Impact of Digital Twins on the Logistics Industry' (DHL Trend Research, 2020).
[161] 'Digital Twin of a Manufacturing Line: Helping Maintenance Decision-Making', 2022, https://www.anylogic.com/resources/case-studies/digital-twin-of-a-manufacturing-line-helping-maintenance-decision-making/.
[162] 'Nexeed: Welcome to the Smart Factory', Bosch Global, 2022, https://www.bosch.com/stories/nexeed-smart-factory/.
[163] 'Nexeed'.

avoidance of asymmetric information, optimization of processes and the greater ease in taking effective strategic decisions. Moreover, it optimized the intralogistics system and the sustainable performance through a more efficient energy management – considered the 40% less power consumed in the Homburg plant thanks to this application.

An American corporation operating in the oil industry segment – Baker Hughes – have built a digital twin of its plant located in Nevada in the USA with a model that collects data from machines, processes and component deliveries from suppliers. The real-time factory performance provided permits to see improvement opportunities and fast-reaction to issues, enhancing agility and resilience. The goal of the company is to use the digital twin to double the rate at which materials flow through the plant, achieving a best-in-class on-time delivery rate. On its annual report of 2017, Baker Hughes states that it has generated over $300 million of business value through its 661,000 twins, which converge in a platform named Predix that aggregates them to provide the best solution.

Digital twins have been widely explored in the medical sector too. Logistic challenges such as the increasing demand for diagnostic medical imaging – more than 80 million CT scan in the US[164] - can be addressed through simulation. The German medical device company Siemens Healthineers have partnered with the Mater Private Hospital in Dublin to realize a digital twin of its radiology operations. The identified improvement potential was a nearly half-hour reduction in patient waiting time, and significantly reduced staff overtime costs[165]. This results enhanced patient experience, lowered operating costs, and increased the value of care.

Coming to the infrastructure sector, an interesting digital twin application is the one of Alstom – a French manufacturing company in rail transportation markets – that simplified the management of its train maintenance operations in UK lines. Data running in the systems include the ones related to every train in the fleet and of their operating timetables and maintenance regimes. It schedules maintenances according to live information on train locations and planned movements, altering it in relation to urgent

[164] 'Radiation Risk from Medical Imaging', *Harvard Health*, 2021, https://www.health.harvard.edu/cancer/radiation-risk-from-medical-imaging.

[165] 'The value of digital twin technology', Whitepaper (Siemens Healthcare GmbH, 2019), https://www.siemens-healthineers.com/it/services/value-partnerships/asset-center/white-papers-articles/value-of-digital-twin-technology.

repairs[166]. Moreover, Alstom exploited the digital twin to reduce testing times for its autonomous driving[167] freight project by replaying issues encountered in the field and pretesting new software versions before installing them on the train[168].

In the Aircraft sector, Boeing have achieved up to 40% improvement in first-time quality of the parts and systems it uses to manufacture commercial and military airplanes by exploiting digital twin asset development model[169]. The technology allows the company to simulate how their functioning will perform during their lifecycle, considering the wear and tear of components.

While the examples mentioned until now relates to industries in which there are large and complex assets to manage, things differs when considering the retail and e-retail sector, which involve an enormous quantity of simple objects. Here digital twins are used mostly to track the flow of products along the supply chain or to develop models focusing on consumers behaviour. Amazon combines digital twins and augmented reality to help customers visualize products. AR places the digital twin in a customer's reality permitting consumers to visualize how products fits in their real life[170].

3.5. Blockchain

The blockchain is for sure one the most discussed technologies of these days. It gained popularity with the Bitcoin digital currency, which has marked the landscape of decentralized cryptocurrencies. Despite its success in the financial sector, its applications are wider and vary between all the industries. Blockchain is a revolutionary technology to control and manage a huge quantity of data whenever there is this need. We can describe it as a certified archive in which information are registered in blocks encrypted without the need of an intermediary. Its strengths are decentralization and security of

[166] Heutger and Kueckelhaus, 'Digital Twins in Logistics - A DHL Perspective on the Impact of Digital Twins on the Logistics Industry'.
[167] Referred to as ATO, automatic train operation, permits energy savings by regulating traction and bracking efforts while increasing network capacity by reducing timetable margins.
[168] 'Digital Twins and Driverless Shunting: The Future Is Now', Alstom, 2020, https://www.alstom.com/press-releases-news/2020/7/digital-twins-and-driverless-shunting-future-now.
[169] C. K. Lo, C. H. Chen, and Ray Y. Zhong, 'A Review of Digital Twin in Product Design and Development', *Advanced Engineering Informatics* 48 (2021): 101297, https://doi.org/10.1016/j.aei.2021.101297.
[170] Al Torres, 'Using Digital Twins For E-Commerce Engagement', *Forbes*, 2019, https://www.forbes.com/sites/forbestechcouncil/2019/03/26/using-digital-twins-for-e-commerce-engagement/.

information contained. This is possible since it works as a distributed ledger in which information are stored in blocks. Each block looks like a text-document composed by strings of code representing the transaction. The system builds upon a consensus mechanism for which transactions are recorded when there is a general agreement of networks participants to close the block. This process is based on sophisticated algorithms named "Proof of Work" – POW – and "Proof of Stake" – POS - that while ensuring the validity of transactions made, enable decentralization. The consensus mechanism ensure the truth and correctness of information, which are encrypted through cryptography that enables only authorised parties to decrypt it. Once the block is closed, its content is immutable and the impossibility to tamper the system contributes to granting the blockchain security. Blocks are disposed in chronological order, and a unique ID identifies each of them, which connects it to the previous and the following blocks. To let this happen, there are some key users – identified as nodes and miners – that make available their hardware to support the network. Nodes, in particular, keep a copy of the distributed database while checking the miners. Miners, on the other side, collect the transactions in blocks. Those are in fact created through a process named "mining" - possible thanks to the POW and POS. Once the block is created, the other miners receive it in order to validate it. Only when this operation is completed the block is added to the chain of the ones already produced with the same mechanism.

This revolutionary technology has the potential to both create new business or service models and to improve existing process flows[171]. It definitely fall in the perimeter and contribute to the digital transformation process which companies are going through, even if some authors suggest to think to blockchain not as an absolute problem-solving solution. Rather, companies have to engage a long-term strategic approach while consider processes reinvention, to understand in which cases redesign and digitalization of processes is sufficient and deliver the desired output.

Many platforms were born to allow the development of blockchain-based applications in the past years. Some of them are public – meaning that anyone is able to join and participate to the network – others are private – allowing entrance only to verified participants. There are also hybrid solutions - controlled by an authority with some

[171] Forrester Consulting, 'Emerging Technology Projection: The Total Economic Impact™ Of IBM Blockchain', 2018, https://tools.totaleconomicimpact.com/go/ibm/blockchainTEI/?cm_mmc=Email_Nurture-.

permissionless processes – together with the "consortium", in which a group of organizations share the governance.

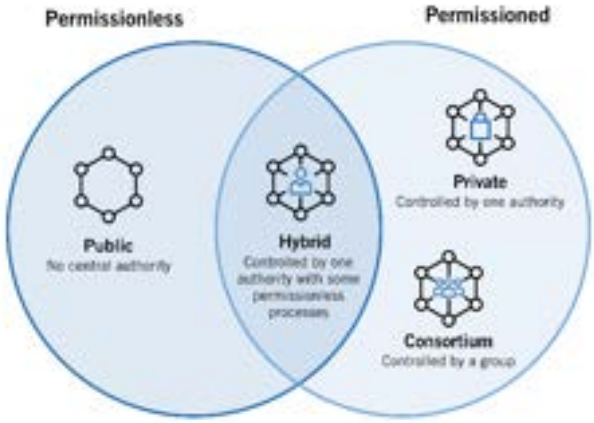

Figure 32 Types of blockchain. Source: Foley & Lardner.

The Bitcoin blockchain – released in 2009 - is public given that everybody can join the network and operate financial transactions even anonymously. Another public blockchain is the Ethereum blockchain, in which it is possible to trade with the Ether cryptocurrency. Participants to Ethereum gives the availability of their hardware contributing to a distributed CPU[172] named Ethereum Virtual Machine. Born in 2013 with the aim to exploit the blockchain technology for more than currencies transactions among parties, this blockchain enables programmer to run programs based on it. These software are called "smart contracts", namely computer programs which automatically execute, control or document legally relevant events and actions according to the terms of a contract or an agreement[173]. The name could be misleading – considering that they are not really smart and not even really contracts[174]. They are pieces of code that codify the business logics facilitating the storage, verification and self-execution of rules with no intermediaries needed. In this way, they are really revolutionizing business logics in many fields. For example, they can be applied in supply chain transactions such as delivery of raw materials or finished goods, payment for value-added services, transfers of copyright or

[172] Central Processed Unit, CPU.
[173] *Smart Contracts* (Mohr Siebeck GmbH and Co. KG, 2019), https://www.jstor.org/stable/j.ctvn96h9r.
[174] TEDx Talks, *How Smart Contracts Will Change the World | Olga Mack | TEDxSanFrancisco*, 2018, https://www.youtube.com/watch?v=pA6CGuXEKtQ.

IP value, and insurance payouts[175]. The core mechanism is to link the information contained in the blockchain to consequences when agreed terms are met.

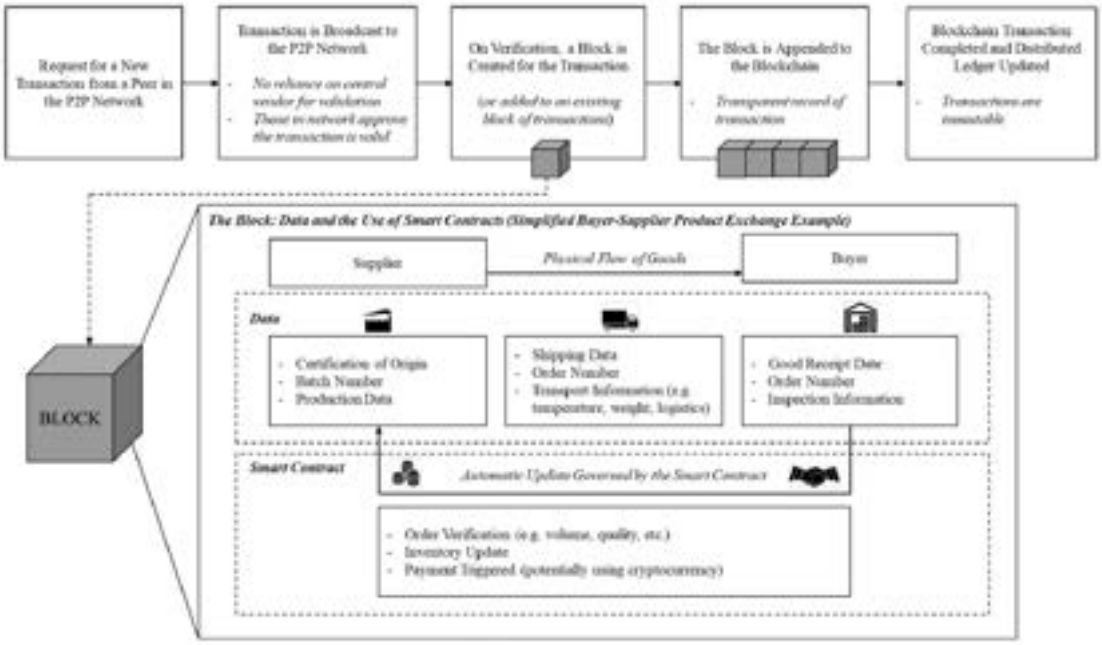

Figure 33 OSCM blockchain mechanism. Source: IBM.

The figure above present a simplification of the mechanism of a blockchain in the operations and supply chain management context in which blocks may contain data or trigger smart contracts. The upper side shows the path from the request of a new transaction by a networks participant, through the verification, closing of the block and finalization of the transaction. The lower part present a detailed view of a simple buyer-supplier case highlighting the potential value-added of smart contracts[176].

Going back to private networks, Hyperledger - an umbrella project of open source blockchain and related tools founded by the Linux Foundation in 2015 - plays a great role. Hyperledger Fabric is the standard for enterprise blockchain platform[177], used in many cross-industry blockchain projects. Private blockchains are not fully decentralised but

[175] Amitt Ganeriwalla et al., 'Does Your Supply Chain Need a Blockchain?', *The Boston Consulting Group*, 2018, https://www.bcg.com/it-it/publications/2018/does-your-supply-chain-need-blockchain.
[176] Rosanna Cole, Mark Stevenson, and James Aitken, 'Blockchain Technology: Implications for Operations and Supply Chain Management', *Supply Chain Management: An International Journal* 24, no. 4 (2019): 469–83, https://doi.org/10.1108/SCM-09-2018-0309.
[177] IBM, 'What Is Hyperledger Fabric?', 2022, https://www.ibm.com/topics/hyperledger.

were born as a solution to satisfy industrial-grade security requirements[178] that needs the possibility to restrict the information visibility only to parties directly involved in transactions, and not to the whole network to which could participate competitors too.

Before presenting some examples, we have to specify that this emerging technology has still a lot to do to become the new technological paradigm that many foresee. Some defines it the most democratic technology of this century. Others are still suspicious by raising question of sustainability of such architecture and lack of standards and regulations especially referred to the cryptocurrencies application. The co-founder of Ethereum Vitalik Buterin coined the concept of the "blockchain trilemma": programmers have to sacrifice one aspect among decentralization, security and scalability when developing blockchain solutions. Security refers to the ability of the network to prevent cyber-attacks ensuring the correct working of it and is the cornerstone of the whole system. Decentralization contributes to the trustful environment providing end-to-end transparency, granting security and low costs. However, high level of decentralization compromise scalability, the ability of the system to bear an exponentially increasing number of users and nodes, to process and load their transactions while maintaining the speed of processing and the cost for users to verify transactions. Some solutions proposed to the issue of scalability contemplate the split of the network into smaller part – commonly referred to as "shard", from which the name "sharding" – or to include an off-chain transaction channel that would dialogue with the blockchain to minimize the use of on-chain operations – configuring a "state channel" solution.

At the date, many companies have already began to explore blockchain. Some are engaged in pilot projects while others are working on the implementation of applications with other actors in their environment.

A protagonist in the current landscape is IBM, an American technology corporation that developed flexible, functional and customizable blockchain solutions. Together with Walmart – a multinational retail corporation that operates a chain of hypermarkets, discount department stores, and grocery stores – the company created a food traceability system based on Hyperledger Fabric launching in 2016 two proof of concept projects to

[178] Kate Vitasek et al., 'How Walmart Canada Uses Blockchain to Solve Supply-Chain Challenges', *Harvard Business Review*, 5 January 2022, https://hbr.org/2022/01/how-walmart-canada-uses-blockchain-to-solve-supply-chain-challenges.

trace mangos sold in the United States and pork in China. The system worked, allowing the upload of certificates of authenticity to the chain and reducing the time needed for tracing from 7 days to 2.2 seconds[179]. This success elicits the interest of Nestlé, Unilever and of Kroger[180], which jumped in the project and - together with other important brands in the food industry - participated in 2017 to the launch of the IBM Food Trust™ project for product's traceability in the food supply chain. This application is of particular interest for consumers that can have a warranty of information concerning the origin of raw materials and – in the case of products with certified origin – can ensure their authenticity. Walmart was able to track more than 1.1. millions of items to trace the history of products[181] through blockchain.

To the same purpose of provenance certification, in the luxury sector authenticity of products can be granted through the blockchain thanks to trust provided by it. In 2018 the Boston Consulting Group worked together with DeBeers Group to develop Tracr™- the first distributed diamond blockchain platform that provide tamper-proof source assurance on diamond's provenance. The great value delivered is to meet the customer's expectations of knowing the provenance of the product, having confidence on the origin of the product purchased. This result is achieved through the integration of the blockchain technology with IoT and AI. The Group – providing one third of the global supply of diamonds by value - had the market position, financial ability, and industry relationships to attract industry players from across the supply chain in developing a solution for the entire diamond industry[182].

Later in 2019, Walmart developed together with DLT Labs – a global leader in development of blockchain based solutions for enterprises - an automated system based on a blockchain private network based on Hyperledger Fabric to manage invoices from and payments to its 70 third-party freight carriers. The company realised that there was too much need of manual reconciliation caused by the multiple information systems used

[179] Vitasek et al.
[180] Christopher Mims, 'Why Blockchain Will Survive, Even If Bitcoin Doesn't', *Wall Street Journal*, 11 March 2018, sec. Tech, https://www.wsj.com/articles/why-blockchain-will-survive-even-if-bitcoin-doesnt-1520769600.
[181] Rajiv Lal and Scott Johnson, 'Maersk: Betting on Blockchain' (Harvard Business School, 2018), https://hbsp.harvard.edu/product/518089-PDF-ENG.
[182] Jan Philipp Bender, Kaj Burchardi, and Neil Shepherd, 'Capturing the Value of Blockchain', *BCG Global*, 2019, https://www.bcg.com/it-it/publications/2019/capturing-blockchain-value.

by the parties, becoming unsustainable and hindering operational and financial gains[183]. The new system continuously gathers information at every steps intercurring from the tender offer of the carrier to the proof of delivery and the approval of payment. Information are automatically captured and real-time synchronized, being visible only to the parties involved in the transaction. The success of this application was tangible considered the shift from the 70% of disputed invoices to less than 1%[184].

Another interesting case is the one of "TradeLens", a blockchain based supply chain platform launched in 2018 by the joint venture between IBM and Maersk - the largest container shipping line and vessel operator in the world. The shipping company realised the impact of the inefficiencies of the industry, related to paper-based processes, insufficient visibility on product location along the supply chain and high administrative costs – combined with difficult communication among parties[185]. Starting from this, it partnered with IBM to develop a new global trade digitization platform intended to bring value for the industry as a whole[186]. This clearly ensuring neutrality with respect to the Maersk role, to allow all the actors to benefit of the possibilities of improvement in process flow and visibility. The shipping industry accounts for the movement of $4 trillion worth of goods annually, the 90% of global trade. Administration costs cover around 15/20% of the total value, in a complex multimodal supply chain that includes marine, railroad and truck transportation[187] involved in different countries. Actors vary across shippers, freight forwarders, ports and terminals, ocean carriers, intermodal operators, government authorities, customs brokers and more[188], and TradeLens offers a customized value proposition differentiated on the characteristics of their role. The platform – the first blockchain based one developed on a large scale – hosts millions of shipping events per day, with the availability of half of the ocean container cargo. Through years, all the important players of the industry have joined the network, such as MSC, CMA CMG, ZIM, Seaborg Marine and many others. IBM built a private network solution in which all the participants are known and have received a permission to participate. TradeLens exploit the smart contracts technology to automate the tasks in the shipping process,

[183] Vitasek et al., 'How Walmart Canada Uses Blockchain to Solve Supply-Chain Challenges'.
[184] Vitasek et al.
[185] Lal and Johnson, 'Maersk: Betting on Blockchain'.
[186] Lal and Johnson.
[187] Luiss Business School, 'Blockchain Applications in Supply Chain - Examples'.
[188] 'TradeLens | Our Network', 2022, https://www.tradelens.com/network.

thanks to electronic devices that monitor what happens inside containers and that trigger automatically a consequence if the environment differs from what agreed – for example the shipment of a new product for replacement if the container environment is not the proper one[189]. Thanks to the blockchain technology, all the participants to the network access the same information on the shipping status and this enhance transparency, traceability and security of information, reducing significantly the possibility of collaboration failures given the autonomous system of rules enabling automated execution.

Thus, the blockchain technology foster trust and lower transaction costs. It improves transparency and traceability, removing intermediaries and granting immutability of information stored thanks to cryptology. What emerge from real experiences is that this technology that has a great potential in supply chain management too. It can enhance resilience giving the possibility to apply preventing and proactive approaches that – when applied – can reduce the impact of disruptions[190]. However, there is no one-size-fits-all solution and companies have to take some important decisions once identified areas in which the immutable distributed ledger can unlock value. Moreover, they have to change their approaches to supply chain management and think about the best combination with the other emerging technologies and the state of the art. Centralized data systems are not less efficient that blockchain if considered from the operational point of view[191]. However, those do not provide the same opportunities in terms of trust and visibility.

If we consider the visibility aspect, digital control towers provide this benefit too. They enable a centralized view of business operational status on the end-to-end supply chain sending alerts to permit a quick diagnosis and a rapid resolution of problems. Meaning that blockchain is not the only solution to visibility, and companies can achieve it even without investing in blockchain. The conclusion is that companies need to have clear in mind their priorities and the measure in which automation and trust value in the business. If both are of high value, blockchain has the potential to give additional benefits. When only value of trust is high, blockchain can still unlock value. On the contrary, if trust is not

[189] Fabrice Lumineau et al., 'How Blockchain Can Simplify Partnerships', *Harvard Business Review*, 2021, https://hbr.org/2021/04/how-blockchain-can-simplify-partnerships.
[190] Pankaj Dutta et al., 'Blockchain Technology in Supply Chain Operations: Applications, Challenges and Research Opportunities', *Transportation Research Part E: Logistics and Transportation Review* 142 (1 October 2020): 102067, https://doi.org/10.1016/j.tre.2020.102067.
[191] Ganeriwalla et al., 'Does Your Supply Chain Need a Blockchain?'

critical but speed and efficiency provided by automation are critical control towers are more cost-efficient[192] and could be the best option.

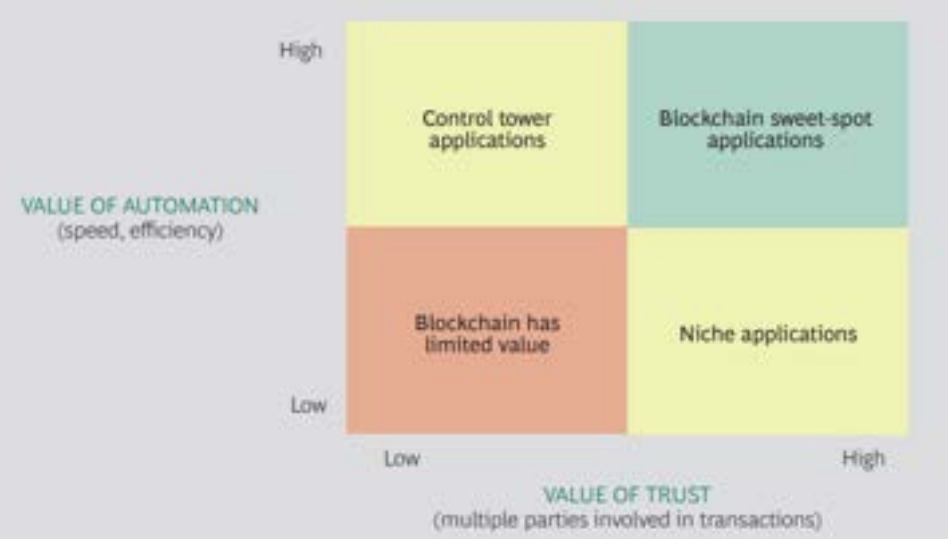

Figure 34 Blockchain and control towers applications by automation and trust value. Source: BCG analysis.

Summing up, blockchain is a revolutionary technology that can bring significant benefits to business area in which trust and automation plays a key role. It can be the ledger on which data coming from IoT sensors, ERP systems, inventory palettes and shipping events[193] are stored in an immutable way. This in order to trigger following events through the smart contracts system providing cost and time saving. The blockchain permits to manufacturing companies to trace problem with products, components or raw materials much faster[194], permitting them to limit the damage. With reference to its applications to operations and supply chain management, the blockchain characteristics are relevant because:

- Transparency and agility is provided by the distributed ledger;
- Automation through smart contracts provides time saving and cost reduction;
- Immutability of data provide trust eliminating the risk of fraud;

[192] Ganeriwalla et al.
[193] Sangeet Paul Choudary, Marshall W. Van Alstyne, and Geoffrey G. Parker, 'Platforms and Blockchain Will Transform Logistics', *Harvard Business Review*, 19 June 2019, https://hbr.org/2019/06/platforms-and-blockchain-will-transform-logistics.
[194] Atin Angrish et al., 'A Case Study for Blockchain in Manufacturing: "FabRec": A Prototype for Peer-to-Peer Network of Manufacturing Nodes', *Procedia Manufacturing*, 46th SME North American Manufacturing Research Conference, NAMRC 46, Texas, USA, 26 (2018): 1180–92, https://doi.org/10.1016/j.promfg.2018.07.154.

- Decentralization reduce governance requirements and the need to rely on a specific actor[195].

Companies should develop blockchain solutions for the cases in which this brings a real value unreachable through the other existing systems such as cloud-based solutions, current ERP systems and RFID[196] or WSN[197].

[195] Dutta et al., 'Blockchain Technology in Supply Chain Operations'.
[196] Radio frequency identification
[197] Wireless sensor network

CHAPTER IV

De' Longhi Group, Everyday Makers

4.1. History of the Group, brands and products

The De' Longhi Group is one of the world's leading players in the small household appliance sector. Its roots date back to the early 1900s when the Italian De' Longhi family engaged in the production of industrial components. Growing in the business as a manufacturer of finished goods for third parties, the history of the Group began in 1974 when the De' Longhi brand proposed to the market an oil-filled radiator which gained a massive success. In the subsequent years, the company enriched its product range gaining success and recognition in portable electric heaters and air conditioners thanks to the focus on innovative solutions to booster efficiency. While in 1985 it opened the first foreign branch in the Empire State Building in New York, 1986 is a remarkable date in the company's history given the launch of the iconic portable air conditioner named "Pinguino". In 2001, the company expanded its business with two important acquisition: the British Kenwood and the Italian Ariete - marking the entry in the food preparation, home cleaning and ironing sectors. While the other brands compete in the high-end and medium-high segment, Ariete's products focus on the mid and low-end one[198]. To this followed the listing on the Milan's stock exchange in 2001. In the succeeding years the De' Longhi brand released in the market both pump and super automatic coffee machines, which are now key competitive products for the Group, which success led to an agreement with Nespresso and Nestlé for the distribution of capsule coffee machines. These strategic partnerships are enclosed in the exclusivity of manufacturing and distribution of the "Lattissima" range in more than 20 countries, while holding distribution rights for "Nestlé Dolcegusto" model. In 2005, the Group expanded its production facilities portfolio opening a 20.000 sq m factory in the Chinese province of Guandong. On the other side of the world, a terrible fire devastated the Italian production plant in Treviso – today

[198] Diego Campagnolo and Arnaldo Camuffo, 'Ownership and Location in the Small Domestic Appliances Industry: The De'Longhi Case', in *Breaking up the Global Value Chain*, vol. 30, Advances in International Management (Emerald Publishing Limited), 3–27, accessed 6 May 2022, https://doi.org/10.1108/S1571-502720170000030002.

headquarter of the company - on 19th of April 2007. However, the resilience of the company permitted to restore in a very short time the product lines involved in the fire equipping the other Italian plant in Mignagola di Carbonera – close to Treviso. The incredible work done in order to limit the damage enabled the company to grant the availability of products and the continuity of the activity. In fact, despite adverse events, 2007 is also recognized as the year in which the company established its leadership in the coffee machine segment. In 2012 the acquisition of the perpetual license for the Braun brand from Procter & Gamble – only for small domestic appliances products - enriched the brand portfolio of the company. The expansion continued in 2017 with the acquisition of the 40% of the Swiss Group Eversys - producer of professional espresso coffee machine - and in 2020 with the one of Capital Brands Holdings Inc., an American leader in the personal blenders segment[199] with the NutriBullet and MagicBullet brands focused on nutrition. Lastly, in 2021 the Group completed the acquisition of the remaining 60% of Eversys, acquiring full control on it and expanding in the professional coffee machine segment. Today the Group's offer consists of a range of small domestic appliances operating in the coffee, kitchen, home conditioning and home-care segment, through the five brands of De' Longhi, Kenwood, Braun, NutriBullet and Ariete. Approximately 70 subsidiaries and 3 technical centres cover more than 120 markets into the three regions of Europe, Asia Pacific and Americas and Middle East, India and Africa. The Group owns six manufacturing plants and a plant in Joint Venture in China. It mainly operate selling to consumers through business intermediaries such as retailers or wholesalers but since 2020 is significantly increased the revenues gained through the D2C e-commerce.

Figure 35 De' Longhi Group Brand portfolio.

With its brands, the Group operates in the segments of:

- Coffee makers: fully automatic, manual and capsule system.
- Food preparation: kitchen machines, personal and hand blenders and other SDA[200].

[199] 'History | De' Longhi Group', 2022, https://www.delonghigroup.com/en/group/history.
[200] Small Domestic Appliances

- ❖ Comfort: portable air conditioner and heater, fan heaters and air purifier.
- ❖ Home care: irons and ironing systems and vacuum cleaners.

Figure 36 Some of the De' Longhi Group products from its portfolio.

The De' Longhi Group differentiate itself from its competitors – such as Philips, SEB Group, Electrolux and Bosch – for its large portion of high-end and mid-high products that characterize its price positioning and for its focus on the segment of small domestic appliances only[201].

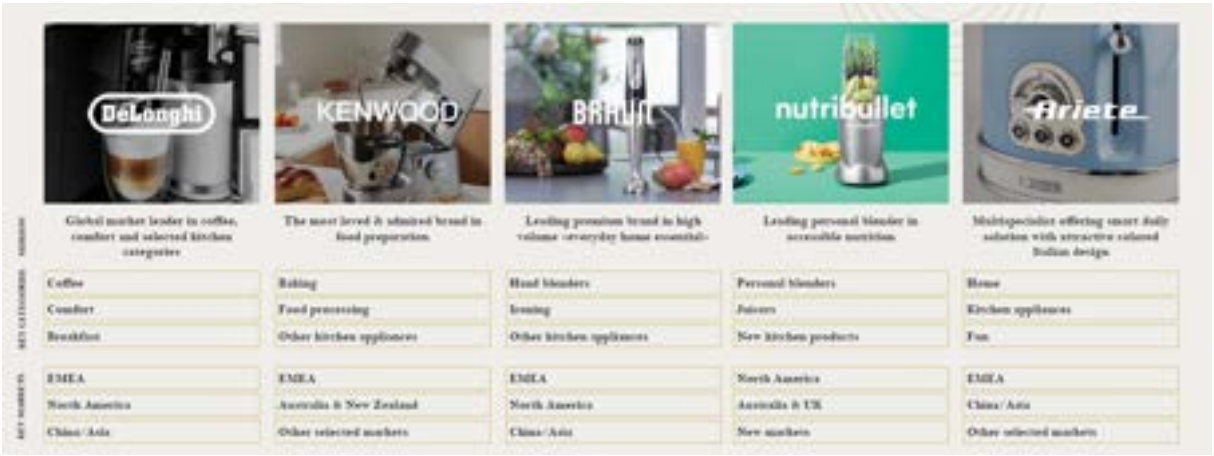

Figure 37 De' Longhi Group Brands. Source: Corporate Presentation 2022.

[201] Campagnolo and Camuffo, 'Ownership and Location in the Small Domestic Appliances Industry'.

As it is possible to observe from the figure, each brand has a clear mission that express its objective and its core value proposition served to customers, focusing on its own key products to serve its markets. One of the De' Longhi brand strengths is of course the Italian design and appliances tradition, a country itself that around the world is synonym of quality, authenticity and emotions. Italianity is spread through the name of the family itself that confers an additional sense of transmission of the manufacturing heritage along generations together with integrity and commitment. De' Longhi – which motto is "Better Everyday" - aims to be the global market leader in coffee, comfort and selected kitchen and homecare products providing consumers with high level of performance combined with style, engaging an international approach taking into consideration the differences among cultures and people.

Kenwood brand was born in 1947 with the aim to enjoy cooking thanks to the use of timesaving machines that could deal with the food preparation challenges, favouring creativity in the kitchen. "Feed your imagination" encourage consumers to embrace new adventures being confident to have the right products supporting them in the realization of the dishes they dreamed of. For this reason, the brand strength stands in the brilliant engineer enclosed in products, which gives them the possibility to deliver top-performance transmitting passion and joy.

The Braun brand – "Designed for what matters" – was founded in 1921 and provides a quality promises given its German origins, which promises quality, innovation and smooth experiences with products. Since 1957, Braun has won over 150 design prizes and its spearhead is the hand-blender product category. Its goal is to provide a daily and reliable help, with an intuitive experience conferred by its design.

Ariete – "The genius of the house" – was born in 1964 in Tuscany. Its value proposition is the one of delivering innovative technology with smart solutions for the home, together with creative design inspired by vintage looks. Its product categories range between kitchen, ironing and house cleaning.

Nutribullet is a different story, being the most recent acquisition of the Group and consequently still expanding in new markets. The motto "Nutrition made simple" perfectly express its mission to provide maximum nutrition with minimal effort. The product vary from personal and full-size blenders, juicers, a baby-dedicated line and

supplements and superfoods - ready-to-blend smoothies, plant-based proteins, and greens and energy, immunity, detox and fat burn boosts[202].

The Group's brands together enjoy a clear global leadership in its core product segments, contributing to the Group identity of "Everyday Makers". As it is represented in the following figure taken from the Group's corporate presentation released in 2022, 52% of total sales pertain to the coffee makers segment – mostly full automatic and capsule machines -, 28% to food preparation and 20% to homecare and comfort.

Figure 38 Business by products. Source: Corporate Presentation 2022.

4.2. Business model, vision and values

The Group presents its business model in the annual report. It is made of four cornerstones that explain the way in which the organization creates, capture and deliver value to its stakeholders. We can clearly see the importance and the pride that the company has for its manufacturing capabilities, placing importance on the quality on the entire supply chain from raw material to finished goods. The company boasts consistent standards across all factories, rigorous procedures to select suppliers, full traceability systems in place and superior standards of the food & beverage industry. Notice that the company has recently gained an acknowledgement from the World Economic Forum, which in September 2021 included the Italian plant of Mignagola in the "Global Lighthouse Network". This put together the production sites and value chains recognized as world leaders in the adoption and integration of cutting-edge technologies. The Group has « invested in digital and analytics to become more agile (reducing minimum order quantity by 92% and lead time by 82%) and more productive (improving labour productivity by

[202] De' Longhi Group, 'NutriBullet', 2022, https://www.delonghigroup.com/en/brand/nutribullet.

33%) and achieving high standard quality (improving field quality by 33% and obtaining Food and Beverage industry certification)[203]». Moreover, the Group placed an investment of more than 16 million euros in infrastructure to build its new headquarter and innovation centre. With the aim to strengthen the research and development function, the new building – risen from the ashes of the old factory burned in 2007 – is mainly meant to host the technical departments where innovation begins. The new offices and facilities mirror the incredible growth that the company was able to achieve in the last years. It will be completed in 2023, providing employees - the workforce amounted in 2021 to an average of 10.069 employees - with a great workplace and cutting-hedge research laboratories to ensure the quality and the safety of the De' Longhi Group products. Another remarkable step forward is represented by the first global campaign of the De' Longhi brand with Brad Pitt – and the actor and singer Hu Ge for the China region[204] - as ambassador for home coffee machines. The brand registered visits on the e-commerce site in the fourth quarter two times higher compared to the ones of the previous year. The noticeable results achieved confirm the right direction of this acceleration strategy of marketing and communication campaigns.

Figure 39 De' Longhi Group business model. Source: Annual Report 2021.

[203] 'Lighthouses Boost Sustainability with Fourth Industrial Revolution Transformation', World Economic Forum, September 2021, https://www.weforum.org/press/2021/09/lighthouses-boost-sustainability-with-fourth-industrial-revolution-transformation/.
[204] De' Longhi Group, 'Financial Annual Report at 31 December 2021', 2022.

The attention to its consumers is confirmed by the investments made in strengthening the e-commerce channel, which establishes a direct relation of the company with end-users of its products and that will be discussed in the later chapters. The business model is reflected in the strong vision of the company, which defines its long-term objective, summarizing the direction that the company wants to pursue in the long term.

«Worldwide, Every Day, by your Side

A desirable object, An emotion, An authentic experience

To be lived, To be shared.[205]*»*

As we can see from the statement above, the vision of De' Longhi is that of providing its customers with more than a product. The focus is on its emotional value, on the attachment that a consumer could have with an object that is part of its everyday life, which enriches it providing occasions to share with the others. Most important the "worldwide" hint reflect the ambition to give attention to all the different cultures and lifestyles in the markets served. In pursuing its long-term objectives, the Group has identified seven core values that guide the operation of people and projects: heritage, passion, courage, teamwork, ambition, competence and respect. It is straight to understand how these values mirror the importance placed in the quality of the product and in the human capital of the company, two fundamental elements for manufacturing companies to achieve success. The multiple awards received - ranging from design award, reddot winner, German innovation award and good design award - confirm products excellence. In Italy, several teams are fully dedicated to the New Product Development process, in order to feed the innovation on a continuous basis, together with the local research centres in the countries in which it operates.

4.3. Economic performance

The De' Longhi Group is a family public company, having three components of the De' Longhi family covering significant roles in the board of directors. The share capital is made up of 150,754,135 ordinary shares of par value €1.5 each, for a total of € 226,131,202.5[206]. Its leadership and expansion in the market is confirmed by the outstanding economic performance achieved in the last year. In 2021, the Group totalized

[205] 'Vision & Values | De' Longhi Group', 2022, https://www.delonghigroup.com/en/group/vision-values.
[206] As of July 16, 2021.

€3.2 billion of revenues, with a 37% growth compared to the previous year. This result is coherent with the growing trend that we can observe in the graph reported below, highlighting the Group's revenues for the period 2016-2021 and the related year-on-year growth. Higher volumes consequent to an increase in the market share have been fundamental to reach those results[207], together with improved efficiency in production and the ability to offset the negative impact of raw material cost and transportation increases with an effective pricing strategy. Coming to markets, 64.4% of revenues belong to Europe, 17.5% in the Americas, 12.4% in Asia Pacific and 5.7% in MEIA region[208].

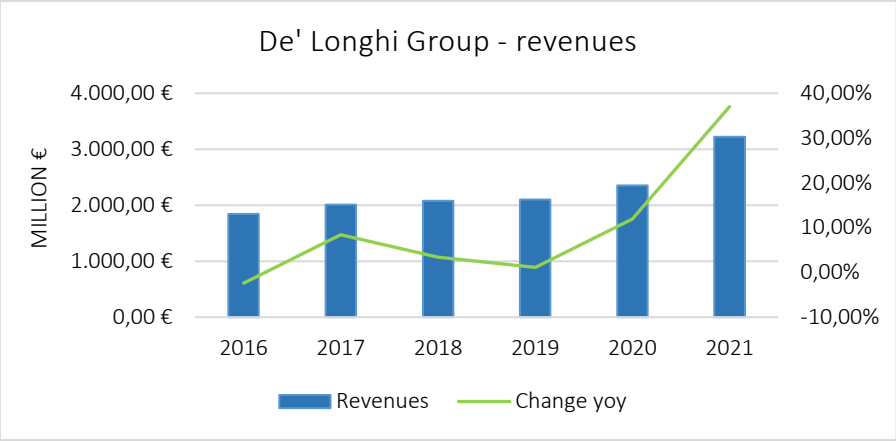

Figure 40 De' Longhi Group revenues for the period 2016-2021.

From the point of view of product lines, coffee machine and food preparation products recorded a double-digit in sale, while home care remained almost at the level of the previous year.

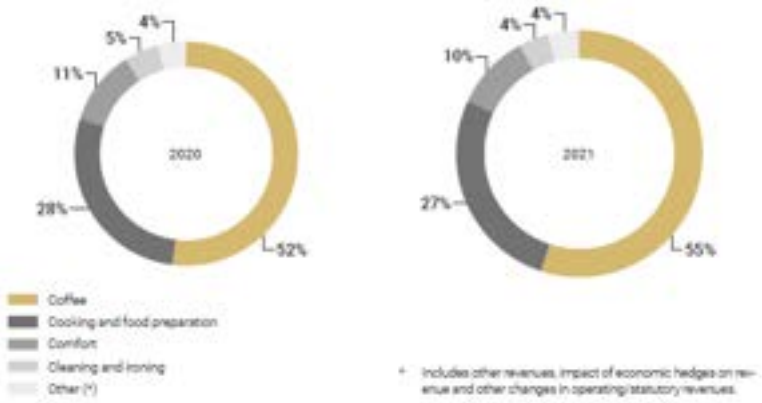

Figure 41 De' Longhi Group consolidated revenues by product category. Source: Annual Report 2021.

[207] De' Longhi Group, 'Financial Annual Report at 31 December 2021'.
[208] De' Longhi Group.

The coffee segment was responsible for the 55% of revenues – increased with respect to the 52% of the previous year – while cooking and food preparation the 27%. Comfort, cleaning and ironing have a weaker role covering the remaining 18%.

The leadership in the coffee segment is not only due to the exceptionality of the De' Longhi coffee machine, but is the result of a mix of ingredients that the company is able to deliver that makes it a complete sensory experience. It is the best time for De' Longhi to expand in this market especially with respect to regions out of Europe. The food preparation market is different: after a period of growth in the period 2009-2015, the line flattered up to 2020 when it showed the first recovery signs[209].

Going back to the financial performance, the following table highlight other key figures.

Table 4 De' Longhi Group key financial figures for 2021. Source: corporate website.

million €	2021	2020	2019	2018	2017	2016
Net industrial margin	€1.600,17	€1.157,05	€990,22	€990,7	€971,	€905,8
adjusted Ebitda	€514,95	€366,5	€295,32	€312,8	€309,5	€295,4
% of revenues	16,00%	15,60%	14,10%	15,10%	15,40%	16,00%
Ebit	€386,9	€262,01	€210,9	€242,9	€243,7	€239,
% of revenues	12,00%	11,10%	10,00%	11,70%	12,10%	13,00%
Profit (loss) of the Group	€311,1	€200,13	€161,	€184,7	€178,3	€167,4
Total net equity	€1.568,58	1.267,35	€1.190,45	€1.065,9	€1.021,7	€1.014,
Net financial position	€425,09	€231,99	€277,8	€228,1	€233,5	€307,6
Leverage Ratio (Net Debt / Ebitda) X	-0,88	-0,68	-0,96	-0,75	-0,77	-1,10

Over the last three years the Group invested over €750 million in advertising and promotion activities, more than €150 million in research and development activities and over €210 million of capital expenditure – used to buy, maintain or improve fixed assets such as productive plants and facilities, equipment, technology and many others. The Group's commitment to investments is significant in its industry, and the effort in continuous improvement permitted in 2021 to exceed the great results achieved in 2020 – a particular year considered the "stay at home" spending rebound caused by the covid-19 pandemic. This trend is furthermore confirmed by the already released results of first

[209] De' Longhi Group, 'The Group at a Glance -Updated as at October 2021 on the Basis of FY2020 Results', 2021.

quarter of 2022, which express a 8.4% revenues growth compared to the same period of the previous year – €678.7 million in 2021 and €735.5 million in 2022.

4.4. The De' Longhi Group operational and supply chain footprint

The De' Longhi Group counts on six manufacturing plants – and a plant in Joint Venture in China - located:

- 1 in Italy, in Mignagola di Carbonera which was converted in 2007 for the production of fully automatic coffee machines which still are its point of reference;
- 3 in Romania, one in the city of Satu Mare recently acquired in February 2021, the others in the cities of Cluj – acquired in 2013 and focused on fully automatics too - and Salonta – acquired in 2020 and specialized for Braun brand kitchen products;
- 2 in China, one in Dongguan which joined the Group back in 2001 together with the acquisition of the Kenwood brand to which food preparation products is dedicated, and in Zhongshan where cooking and comfort items are manufactured[210].

Along its whole production lines, the Group provide advanced and automated process for a perfect execution, the in-house manufacturing for all the strategic core products while exploiting the best-in class outsourced technologies.

Moreover, in September 2021 the Group – as already mentioned before – entered the Global Lighthouse Network, a prestigious community of manufacturers that have demonstrated leadership in the adoption of Industry 4.0 technologies to transform factories, value chain and business model promoted by the World Economic Forum[211]. The network is at the date composed of 103 manufacturers from different industries, with a special eye to the

Figure 42 Mignagola plant.

[210] De' Longhi Group.
[211] 'Technology and Innovation for the Future of Production', World Economic Forum, 2022, https://www.weforum.org/projects/global_lighthouse_network/.

matter of sustainability too. Agility, customer centricity, supply chain resilience, speed, productivity and eco-efficiency are common factors for the companies named in the list – such as Unilever, Henkel, Schneider Electrics and Ericsson.

Figure 43 Mignagola plant.

To maintain its leadership position based on the high standard quality of its products, De' Longhi faced the need to invest in digital and analytics in its productive process specifically for the Mignagola plant. The results achieved related to a reduction in minimum order quantity and lead time, several improvements in labour productivity and in field quality, other than havening obtained the Food and Beverage industry certification[212]. The digital transformation involved planning, procurement, manufacturing, logistics and asset management too, empowering employees to be more informed and productive[213].

Table 5 De' Longhi Plant Technologies and Impact. Source: WEF.

USE CASE	IMPACT
Digital-enabled flexible manufacturing	- 92% Minimum order quantity
Digital track and trace	- 7% Warranty repair cost
Quality improvement by predictive analytics	+ 30% Machine lifespan
Digital dashboards to monitor performance	+ 7% Asset utilization
Digitally enabled man-machine matching	- 5% Scrap

The Group partnered with SAP, which provided the IT software needed to pursue the digitalization journey implementing a standardized manufacturing platform. Moreover, the company implemented IoT automation technology to connect shop-floor systems, empowered employees with real-time information via mobile devices, provided the right

[212] 'Technology and Innovation for the Future of Production'.
[213] SAP, 'Italy's Leading Appliance Manufacturer Is Leveraging Industry 4.0 To Digitize Manufacturing', *Forbes*, 2020, https://www.forbes.com/sites/sap/2020/11/05/italys-leading-appliance-manufacturer-is-leveraging-industry-40-to-digitize-manufacturing/.

Figure 44 Mignagola plant.

reports to spread quality, performance, and maintenance information and designed and implemented new assembly and product testing processes[214]. About the last point, a great innovation pertain the new process of machines testing. Exploiting vision systems and digital-matching technologies - together with machine learning algorithms - no more coffee beans are needed in this necessary part to ensure the product functioning and quality. In this way, De' Longhi benefits of 10 tons of coffee beans saving per year[215], gaining economic advantages and improving the sustainability of its process. The commitment of the company towards sustainability is confirmed by the reduction of 7% of CO_2 emission for each unit produced in 2020 compared to 2019, together with the attempt to reduce the energy dependence on fossil sources.

The Group counts more than 10.000 employees, of which around 1.400 work in the productive plant of Mignagola. The company engaged digital transformation to make the most out of the personal skills of each of them too. The assembly lines in the plant dedicated to the Group's main product – coffee machines – employ about 800 people. To coordinate their work in the best possible way, the company implemented AWMS® an advanced workforce management system based on the cloud computing technology of SaaS. Artificial intelligence enables a proper human capital management that plans the right person in the right place at the right time, considering the production plan, the matrix of skills, the physical limitations of the workers and the risks of the workstations[216].

[214] SAP.

[215] Chiara Volonté, 'Tutto quello che c'è da sapere sullo stabilimento di De' Longhi premiato dal WEF', *Industria Italiana* (blog), 2021, https://www.industriaitaliana.it/de-longhi-mignagola-wef-riconoscimento-premio-industria/.

[216] Serena Guerra, 'A Workforce-Management Software Programme - De' Longhi's Digital Transformation', 2021, https://www.awms-system.com/en/blog/case-studies/a-workforce-management-software-programme-de-longhi-s-digital-transformation/.

For what concerns the supply chain, it involves more than 500 of people located in 35 different countries, with centralized functions at Group levels in Treviso, Romania and China. It manages around 40 warehouses across the world, some with the function of central hubs and others managed directly by the subsidiaries. Coming to suppliers, we can identify suppliers of standard and low technology components – which production is directly managed by the supplier without strict control from the Group – and suppliers of high technology components – that are critical components for the final product[217]. Moreover, the company relies on some contract manufacturers that are fundamental to exploit outsourcing possibilities. The supply chain function is organized in teams that work on the activities of demand planning, logistics and order management, supply chain technology and supply planning – with a split for Europe and China. The major challenges are the incredible growth reached at the Group level in the last years, the need of more accurate forecasts and to deal with macroeconomic trends. Then, the multichannel distribution with its diverse need increase complexity, considering the requirements coming from some customers that work at Pan-European[218] level, and lastly retailers working with less working capital. The goals of the team are to achieve a best in class service level by designing a customer driven supply chain, based on a responsive and resilient operating model that achieves efficiency thanks to automation and digitalization.

To this purpose, we have to consider the Customer Fulfilment Excellence program that is ongoing and that will bring the Group's supply chain to operate at a next level.

4.4.1. The use of technologies for the supply chain transformation: CFEx project

In order to enhance the Group competitiveness on the market adapting to changing times, and to support the entrance in the D2C e-commerce dynamics serving at the best consumers the De' Longhi Group have launched a program entirely dedicated to its supply chain transformation. The aim is to improve the customer service level through better product availability result of an enhanced S&OP process. The CFEx involves an international cross-functional team with experts from the head quarter, markets and plants that work to pursue this end-to-end transformation. Several factors make the

[217] Gioele Mazzon, 'Supply Chain Planning: De'Longhi Appliances Srl. Analysis and Improvements Supervisor' (Ca' Foscari University of Venice, 2017).
[218] Involving all or most of the nations of Europe.

Group's supply chain activity crucial and extremely challenging. In fact, together with external factors increasing complexity per se, the complex product-markets matrix of the Group's offer – composed by more than 120 markets and thousands of SKUs[219] - together with the presence of seasonal categories, the adherence to promotional events such as the Black Friday or Amazon Prime days and the multiple distribution channels makes planning a complex task.

To overcome challenges, the Group launched the implementation of a new integrated planning platform partnering with the software provider SAP. The chosen solution – SAP IBP or SAP Integrated Business Planning – is at the core of the Customer Fulfilment Excellence – CFEx – project that will revolutionise the business' supply chain dynamics enhancing its overall performance. As the name suggest, the goal is to reach a customer-centric supply chain that puts the customer satisfaction at the core maximising the service level. The global program revise the forecasting and planning processes[220] to make them more flexible to respond promptly to changing market requirements and to include automation to obtain more efficiency. Among the benefits of the new system, we find increased on-time delivery, forecast quality and enhanced supply planning thanks to a better capacity planning and procurement[221].

The end-to-end transformation will enable increased agility and a more effective decision-making available in real-time transparent information to stakeholders, thanks to the control tower function that ensures that the right people have at the right time useful data to support the decision-making process. The control tower favour visibility exploiting new technologies – such as AI and IoT – to make the data tell the story thanks to the help of meaningful key performance indicators.

Through the use of advanced forecast algorithms – that through machine learning integrates data such as weather conditions to combine them with other significant datasets on consumers - with the support of Amazon Web Services, the supply chain will be able to grasp the changes and the developments of the market in advance, reducing the

[219] Stock Keeping Unit, code used for inventory management to identify products and their attributes.
[220] De' Longhi Group, 'Financial Annual Report at 31 December 2021'.
[221] 'De' Longhi, La Supply Chain Estesa Che Mette al Centro Il Cliente', *Digital4* (blog), 2022, https://www.digital4.biz/supply-chain/de-longhi-la-soddisfazione-del-cliente-al-centro-della-supply-chain-estesa/.

impact of volatility on the business. Early signals permits to the company to react before time if production or inventory is not prepared to events.

The project is composed of two phases, the first ongoing one relates to the implementation of the new demand and supply processes. The second one will be focused on production scheduling and optimization of customer order management[222].

SAP IBP is a great technology innovation for the company, based on the cloud computing technology and on the on premise and cloud enterprise resource planning SAP S/4HANA. It is the revolutionizing tool that will permit to the Group to reduce its forecast error, being more responsive and enabling collaboration to better meet the needs of customers.

4.5. The launch of a D2C distribution through e-commerce

This section is devoted to the specific experience of the De' Longhi Group, with a focus on the recent strengthen of the D2C e-commerce business, that enhanced the Group's leadership in its operating segments.

The Group has historically competed through a B2B distribution system relying on wholesalers and retailers that sell its products serving more than 120 different markets in the three geographical regions of Europe, Asia Pacific and Americas, Middle East India and Africa. The digital channel – before 2020 – was exploited mainly through the subsidiaries and retailers e-commerce without a consolidated headquarters central administration. The Group's products are presents in the most important marketplaces too, mainly Amazon for Europe and Alibaba in China, which management does not pertain to the D2C sphere given that the products are sold by the marketplaces that are full-fledged B2B customers of the Group. In 2020, the company has invested a considerable amount of resources on its own D2C e-commerce channel in order to create a direct relation with its end-consumers and to bridge a gap in terms of digitization of its information systems that was present compared to competitors. The intervention aimed at delivering an ever-increasing quality of the consumer journey, in the two directions of omnichannel and phygital – to provide its customers with a seamless experience that combines both physical and digital channels in an integrated way. The project was led by the current Head of Global eRetailer and eCommerce of the De' Longhi Group together

[222] 'De' Longhi, La Supply Chain Estesa Che Mette al Centro Il Cliente'.

with Portaltech Reply as a partner and a support in the implementation phases. The task was the redesign of the previous group's websites - for the brands De' Longhi, Kenwood, Braun and Nutribullet - on SAP Commerce Cloud provider, combined with a shift from a focus on the enhancement of technical characteristics of products to an engaging storytelling with an immersive user experience. Moreover, the customer care service gained a considerable weight and has been improved and enhanced in this new version of the Group's online presence. This change has been planned in line with the new marketing and communication strategy, which sees Brad Pitt as the global ambassador for the De' Longhi brand[223].

The online D2C e-commerce development plan of De' Longhi Group had a perfect timing considered the pandemic due to the COVID-19, that has forced the majority of businesses to rely mainly on their online channels while rethinking their ways of doing business. The dramatic situation that have seen several months of lockdowns around the world turned in the impossibility to sell in physical shops and in severe supply chains disruptions. In this context, companies who were able to overcome difficulties and enhance their online business were the only ones registering growth. Around 70% of global manufacturers stated that they generated more than 40% of their sales with e-commerce revenues in the month of March 2020[224]. Given the external environment, the De' Longhi Group's e-commerce has seen a considerable acceleration and an exponential growth, definitely marking the importance of channels' diversification and the power of the strategic vision chosen before.

The De' Longhi Group's e-commerce is configured, following a BCG's classification, as a "Bolt-on brand.com" archetype, which establish a direct relation with end-consumers that expands the presence in the market already consolidated with the B2B channel[225].

[223] 'Digitale e storytelling: come De' Longhi rende più coinvolgente l'esperienza dei suoi clienti', *Forbes Italia*, 9 December 2021, https://forbes.it/2021/12/09/de-longhi-digitalizzazione-storytelling-customer-experience/.
[224] Episerver. "B2B e-commerce revenues as share of global manufacturer sales as of March 2020." Chart. April 28, 2020. Statista. Accessed March 28, 2022. https://www.statista.com/statistics/452236/b2b-e-commerce-sales-share-of-us-manufacturers/
[225] Alex Baxter et al., 'Building a World-Class E-Commerce Organization', *BCG Global*, 7 December 2021, https://www.bcg.com/publications/2021/build-world-class-e-commerce-organization.

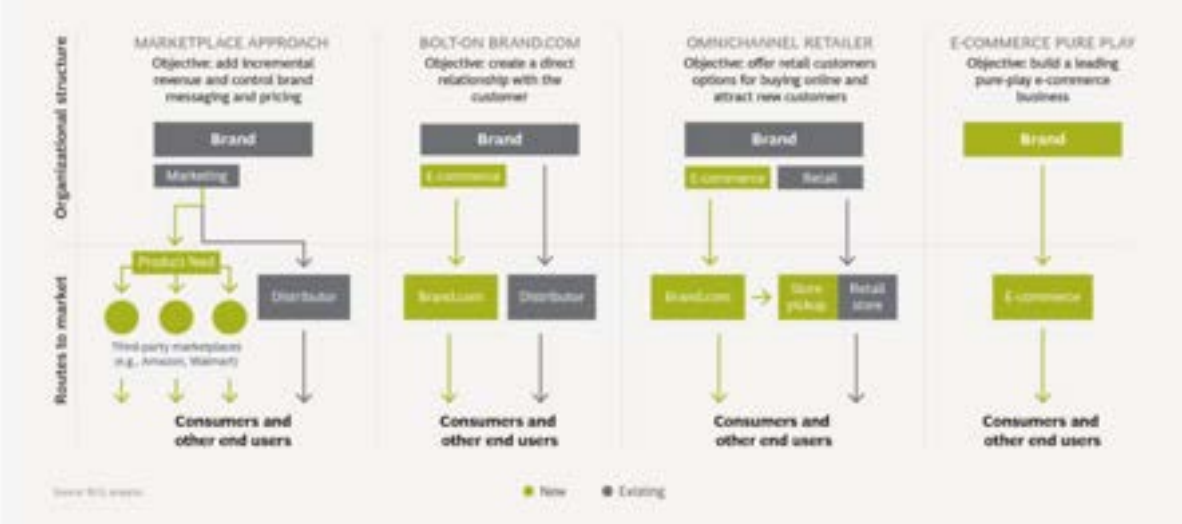

Figure 45 Four archetypes for an e-commerce organization. Source: BCG publications.

At the date, there isn't any type of integration among physical and online channels that would configure the Group's distribution as a real "omnichannel". The Group does not own physical shops – nor in the form of directly operated stores, nor in the form of franchising – and the only way for consumers to purchase physically the product is going to the retailers brick and mortar stores. Omnichannel is a path for those who have the ambition, the product range and the capabilities to have both physical and digital stores. Small domestic appliances sector rarely present brand-stores contributing in a high percentage to the total sales – in most of the case have marketing purposes to get in contact with consumers widening their shopping experience while increasing brand awareness. The frequency and size of purchase favour multichannel and not omnichannel, together with complexities in stock management and logistics that discourage the vertical integration.

Going back to our case, approximately 30 "Delonghees" with specific skills and capabilities compose the e-commerce team based in Italy, performing cross-functional activities and configuring it as a "business inside the business". The hearth of the organization is based in the Treviso headquarter, where the De' Longhi brand is fully managed, but every country in which the Group operates is managed by a local team following the country-specific activities and products.

To perform a situational analysis, we will proceed with the De' Longhi Group's D2C e-commerce SWOT analysis.

Figure 46 2 De' Longhi Group D2C e-commerce SWOT Analysis.

The brand's reputation gives to the D2C channel the possibility to leverage on the reliability gained through a consolidated market presence, results of continuous work in research and development and in an expansion through worldwide markets. The brands are in this sense a great strength for both the offline and online channel, together with the product quality that is distinguishing the global leading player from its competitors. The wide product range in the segments of coffee machines, kitchen, air conditioning and home care permits to the company to serve several segments of consumers, while offering to them multiple alternatives to find the best one to satisfy their needs. Another internal-generated strength is represented by the amount of investments made by the Group – in total €132.3 million in 2021[226] – that are signal of great potential in the company's growth, and part of which dedicated to communication activities of which the e-commerce benefits.

The technology of the user interface (UI) is another factor that, thanks to the shift to the new e-commerce platform, is playing in favour of the D2C channel complementing the user experience on the website. Both the visual and the interaction designs are user friendly and good-looking, meeting customer's expectation and in line with the De' Longhi Group's brand excellence.

[226] De' Longhi Group, 'Financial Annual Report at 31 December 2021'.

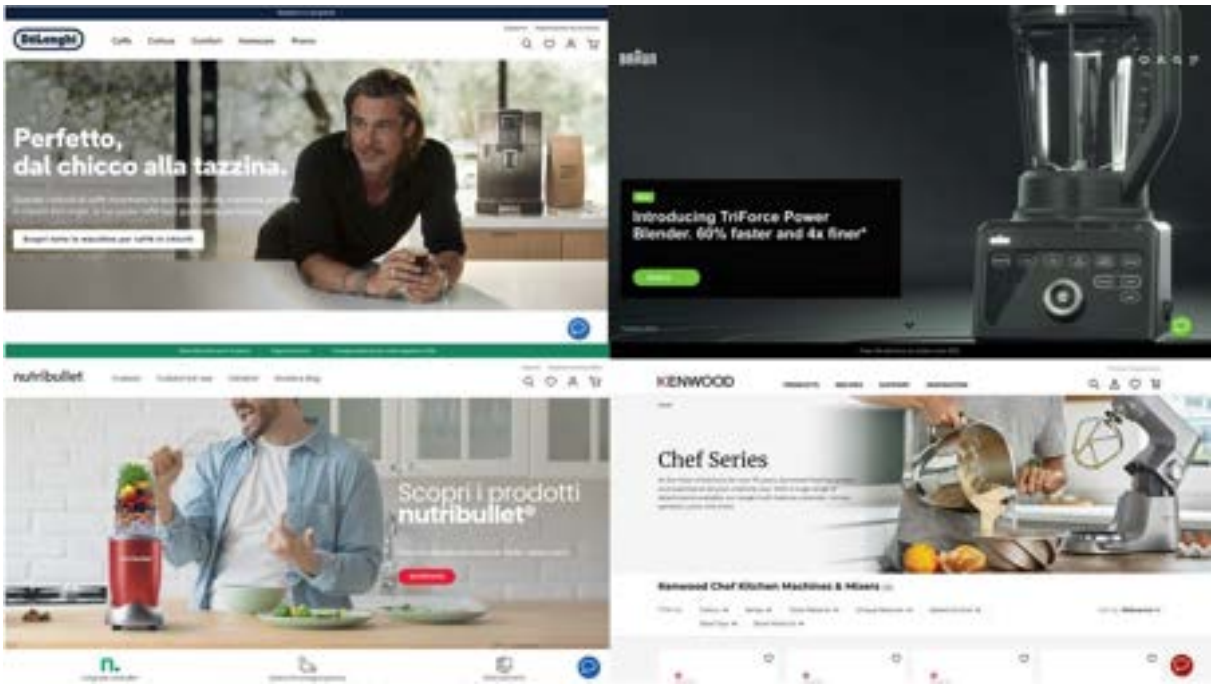

Figure 47 Homepage of De' Longhi, Braun, Nutribullet and Kenwood e-commerce.

Moreover, the configuration of the websites is made in accordance with an informative approach: the e-commerce platforms serve not only as a shop and a showcase, but here customers find a precious source of information on products: technical data, instructions manual and moreover suggestions on recipes to enjoy at the best the products.

Among the weaknesses of the Group's D2C channel, we have the late introduction with respect to competitors that are relying on their online channels from a longer time. This configures as a sort of disadvantage in the measure in which companies are benefitting from learning economies that takes time and practice to be developed. Moreover, the De' Longhi Group's e-commerce is not – at the date – offering alternative delivery options such as in store pickup or alternative delivery points, nor is in any form integrated with the physical channel. The omnichannel business model is already consolidated in the market and the phygital will be expected in the shopping experience of the consumer of the future.

Opportunities can be found in the already existing consumer base of the Group, on which the e-commerce can work to strengthen loyalty and increase customer retention and customer lifetime value. The amount of data collected through the online channel can bring the company to elevate its CRM effectiveness. A great opportunity is then offered by the possibility to sell on the online channel customized products– not easily viable in physical shops – in accordance with customer's needs and preferences, expanding the

product portfolio and providing a wider offer. Customization is a high value added activity, on which D2C manufacturer can invest to gain market share without slip into direct competition with retailers. Looking at external related environment, there is the outstanding market trend of the coffee segment that sees rising forecast for the next years. The coffee market is expected to increase at a compounded annual growth rate until 2025 of 2.0% in Europe, 3.8% in the Americas and 5.5% in Asia[227]. The growth in the coffee industry is at the centre of the Group's strategy, and the coffee segment accounted for 52.1% of the total sales of the Group in 2020 given by sales of espresso coffee machines for household. Lastly, new technologies offer a big opportunity for De' Longhi Group's e-commerce, which could take advantage of 3D visualization and augmented reality to deliver a better perception of products to the users.

Threats are represented mainly by external related factors. First, the supply difficulties emerged with the pandemic and following events, related both to transportation and to electronic component shortage, which caused difficulties in stock's availability and lost sales. Then, conflicts with retailers are a possible threat, since the e-commerce is not conceived to apply price leadership strategies, but retailers can decide to put in place promotions for which consumers will decide to prefer the physical channel of indirect distribution. Another factor to consider are cyber-attacks, dangerous both for customer's sensitive data, which are protected by plenty of regulations, and for the whole organization.

[227] Statista, 'Consumer Market Outlook', 2022.

CONCLUSIONS

In this work, we have looked at the supply chain to understand the impact that the digitalization, the new distribution channels and new technologies had and continue to have on a business and strategic level. What emerged is that - considered the era of uncertainty we are experiencing and the shift to customer centricity – the supply chain processes definitely have a key role in ensuring competitiveness in the market. An efficient planning not only permits the availability of products and the avoidance of lost sales, but also brings several costs reduction and time savings. For this reasons companies are striving to enhance their supply chain resilience, agility and responsiveness to cope with the pressure levels to which they are currently exposed and gain significant competitive advantage.

The recurring crisis brought businesses to some important considerations given the disruptions induced by the pandemic and geopolitical disorders of the last years, specifically with reference to manufacturer of consumer goods. First, the importance of reducing the level of dependency from their previous locations decisions, having readily alternatives to consider when the crisis emerges. Those could refer to alternatives in supply sources, production possibilities, and distribution routes. However, managing a complex network require superior capabilities, considering the other objectives that must be pursued simultaneously.

Secondly, the awareness on the value provided by establishing a direct relation with customers through the online distribution channel – that during the pandemic has been providential for both companies and consumers. However, the implementation of the direct to consumer e-commerce channel for a historically B2B oriented company entails some additional complexity in supply chains due to the different dynamics of the D2C distribution. Once again, mastering the supply and operations planning process is the only way to unlock value and achieve outstanding results.

Companies leader in the markets are the ones who exploited technologies in their businesses gaining strategic advantage. New technologies in particular permit a margin of improvement in some critical areas of supply chain processes and can enhance the supply chain management effectiveness. Companies that will grasp this potential not only

will be able to survive in the market but also will conquer a significant competitive advantage witnessed by tangible outcomes. Considering the results achieved by first movers who already saw benefits, we expect a new season of improvements and impact among all the industries. While cloud computing and internet of things are fundamental provider of the advanced systems and big data – supplying the raw material essential for the others to work – artificial intelligence capabilities and the predictions possible through complex simulation models called digital twins give to companies insights that they would not be able to find otherwise. Those are critical skills especially in relation to the volatility characterizing markets. The far and wide discusses blockchain has still lot to explore but already found its place in enhancing transparency in supply chains through smart contracts.

For what concerns the implications for the De' Longhi Group, as an observer I had the pleasure and the honour to appreciate how the Group reap the rewards of its effort in improving under the technological aspect in all its different shades. Specifically, the great job made in the Italian productive plant of Mignagola bring the company to be recognized by the World Economic Forum in the Global Lighthouse Network. The company demonstrated high resilience in overcoming the hard times of the last years, staying at the forefront of its business. It is also a great example of making the most out of their resources and obtaining incredible results.

The Group's supply chain is passing through an end-to-end transformation journey that will permit to shift completely to a customer-centric point of view, in which the demand forecasting activity is based on machine learning outcomes that exploit the data collected. With the cloud computing capabilities that will be provided thanks to the project, the company is posing the base to plenty of future applications starting from the use of the amount of data available thanks to the new direct-to-consumer e-commerce channel.

The De' Longhi Group is the perfect representation of a company in step with the times which already leverages technologies in an interesting way. There are some development possibilities that could be considered to enhance the Group's supply chain effectiveness. A digital twin could provide several benefits to the complex organization – that manages six productive plants, several warehouses and hubs and a wide supply network – exploiting IoT sensors already installed in some of the machinery of the production plant. From what emerged from the research conducted, the implementation could take time

and be costly but the benefit are tangible. The company could consider the participation to a blockchain private network too, to enhance transparency that could be exploited both with respect to supply chain network – and of which could benefit the internal organization – and with respect to external stakeholders to certify the authenticity of the supply chain – regarding ethics and sustainability matters – and the quality of products to consumers.

In conclusion, companies have no choice other than to embrace the opportunities offered by the Fourth Industrial Revolution being conscious that technologies are the only key to survive and emerge in this increasing complex world, finding their strategic applications and reaching through them excellence.

LIST OF FIGURES AND TABLES

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