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BUSINESS MODEL AND SUSTAINABILITY:

**THE CASE OF AQUAPONICS SYSTEM RIGHT
SOLUTION FOR A SUSTAINABLE FUTURE**

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ABSTRACT

The term “Business Model” was used for the first time in 1957. Over the decades, many definitions of BM have been developed; the most shared one sees it as a simplified and aggregated representation of the relevant activities of a company.

Over the years, the external environment has been changing continuously, forcing companies and organizations to innovate their BM, resorting to digital technologies.

Nowadays, the environmental pressures forces companies and organizations to leave the current linear economy productive system, leading them toward the adoption of “Circular Economy model”- a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste and pollution, based on principles of *waste and pollution’s elimination, circulate materials and products and regenerate nature*. In the next future, companies and organizations will face many challenges; one of the most important will be meeting the world demand for food. Considering that, the traditional agriculture is no more a sustainable solution due to its environmental impact, new and innovative systems need to be developed. In this meaning, aquaponics systems might represent the right solution for a sustainable future. Thanks to smart technologies, the combined aquaculture and halophyte farming (farming of saline tolerant plants) system, as demonstrated by the Aqua-combine project developed in 2019, might generate

incredible environmental, economic and social advantages. Not only around Europe, but around the world, these systems are finding a larger and larger adoption by companies and organizations, which, through the design of successful business model canvas, are achieving significant circular advantages.

ABSTRACT

Il termine “Business Model” è stato utilizzato per la prima volta nel 1957, ottenendo un indirizzo in campo economico soltanto nel 1975. Nel corso dei decenni, sono state elaborate innumerevoli definizioni di Business Model; ad oggi, secondo la definizione maggiormente condivisa, il Business Model è una semplificata e aggregata rappresentazione delle attività principali di un’azienda. Nel corso degli ultimi anni, l’ambiente esterno è in continuo mutamento, costringendo le aziende e le organizzazioni ad innovare i propri Business Model, attraverso tecnologie digitali. Ad oggi, le pressioni ambientali spingono sempre più le aziende ad abbandonare l’attuale sistema produttivo di “Economia Lineare”, in favore del modello di Circular Economy- un sistema di soluzioni che affronta le sfide globali come il cambiamento climatico, la riduzione di biodiversità o inquinamento, basato su principi di *eliminazione dell’inquinamento, riciclo dei materiali e prodotti e rigenerare la natura*. Nel prossimo futuro, le aziende saranno chiamate ad affrontare numerose sfide; una delle più importanti sarà sicuramente soddisfare la domanda mondiale di cibo. Considerando che la tradizionale agricoltura non rappresenta più una soluzione sostenibile a causa del suo impatto ambientale, bisogna sviluppare nuovi sistemi innovativi. In questo senso, i sistemi di acquaponica possono rappresentare la giusta soluzione per un futuro sostenibile. Grazie a tecnologie smart, i sistemi di acquacoltura, combinati con la coltivazione di piante

tolleranti alla salinità del terreno, come dimostrato dal progetto Aqua-combine, possono generare importanti vantaggi dal punto di vista economico, sociale e ambientale. Non solo in Europa, ma in tutto il mondo, questi sistemi stanno trovando una sempre più larga adozione da parte di aziende e organizzazioni, le quali, attraverso lo sviluppo di Business Model Canvas di successo, stanno ottenendo importanti vantaggi circolari.

INTRODUCTION

Business Model has always played a crucial role in companies and organizations' success. Introduced for the first time in 1957, only in 1975, it got an economic address, achieving the exploitation in '90s thanks to the E-Commerce Boom. Over the decades, many authors and researchers have developed innumerable definitions of BM; today, one of the most shared definitions states that BM is a simplified and aggregated representation of the relevant activities of a company; it describes how marketable information, products and/or services are generated by means of a company's value-added component.

However, BM as always conceived until now might be no more a proper tool to ensure the success due to the increasing competition, higher environmental unpredictability and more and more demanding customers; these factors have been forcing companies and organizations to apply innovations and changes to their BM. This is the reason why, nowadays we talk about *BM Innovation*. In addition, a growing world population and lower resources' availability make companies and organizations more and more vulnerable to environmental challenges and higher sustainable pressures. Companies are called to design Sustainable Business Models, resorting to important tools such as the SBM Archetypes, the Triple Layer BM and Digitalization to provide sustainable solutions, reducing their own footprint.

Therefore, the new environmental scenario force businesses to leave the current linear economy productive system- based “extracting resources-producing-throwing them away” principles- and adopt the circular economy model - a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste and pollution, based on principles of *waste and pollution’s elimination, circulate materials and products and regenerate nature*. Many successful Circular business models have been developed to achieve the circular advantage, such as the *Circular Chain Business Model*; the *Recovery and recycle Business Model*, the *Extension of the life cycle’s product” Business Model*; the *“Sharing Platform” Business Model* and the *“Product Service System” Business Model*.

In this meaning, “Aqua-combine project” represents an innovative Circular Business Models developed by a Consortium of 17 partners; the project aims to provide circular solutions by combining aquaculture and halophyte farming (farming of saline tolerant plants) by a complex and precise mechanism. Here, waste is almost eliminated, due to the capacity of transforming plants’ residues in biogas and bio-chair, cosmetics and feed production.

Renowned studies and analyses clearly certificate the success of aquaponics systems and, in general, of Circular Economy under environmental, economic and social aspects.

CHAPTER 1

BUSINESS MODEL, INNOVATION AND SUSTAINABILITY

1.1 Business Model: the concept and its origins

In recent years, Business Model has gained an increasing importance in both business and scientific research. Indeed, today, the Business Model can be seen as a management tool that is crucial to the success of a company or organization. This is mainly because it has become more linked to gaining and keeping a competitive advantage. However, this was not always the case. Bellman was the first person to use the term "business model" in an article in 1957. At first, it was used in a very general way. Only in 1975, Konczal suggested using business models as tools for management.

A real turning point for the concept of BM was the development of technology and, in particular the rise of electronic businesses. More specifically, during the boom of e-commerce in the 1990s, recent improvements in communication and information technologies, like the Internet's rapid growth and the big drop in the cost of computers and phone calls, have made it possible to find new ways to create and deliver value. In fact, these changes have made it possible for businesses to change fundamentally how they organize and conduct business transactions, both within and across firm and industry boundaries.

In this scenario, the business model concept was first used to explain complicated business ideas to potential investors quickly (Zott et al., 2011).

Today, the business model is no longer viewed as a basic operational plan to produce a proper information system; rather, it has evolved into an integrated presentation of the company's organization in order to aid in decision-making processes. In recent years, it appears that a more consistent concept of the business model has developed; in fact, more and more authors agree that the business model represents the entire organization and not just a subset of it. Moreover, there is a strong consensus on the purpose and role of a business model, increasingly as a future-oriented strategy tool and as a tool to implement the strategy in a coherent manner. For this reason, a business model can be viewed as a bridge between future planning (strategy) and operational implementation.

Over the years, many authors have tried to explain what the term "business model" means. Even though they agree on some of the main points, it is important to look at the differences between the different definitions. Magretta (2002) says that a business model is "how business is done." In particular, a business model shows not only how a company makes money, but also answers basic questions like "Who is the customer?" and "What does the customer value?"

Business models can be seen as simplified versions of an organization's value proposition, value creation and delivery, and value capture, as well as the links between these parts.

It talks about how businesses can propose, create, deliver, and take advantage of value (Richardson, 2008; Teece, 2010). A business model can be thought of as an "activity system" that shows how a company is built. It shows what the most important business

tasks are, how they are set up, and who is in charge of them. It can be in the form of a template, like the "business model canvas" by Osterwalder and Pigneur.

Eriksson and Penker (2000), for example, see the business model as a way to show in a clear and concise way how all the different parts of a company work together. Both Treacy and Wiersema look at the Business Model in a similar way, but they pay more attention to how the different parts of a company work together and how they affect each other.

Shafer et al. (2005) say that a Business Model is focused on creating value and making money off of that value, while a model is just a representation of reality. Some authors, such as Wirtz (2002), also define BM as a streamlined and consolidated view of a company's most important activities. This shows how the value-added part of a business creates information, products, or services that can be sold. In addition to the architecture of value creation, strategic as well as customer and market factors are taken into account to meet the goal of creating or, more precisely, securing the competitive advantage. Therefore, a business model should always be looked at from a dynamic point of view, with the knowledge that internal and external changes may require adaptation or new ideas over time.

Analyzing the relevant components is a relevant phase of getting a clear idea of what a business model is. There is a general agreement in considering *strategy* as an important component of making a business model, sort of like a map. At the same time, both *material and immaterial resources* are often seen as important parts. A business model's core assets are the company's internal and external resources, skills, and abilities. Moreover, *networks*, which are different and mostly external interactions of the business model, and *partnerships* can have a big impact on how a company creates value and

should be thought of as part of the business model. Literature also talks a lot about how important customers are. The customer model shows all the relevant offers, and the market offering model can include the value proposition, competitors, and the whole market structure. At the same time, the *revenue model* is also often talked about as a key part.

1.1.2 Business model representations

Zott and Amit: A View from the Activity System

In 2001, Zott and Amit defined a business model from the point of view of an activity system. So, a business model can be thought of as "a system of activities that depend on each other and go beyond the main firm." The activity system lets the company make money and get a piece of the money it makes. An "activity system" is a group of interdependent organizational activities that revolve around a central company. All of these things are done by the main company, its partners, customers, and so on. The business model and how a business works are shown by the activity system design. The main goal of a company's business model is to take advantage of a business opportunity by making money for everyone involved and meeting customer needs. In particular, businesses must evaluate two sets of parameters: the "design elements" (content, structure, and system) and the "design themes" (novelty, lock-in, complementarities, and efficiency), which describe the sources of value creation within an activity system.

Design elements are made up of three parts: content, structure, and governance. They describe the architecture of an activity system, which shows how a company fits into its environment and who its suppliers, partners, and customers are. "Activity system content" refers to the activities that are chosen. "Activity system structure" describes

how the activities are linked (for example, in what order they happen) and shows how important the business model is based on whether it is at the center, on the edges, or somewhere in between. Who runs the activities is part of the activity system's governance. For example, one way to manage a system of activities is through franchising. "Activity system governance" is a term that refers to who does the activities. In this sense, franchising is one way that activity system governance can be done. To sum up, activity system design describes how businesses run and gets to the heart of what the business model is all about.

The second important set of parameters is the themes in design, which are newness, lock-in, complementarity, and effectiveness. Newness: At the heart of novelty-centered activity system design is the use of new activities, new ways to link the activities, and new ways to control the activities. In this sense, Apple could be a well-known example. It used to be focused on making new hardware, but with the development of the iPod and the iTunes music download business, Apple became the first electronic company to offer music distribution as a service. This was made possible by linking the development of the iPod's hardware and software to the iTunes music download business.

Lock-in is a company's ability to keep third parties interested in its business model. Lock-in can show up as switching costs or network externalities that are caused by the structure, content, or way of running the activity system. For example, in eBay's activity system, customers do most of the marketing and sales activities (sellers). What keeps them so interested, keeps them doing these things, and keeps them from switching to a different service provider? One important thing is that the eBay activity system has positive network externalities built in. With so many potential buyers, sellers know they

are more likely to make a deal at a good price on eBay than anywhere else is. Therefore, they keep coming back, which means they cannot leave.

–Complementarity is when putting two or more things together in a system is better than running them separately.

–Efficiency: Efficiency-centered design is a way for companies to make their activity systems more efficient by lowering the costs of transactions. For example, a focal firm may decide to integrate vertically to avoid being "held hostage" by its trading partners, who may have a reason to take advantage of a co-dependency situation.

In reality, the activity system approach has a number of benefits. For example, it encourages the company to build its business model with a systemic and holistic mindset instead of focusing on individual decisions. It also gives a lot of room for further theoretical development and improvement. We could look more closely at how organizational actors come up with activities. We could also look into the social aspects of the relationships between the people in a business model, in addition to the transactional ones.

Osterwalder and Pigneur: the Business Model Canvas

Alex Osterwalder and Yves Pigneur made this strong model in 2010 to help people fully understand what a company offers. Business Model Canvas, or BMC, is the most popular and important way to show the parts of a Business Model, the possible connections between them, and the effects of generating value, as well as to capture new

ideas. As a visual aid, the BMC can help with discussions, debates, and looking into what could happen.

It has nine parts: customer value proposition, customer segmentation, customer relationship, channels, key resources, key activities, partners, costs, and revenues.

1. Type of Customer A customer segment is a group of people or businesses that want to be able to reach and be served by a business. Royan (2014) says that a customer segment is a group of people who help a company make money by buying its products.

2. Value Proposition The value proposition block shows how products and services work together to create value for a certain customer segment. Value proposition can resolve The Use of... (Ariya T. Puspayuda and Rico S.J. Jaya) 34 Jurnal Ilmu Manajemen, Volume 18, Nomor 1, 2021 customer problems or meet customer needs. Kotler and Keller (2016) said that a company's value proposition is made up of all of its benefits that go beyond the core positioning of the offer.

3. Channels The block of channels shows how a business talks to its customers and reaches out to them to give them a value proposition. Wladyslaw and Szopa (2012) say that a channel is a group of people in an organization whose job is to connect a business and its customers through the delivery of goods or services.

4. Getting along with customers The block of customer relationships shows the different kinds of relationships that businesses can build with different types of customers. Royan (2014) said that the goal of customer relationships is to make a new relationship with new customers, keep old customers, and offer old and new products or services to both old and new customers.

5. Sources of Income The revenue streams block shows how much cash each customer segment brings in. There are two types of revenue streams in a business model: the

revenue from transactions that come from one customer's payment, and the revenue from ongoing payments that either give customers something of value or help them with their past purchases.

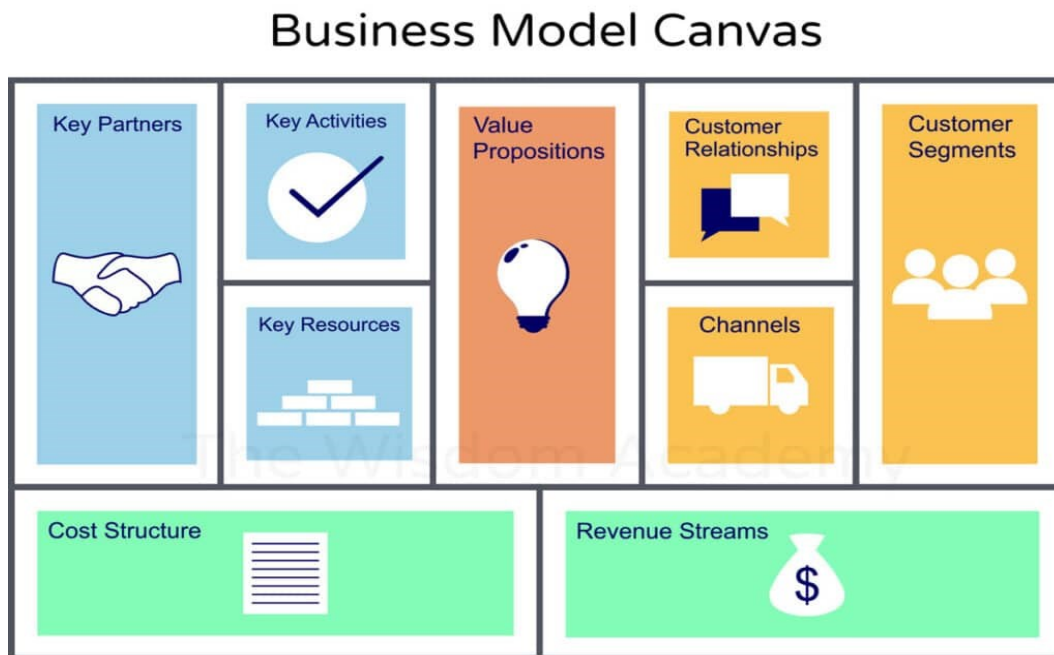
6. Important Sources For a business model to work, the block of key resources is the most important asset. Key resources are needed for every business model. The company's resources allow it to create and offer a value proposition, reach the market, keep in touch with a customer segment, and make money. Primary resources can be things, money, knowledge, or even people.

7. Main Things to Do The block of key activities lists the most important things that a company must do for its business model to work. For a business model to work, it needs a number of main activities. These are the most important things that a business needs to do to run well. Main activities are also needed to make and give a value proposition, get to the market, keep customers happy, and make money.

8. Key Alliances The supplier network and partners that make the business model work are shown in the block of key partnerships. A partner is a business entity that affects the pros and cons of a company (Horton et al, 2009). A business forms a partnership for a number of reasons, and the basic structure of a partnership depends on the business model.

9. Cost Structure The block of costs shows all the costs that a business model needs to run. This section talks about the most important cost of running a certain business model. Osterwalder and Pigneur (2012) say that there are two types of cost structure: lowering costs and adding value.

Figure n. 1.1: Business model Canvas



Osterwalder, Pigneur (2012).

1.2 Business Model Innovation

However, the traditional Business Model as we have conceived it until now might be no more a proper tool to guarantee firms and organizations' success due to the astonishing changes that are characterizing the last two decades. Indeed, according to both practice and theory, the global economy of the 21st century will be complicated, hard, full of competitive opportunities and threats, and getting more and more chaotic and unpredictable. Shorter product life cycles, faster and more unpredictable changes, an explosion of data and the need to turn it into useful information are all factors. Joseph

Gorman, the CEO of TRW, says that regional economies and industries are becoming global, which is a big change. Businesses will have to compete in a completely new environment if they want to stay in business and make money. The environment has been pretty stable and predictable over the past few decades, especially compared to how it is now and how it is expected to be in the 21st century. In the past, change was often seen as a straight line and the majority of important competitors were from the same country, not from other countries. Today, in the global economy, business deals are becoming the most important factor in how countries treat each other. Today, goods can be sent to any part of the world in just a few days. Communication happens right away, and the time it takes to make and sell a new product has never been shorter. In some high-tech fields, six months is the norm. The global economy has created a new competitive environment in which things change all the time and cannot be predicted. Most of these changes are revolutionary, not just incremental, and they affect almost every part of an organization at the same time. Revolutionary changes cause uncertainty, ambiguity, and breaks in continuity, which forces firms and their strategic leadership to speed up how they make decisions and put strategies into action.

It is easy to understand how all these revolutionary changes create serious challenges for companies and organizations wanting to business and, at the same time, maintaining the same Business Model developed in the past. This is the reason why, academics and practitioners are emphasizing the need rethink the existing Business Model, through a deep innovation.

Business Model innovation (BMI) is when companies change how they create, deliver, and capture value to get customers to pay for it and turn this into profits (Baden-Fuller and Morgan, 2010; Teece, 2010). It is seen as a key activity for large multinational

corporations (MNCs) to stay competitive (Baden-Fuller and Morgan, 2010; Robins, 2013; Wirtz et al., 2016; Zahra et al., 2006; Zott et al., 2011), leading to new customer offerings and revenue streams (Chesbrough, 2010; Massa et al., 2017).

BMI refers to changes in the most important parts of a company's business model (BM) or to the architecture that ties these parts together in a structured, new, and nontrivial way (Foss and Saebi, 2017). In substance, BMI is a way for companies to make changes to the activities and functions of their BMs and look into new architectural designs. It involves looking into new ways to create, distribute, and capture value for customers, suppliers, and partners (Casadesus-Masanell & Zhu, 2013; Gambardella & McGahan, 2010; Kraus, Filser, Puumalainen, Kailer, & Thurner, 2020; Amit and Zott, 2012). Business models Innovation might concern a single aspect of a business model, modifying numerous elements concurrently, or altering the relationships between elements of a business model are all viable avenues for innovation exploration. Kiron et al. (2013) discovered that businesses that combine customer focus with value chain innovations and alter one or two other aspects of their business models are more likely to profit from their sustainability efforts. Additionally, they discovered that businesses that alter three to four parts of their business models likely to profit more from their sustainability initiatives than those who alter only one element. However, changing the original BM, on the other hand, comes with a lot of risk, ambiguity, and uncertainty. BMI does not automatically lead to good performance; it can be very good or very bad for the performance of a company or organization. Depending on how well the BM is put into place, a company can grow a lot or go out of business. Therefore, it is important for firm managers and owners to know how and when to change a BM (Hartmann et al., 2013). In particular, it might be a good idea to look at the mediators and moderators that

help firms turn BMI into better performance (Guo et al., 2017). Recently, BMI scholars have been thinking about how growth in efficiency, growth in revenue, and organizational capabilities can act as *mediating factors* to achieve high performance through innovation.

Regarding the organizational capabilities, different BMs may need different organizational resources and skills. Ordinary capabilities allow companies to make and sell their value propositions, such as routines for new product development, quality control, knowledge transfer, and performance measurement (Eisenhardt and Martin, 2000). However, if they want to look for and take advantage of opportunities and change their business processes and models to fit the new business environment, they need something more (Foss and Saebi, 2015). This is similar to what Teece (2007) said about *dynamic organizational capabilities*, which he defined as "the firm's ability to integrate, build, and reorganize internal and external competences to deal with rapidly changing environments" (Teece et al., 1997). The history, values, and routines of a company shape its capabilities, which can be unique to that company (Teece, 2012). This makes it hard for competitors to copy the company's BM. Teece (2007) put a company's dynamic abilities into three groups of tasks and processes: sensing, seizing, and transforming. Our organizational capabilities mediator group makes it easy to connect these three groups:

(1) "sensing," which is defined as "identifying and evaluating opportunities," can be matched with "opportunity recognition" and "innovativeness" in our mediator group;

(2) "seizing," which is defined as "mobilizing resources internally and externally to address opportunities and capture value from doing," can be matched with "entrepreneurial orientation";

(3) "transforming," which is defined as "continued renewal of the organization," can be matched with "continuous renewal of the organization" The organizational culture, which is made up of core beliefs and where values play a central role (Philip and Mckeown, 2004), can either encourage change and entrepreneurship or lead to organizational inertia, which is bad for the organization's performance. This is why we argue that BMI is often closely related to the transformation of an organization that is done to make sure that the expected performance is achieved. Therefore, a fundamental change in the organization's culture is needed for a successful organizational transformation (Audzeyeva and Hudson, 2016, p. 32), and this is closely related to BMI. Researchers have found a number of important things that can be thought of as organizational capabilities. First of all, the ability to come up with new ideas is one of the most important things that can help a business do better (Burns and Stalker, 1961; Porter, 1990). In today's tumultuous business world, a company can do better if it comes up with new ideas. Second, an organization's culture, which is made up of its standards, values, and beliefs, can make people act in ways that improve business performance (Hult et al., 2004). When certain attitudes are reflected in an organization's culture, the effects are spread across situations, groups, and people within the organization. It is hard to copy a culture that supports the implementation of a strategic plan and encourages the enthusiastic participation of all employees. This can help create a competitive advantage that lasts (Anning-Dorson, 2017). Third, Hult et al. (2004) found in a study of 181 firms that market orientation and entrepreneurial orientation, which come from BMI, have a positive effect on innovativeness and, through that, on the performance of the business. In their empirical research, Hult et al. (2004) found that being innovative seemed to be a key mediator. This can be done in different ways within a company, such as by telling

everyone about the business idea, getting better at looking for opportunities, and making real value propositions. Consequently, BMI can contribute to innovativeness (Bouwman et al., 2018a). Fourth, there may be a link between BMI and performance and the ability to look for opportunities. Several studies have focused on the role of BMI in how people look for opportunities (Chesbrough, 2010; Dewald and Bowen, 2010). The logic of how firms create, deliver, and capture value is shared with the whole organization and all of its networks, and stakeholders actively look for new opportunities for the firm.

Mahmood and Hanafi (2013) have shown that an entrepreneurial mindset is a resource and skill that gives a firm a competitive edge and a big boost in performance. Several studies looked at how corporate entrepreneurship directly affects how well a company does (George and Bock, 2011; Karimi and Walter, 2016; Miller, 2011). Lastly, organizational learning is one of the most important ways that information and knowledge can be processed within an organization. It can change an organization's attributes, behaviors, capabilities, and performance (Cohen and Levinthal, 1990).

Because of this, we suggest that organizational capability be added as an alternative mediating factor between BMI and firm performance. Organizational skills like innovativeness, opportunity recognition, organizational learning, and culture can help owners, managers, and employees excel at the scanning, learning, and creating that are needed to find new technological and market opportunities (Foss and Saebi, 2015).

Organizational capabilities like "opportunity recognition" and "organizational learning" (Leih et al., 2015) make it easier for a firm to coordinate its resources and use them in the best way possible. This lets the firm look for and take advantage of opportunities and synchronize its business processes and models (Teece et al., 1997). These skills give the firm the freedom to make the necessary changes and adjustments both inside and

outside of its ecosystem. Leih et al. (2015) say that learning capability can help firms find and deal with market challenges better, faster, and cheaper than their competitors. It can also help firms come up with new ways to serve customers in new or existing markets.

1.3 Sustainable Business Model and Archetypes

1.3.1 Sustainable Business Model

There are more outside factors than the ones already mentioned. With the possibility of a growing global population, faster global growth, and a corresponding rise in resource use and damage to the environment, it is becoming more and clearer that doing business as usual is no longer a good option for a sustainable future. According to Global Footprint Network, we are currently using the same amount of resources as 1.5 planets. It means that every year, we use 50% more resources than those that earth is able to regenerate. This indicator is called “ecological footprint”. According to the predictions, by 2050 we will need the equivalent of three planets to satisfy the demand.

It is easy to understand that the usual business is no more a possible solution; companies and organizations must adapt or even change their current business models through the adoption of sustainable perspectives. Roome and Louche (2007) looked closely at the organizational changes that led to more sustainable business models. Peter Wells said that the architecture, principles, and parts of the current business model need to be analyzed in detail in order to understand how these adaptive and transformational processes work. In 1987, the World Commission on Environmental Development said

that sustainable development is "development that meets the needs of the present without hurting the ability of future generations to meet their own needs."

On the organizational level, the vision of sustainable development has inspired the concepts of "sustainability management," "corporate sustainability," "sustainable innovation" and "sustainable entrepreneurship" as well as "*sustainable business model*."

"Sustainable management" refers to approaches that integrate social, environmental, and economic concerns in order to reform organizations so that they contribute to the sustainable development of the economy and society within the boundaries of the ecosystem.

Business models for Sustainability or Sustainable Business Models (SBMs) assist in describing, analyzing, managing, and communicating a company's sustainable value proposition to its customers and all other stakeholders; how it creates and delivers this value; and how it captures economic value while preserving or regenerating natural, social, and economic capital beyond the organization.

A sustainable business model can facilitate the coordination of technological and social breakthroughs with system-level sustainability. Sustainable business models are business models that include proactive multi-stakeholder changes; the multi-stakeholder nature of sustainable business models has been taken into account in two of the elements: the focus on the customer and the monetary value of the value capture element.

Ludeke-Freund describes the SBM as a "business model that creates competitive advantage through superior customer value and contributes to a sustainable development of the company and society."

The use of the term Sustainable Business Model is referred as this capacity of firms to contribute to global sustainable development and all the challenges regarding economic, social and environmental interconnections together with short, medium and long term aligned and conflicting demands.

It is useful to analyze the most important components of a Sustainable Business Model: sustainable value proposition, sustainable value creation and delivery and sustainable value capture.

-Value proposition: In the context of SBM, "value proposition" refers to stakeholders other than the "classic" customer, such as investors/shareholders. But when talking about the idea of sustainable value, firms are pushed to think about other stakeholders like employees, trade associations, suppliers, governments, non-governmental organizations, communities [24], as well as the environment and society [3]. From this point of view, a company can be considered successful if the companies that help it and the infrastructure around it are also doing well.

Using the stakeholder theory and the fact that the value proposition is what the firm has to offer, the firm's sustainable value proposition is put together based on the needs and wants of internal and external stakeholders. Still, it's not always easy to align the goals of different stakeholders, because sometimes those goals are in conflict with each other. So, the challenge is to find ways to run a business that are both good for the company and good for the people who have a stake in the company. This means trying to make everyone happy in the short term and in the long term. In the literature, these kinds of benefits are called shared values, win-win solutions, or sweet spots.

-Sustainable value creation and delivery: This part of SBM is about business processes. In this case, the management of business processes should take into account not just

economic drivers, but also social and environmental ones. The company can count on its tangible and intangible capabilities and resources to make these things happen. Corporate sustainability are pushed to develop certain skills and resources, such as the ability to change a company's business model, the technology to make sustainable products and processes, responsible and sustainable leadership, and the reputation of corporate sustainability, among others. Van Kleef and Roome (2007) looked at the research and came up with a list of specific skills that are needed for innovation for sustainability. These skills are system thinking, learning, integrating business, society, and the environment, coming up with different dynamic business models, networking, and building collaboration. Given how important stakeholder management is in the sustainable value proposition part of SBM, the network and alliance capability is an important capability to manage and improve. This includes working together with partners for joint research and development and with suppliers to find ways to balance business needs with the needs of the community.

-Sustainable value capture: Even if a business comes up with a good value proposition, makes it, and delivers it, that doesn't mean it will be successful if it doesn't capture this value. In traditional writings about business models, this part is called the cost structure and revenue streams. When it comes to the sustainability of a business, economic results are not enough to make sure that value is captured in a sustainable way. This is because sustainable development is about collective axiological goals. In other words, it is about creating value for the firms and their internal and external stakeholders, taking into account both short-term and long-term effects. In this way of thinking, TBL performance indicators like those proposed by the Global Reporting Initiative (GRI) are a way to measure how firms affect the economy, the environment, and society. For

example, investments in eco-efficiency can bring value to the firm (by reducing the costs of production inputs like raw materials, energy, and water), the environment (by reducing the depletion of natural resources and promoting their conservation), and society (by helping people get the most out of what they have) (reducing health problems due to less pollution and emissions). One important thing to do to make sure sustainable value capture is to talk about the firm's effects in the right way. If a company's sustainability performance is shared in the right way, it may affect how consumers choose to buy from that company. In this way, sustainability reporting can be a useful tool for making clear the benefits for a business's stakeholders. Also, sustainability reporting can make the stock market more fair, especially when it comes to environmental technical reports [46]. Assessing not only the value that is currently being captured, but also the firm's sustainable value that is being missed or lost, can give SBM interesting ideas for how to improve.

1.3.2. Sustainable Business Model Archetypes

Archetypes of a sustainable business model are used to describe groups of mechanisms and solutions that could help build a sustainable business model. The goal of these archetypes is to create a common language that can be used to speed up the research and practice of building sustainable business models. The archetypes are: maximize material and energy efficiency; create value from "waste;" replace with renewables and natural processes; deliver functionality instead of ownership; take on a stewardship role; encourage sufficiency. Change the business to help society or the environment, and come up with solutions that can be used on a larger scale. The archetypes are categorized into higher-order categories that describe the three primary types of business

model innovation: technological, social, and organizational. This expands on Boons and Lüdeke Freund's (2013) categorization, which was determined to be the most useful in defining descriptive groupings. The technical grouping consists of archetypes with a dominant technical innovation component (e.g. manufacturing process and product redesign); the social grouping consists of archetypes with a dominant social innovation component (e.g. innovations in consumer offering, changing consumer behavior); and the organisational grouping consists of archetypes with a dominant organisational innovation change component (e.g. changing the fiduciary responsibility of the firm).

1- Maximise material productivity and energy efficiency:
This archetype includes ideas like "lean," "eco-efficiency," and "cleaner production," which try to make better use of resources and lessen waste and pollution by redesigning products and processes. This archetype tries to reduce the damage that industry does to the environment by reducing the need for energy and resources. This cuts down on the need for primary extraction and resource depletion, and it cuts down on waste and pollution (waste to land-fill, CO₂, and other polluting emissions). Examples Lean manufacturing is a well-known philosophy that looks for waste in production processes and tries to cut it down as much as possible (Shah and Ward, 2003; Melton, 2005). Waste in this situation includes not only physical trash and wasted energy, but also over-production, handling of materials, over-processing, inventory, mistakes, and rework.

2- Create value from 'waste':

The idea of "waste" is eradicated by transforming waste streams into useful and valuable inputs for other operations and by maximizing underutilized capacity. This archetype aims to reduce the environmental impact of industry by reducing the continuous demand

for resources, by closing material loops and using waste streams as useful inputs for other products and processes, thereby reducing the demand for primary extraction and resource depletion, as well as landfill waste and emissions. This archetype thereby helps to greater resource efficiency. Examples Industrial symbiosis is a process-oriented strategy that converts waste outputs from one process into raw materials for another process or product line (Ayres and Simonis, 1994; Chertow, 2000). The industrial park in Kalundborg is one of the best-known examples of industrial symbiosis (Chertow, 2000). Closed-loop business models (Winkler, 2011) include products and business processes that are built so that waste from a product's end-of-use phase can be used to generate new value.

3- Substitute with renewables and natural processes

Reduce environmental consequences and strengthen company resiliency by addressing the resource restrictions and "limits to growth" associated with nonrenewable resources and present production methods. This archetype is based on ideas of humanity's ability to exist within present resource restrictions, either through utilizing renewable resources more effectively or by drawing inspiration from natural processes. This typology tries to lessen the environmental effect of industry by the replacement of renewable resources and natural processes to produce significantly more environmentally friendly industrial operations. It adds to the larger objective of conserving the planet's limited resources and minimizing waste and pollution.

4- Deliver functionality, rather than ownership:

Give users services that meet their needs so they don't have to buy physical products. This archetype is based on the research on Product Service Systems (PSS) and Servitisation (e.g., Goedkoop et al., 1999; Tukker, 2004), which looks at how

companies change their business model from selling a manufactured product to selling a combination of products and services. Even though the product is still important, the customer experience is the most important part of the value proposition or offering. This archetype is about moving a lot toward the pure service model, which means delivering functionality on a pay-per-use basis instead of selling ownership of a product. This archetype could change how people use things, especially by making it less important to own things. Also, it could give manufacturers an incentive to make products that last longer and can be upgraded or fixed, which could reduce the amount of resources used.

5- Adopt a stewardship role: Proactively engaging with all stakeholders to ensure their long-term health and well-being. This archetype seeks to maximise the positive societal and environmental impacts of the firm on society by ensuring long-term health and wellbeing of stakeholders (including society and the environment). Through their business models, firms actively seek to contribute to sustaining and developing the well-being of their value networks. To In doing so, this archetype contributes partially towards the systemic objective to create a flourishing society and planet (Jackson, 2009).

6- Encourage sufficiency: Solutions that try to cut down on production and consumption. This is what the sufficiency archetype tries to fix by looking at sustainability from the point of view of sustainable consumption. When making a sufficiency-based business model, it's important to reframe the value proposition so that it works better for a wider range of stakeholders in a company. Also, the sufficiency approach should guide how advertising, sales, and growth goals should be used. Examples Energy Saving Companies (ESCOs) help businesses and public buildings use less energy and get paid based on how much they save (FORA, 2010). In the household

energy sector, utility companies are paid subsidies to help their customers use less energy. Both the producer and the consumer have financial reasons to use less energy (Loughran and Kulick, 2004).

7- Re-purpose the business for society/environment:

Prioritizing delivery of social and environmental benefits rather than economic profit (i.e. shareholder value) maximization, through close integration between the firm and local communities and other stakeholder groups. The traditional business model where the customer is the primary beneficiary may shift. This archetype focuses on the changing fiduciary duty and structure of a firm for social and environmental (rather than economic and shareholder) benefits maximization of an organization and groups concepts that collectively see firms integrating more fully with their stakeholders. On a systems level, this archetype could contribute to changing the fundamental purpose of businesses to deliver environmental and societal benefits, and therefore drive global, economy-wide change.

8- Develop scale-up solutions:

Delivering sustainable solutions on a large scale to help people and the environment as much as possible. This archetype is made to think about how business models for sustainability can grow and be used by many people. Approaches like franchising (Dant et al., 2011) and licensing, which are well documented, may allow for fast replication with localized adaptation and financing, without the founders having to pay for and run all operations themselves. Peer-to-peer models, crowd-sourcing (Brabham, 2008), and open innovation are all types of collaborative models that can be quickly scaled up (Bocken and Allwood, 2012; Chesbrough and Crowther, 2006). All of these try to bring

together like-minded people, businesses, and investors to promote the adoption of business ideas. They have the potential to drastically change how people around the world buy things and how things are made.

However, archetypes are not the only useful tools able to help firms in developing sustainable business models; indeed, also the *triple layered business model* and *digitalization* play a key-role in this meaning.

1.4 Triple Layered Business Model

Archetypes are not the only useful tools able to help firms in developing sustainable business models; indeed, also the triple layered business model plays a key-role in this meaning. It is seen as a practical tool for coherently integrating economic, environmental, and social concerns into a holistic view of an organization's business model. The Triple Layer Business Model Canvas (TLBMC) represents a powerful tool that bridges business model innovation (Zott et al., 2011; Spieth et al., 2014) and sustainable business model development (Boons and Lüdeke-Freund, 2013) to support individuals and organizations in creatively and holistically seeking competitive sustainability-oriented change as a way to address the challenges facing us today (Azapagic, 2003; Shrivastava and Statler, 2012). More precisely, The TLBMC builds on Osterwalder and Pigneur's (2010) original business model canvas, which is a popular and widely used tool for supporting business model innovation. It does this by explicitly integrating environmental and social impacts through additional business model layers that align directly with the original economic-focused canvas. The TLBMC is a useful and easy-to-use tool that helps come up with, visualize, and talk about creative ways to

make business models more sustainable (Stubbs and Cocklin, 2008). It has been found that the TLBMC helps users quickly visualize and talk about existing business models, point out data and information gaps, and think of creative ways to improve business models that are more clearly focused on sustainability. The layered format of the TLBMC made it easier for users to understand and show how organizations' current actions and their economic, environmental, and social effects are connected and related to each other. By making environmental and social canvas layers as direct extensions of Osterwalder and Pigneur's (2010) original economic-focused business model canvas, each canvas layer provides horizontal coherence within itself and also connects across layers, giving a vertical coherence or a more holistic view of value creation, which integrates a view of economic, environmental, and social value creation throughout the business model.

First, as a multi-layer business model canvas, the TLBMC offers a clear and relatively easy way to visualize and discuss a business model's multiple and diverse impacts. Instead of attempting to reduce multiple types of value into a single canvas, the TLBMC allows economic, environmental and social value to be explored horizontally within their own layer and in relationship to each other through the vertical integration of these layers together.

Second, the TLBMC provides a concise framework to support visualization, communication and collaboration around innovating more sustainable business models (Boons and Lüdeke-Freund, 2013).

1.4.1 Environmental layer

The main objective of the environmental layer of the TLBMC is to appraise how the organization generates more environmental benefits than environmental impacts. Doing

so allows users to better understand where the organization's biggest environmental impacts lie within the business model; and provide insights for where the organization may focus its attention when creating environmentally oriented innovations. We have nine components to consider:

1. *-Functional value*: it describes the focal outputs of a service (or product) by the organization under examination. It emulates the functional unit in a life cycle assessment, which is a quantitative description of either the service performance or the needs fulfilled in the investigated product system (Rebitzer et al., 2004).

2. *-Materials*: The materials component is the environmental extension of the key resources component from the original business model canvas. Materials refer to the bio-physical stocks used to render the functional value. For example, manufacturers purchase and transform large amounts of physical materials, whereas service organizations tend to require materials in the form of building infrastructure and information technology.

3. *-Production*: The production component extends the key activities component from the original business model canvas to the environmental layer and captures the actions that the organization undertakes to create value. Production for a manufacturer may involve transforming raw or unfinished materials into higher value outputs. Production for a service provider can involve running an IT infrastructure, transporting people or other logistics, using office spaces and hosting service points.

4. *-Supplies and outsourcing*: Supplies and out-sourcing represent all the other various material and production activities that are necessary for the functional value but not considered 'core' to the organization. Similar to the original business model canvas, the distinction here is between is considered core versus non-core to support the

organization's value creation. This can be considered in terms of actions which are unique to the organization and support its competitive advantage and those actions which are necessary but not unique (Porter, 1985) and may also be conceived of as those actions which are kept in house versus those which are outsourced, though this can be not strictly accurate.

5. *-Distribution:* as with the original business model, distribution involves the transportation of goods. In the case of a service provider or a product manufacturer, the distribution represents the physical means by which the organization ensures access to its functional value. Thus within the environmental layer, it is the combination of the transportation modes, the distances travelled and the weights of what is shipped which is to be considered.

6. *-Use phase:* the use phase focuses on the impact of the client's partaking in the organization's functional value, or core service and/or product. This would include maintenance and repair of products when relevant; and should include some consideration of the client's material resource and energy requirements through use. Many electronic products incur use phase impacts when charging a device and using an infrastructure needed to support the network of users. This can outweigh production impacts (Nokia, 2005).

7. *-End-of-life:* End-of-life is when the client chooses to end the consumption of the functional value and often entails issues of material reuse such as remanufacturing, repurposing, recycling, disassembly, incineration or disposal of a product. From an environmental perspective, this component supports the organization exploring ways to manage its impact through extending its responsibility beyond the initially conceived value of its products.

8. *-Environmental impacts*: the environmental impacts component addresses the ecological costs of the organization's actions. While a traditional business model often summarizes organizational impacts primarily as financial costs, the environmental impacts components extends that to include the organization's ecological costs.

9. *-Environmental benefits*: similar to the relationship between environmental impacts and costs, environmental benefits extends the concept of value creation beyond purely financial value. It encompasses the ecological value the organization creates through environmental impact reductions and even regenerative positive ecological value. From a sustainability perspective, this component provides space for an organization to explicitly explore product, service, and business model innovations which may reduce negative and/or increase positive environmental through its actions.

1.4.2 Social layer

A key point of using the social layer of the TLBMC is to extend the original business model canvas through a stakeholder approach to capture the mutual influences between stakeholders and organization.

This layer seeks to capture the key social impacts of the organization that derive from those relationships. Doing so provides a better understanding of where are an organization's primary social impacts and provides insight for exploring ways to innovate the organization's actions and business model to improve its social value creation potential. The nine components of social layer are described below:

1. *-Social value*: social value component refers to the organization's mission, which focuses on **creating benefits for its stakeholders** and society more broadly. For sustainability-oriented firms, creating social value represents a clear part of the mission.

Actually, even more profit-oriented organizations consider value creating potential beyond simply financial gain.

2. *-Employee*: employee's component provides a space to consider the role of employees as a core organizational stakeholder. A number of elements might be included here, such as the number and types of employees, the silent demographics – such as variation pay, gender, ethnicity and education within the organization. There are important discussions in how organization's employee-oriented programs contribute to the organization's long-term viability and success

3. *-Governance*: governance component captures the organizational structure and decision-making policies of an organization. In many ways, governance defines which stakeholder an organization is likely to identify and engage with and how the organization is likely to do so. Organizations can vary widely based on several aspects of governance including ownership, internal organization structures and decision-making policies. Each of these points can influence how an organization may engage stakeholders in creating social value.

4. *-Communities*: while economic relationships are built with business partners, there are social relationships built with suppliers and their local communities. These two stakeholders come together as communities when aligning the three layers of the TLBMC. When interacting with communities, an organization's success can be greatly influenced through developing and maintaining mutually beneficial relationships. If an organization has one or multiple facilities located in the same geographical area, then there may be only one local community. If an organization has facilities in different countries, it is important to consider each community as a different stakeholder with different cultural needs and realities.

While organizations have tended to focus more on the community where they have headquarter, organizations should consider all communities where its facilities are important. Individual suppliers might have more or less influence over an organization- they might be also critical as they provide the organization with critical resources necessary to support its success.

5. *-Societal Culture*: societal culture component recognizes the potential impact of an organization on society as whole. Considering a business cannot succeed when society fails, this component leverages the concept of sustainable value to acknowledge an organization potential impact on society and how, through its actions, it can positively influence society. NGOs represent another element that can be included in the societal culture space as they carry social agendas through their influence on business.

6. *-Scale of outreach*: the scale of outreach describes the depth and the breadth of the relationships an organization builds with its stakeholders through its actions over time. This may include the idea of developing long term, integrative relationships and the outreach of impact geographically; as well as an organization's impact in how and whether it addresses societal differences such as locally interpreting ethical and cultural and countries.

7. *-End-users*: the end user is the person who consumes the value proposition. This space is concerned with how the value proposition addresses the needs of the end-user, contributing to his/her quality of life. Users with similar needs have typically been segmented based on relevant demographics. Importantly, the users is not always the customer as defined in the economic layer of the business model canvas.

8. *-Social impact*: social impact component addresses the social costs of an organization. It complements and extends the financial costs of the economic layer and

the biophysical impacts of the environmental layer. Although there is a growing body of work on social impact measures, there is not yet a consensus on what social impacts to consider, nor how to quantify them. Some of the most common indicators as provided by Benoit include working hours, cultural heritage, health and safety, community engagement, fair competition, respect of intellectual property rights.

9. *-Social benefits*: social benefits are the positive social value creating aspects of the organization's action. This component is for explicitly, considering the social benefits, which come from an organization's actions. Social benefits can be measured using a broad range of indicators

1.5 Digitalization and Sustainability

In the last few years, digital technologies like the Internet of Things have become so common in manufacturing and servitization that a growing research stream has started to look at how digital technologies enable service development. This research stream is called digital servitization (DS) and consists in the use of digital tools for transformational processes that help a company switch from a product-centric business model and logic to a service-centric one. DS represents a relevant driver of innovation for manufacturers' business models (Suppatvech, Godsell, & Day, 2019; Kohtamaki, Parida, Oghazi, Gebauer, & Baines, 2019).

Recently, DS is more and more often associated with the notion of sustainability (e.g. Kohtamaki et al., 2019; Paschou et al., 2020). In the "industry 4.0" (I4.0) paradigm, technologies like Internet of Things (IoT), cloud platforms, and big data enable service-oriented, digitalized and sustainable BMs, make companies able to design and implement more effective and efficient value propositions (Bouncken, Kraus, &

RoigTierno, 2021). In the last few years, the connection between digital technologies and sustainability has grown so strong that George and his co-authors (2020) came up with the term "*digital sustainability*" to describe all "organizational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data." George et al. (2021) say that digital sustainability is "the organizational activities that seek to advance the sustainable development goals through creative deployment of technologies that create, use, transmit, or source electronic data." Briefly, research on digital sustainable entrepreneurship looks at how digital technologies can be used to help entrepreneurs start and run businesses that are good for the environment (Gregori & Holzmann, 2020).

Paschou and her co-authors (2020) report that there are several benefits of such phenomenon for society and the environment: reduction in energy consumption, less environmental impact, a positive impact on social sustainability, delivery of value for the entire society, and the building of sustainable production processes.

In order to understand better how DS affects sustainability, the researchers M.Paiola, F.Schiaone, R.Grandinetti and J.Chen did a careful analysis. They looked for business-to-business (B2B) manufacturing companies with headquarters in Italy that were working on IoT-related projects and offering new B2B services. After a lot of contacts, meetings, and interviews between the end of 2016 and the beginning of 2017, the authors of the empirical research focused on two industries that are getting more pressure to improve their environmental sustainability. First, the packaging industry is under pressure from regulators and customers to be more socially and environmentally responsible (Verghese, Lewis, & Fitzpatrick, 2012; Sumrin et al., 2021). Second,

commercial refrigeration is under a lot of pressure to cut down on waste, save energy, and be more environmentally friendly - about 3% of the electricity used in the EU comes from the food retail stores sector. In particular, 35% of EU-27 CO₂-eq emissions from refrigerants are caused by commercial refrigeration.

For these reasons, the selected firms have increased their attention to the enabling effect of technologies for new programmes and initiatives aimed at progressively reducing the environmental impact and to improving efficiency in the use of resources, both at the plant and at the product level (Ben-Daya, Hassini, Bahroun, & Banimfreg, 2021).

Companies A and B are in the packaging business, and they make packaging machines in particular. Both have a strong reputation for quality, innovation, and customer service that has been around for a long time, and they are leaders in their respective industries. The production requires a large amount of energy, downtimes problems, and Maintenance, Repair, and Overhaul (MRO) are the most expensive parts of an equipment's annual Total Cost of Ownership (TCO), which can be between 6% and 10% of the price of the equipment.

Companies C and D are the top ones when it comes to designing, making, and installing complete retail equipment. Both of them are focused on making furniture for global leaders in food retail. Their products last up to 10–15 years, and on average, 75% of the TCO is spent on energy. The use of digital and green servitization in the selected firms has led to the creation of a technologically advanced PSS the incredible effects of sustainability on the customers' processes.

Company A has taken a technological approach to help customers with applications and solutions that help to help, maintain, and solve plant problems remotely, reduce average downtime and Mean Time to Repair (MTTR), improve Overall Equipment

Effectiveness (OEE), speed up installation, commissioning, and debugging, and track the location, flow, and conditions of the equipment. The most important part of the offer is a multi-device application for IoT-enabled remote access to production dashboards. This allows the tracking, analysis, and visualization of indicators, metrics, and key points of plant performance, which helps the customer monitor the overall efficiency of the machine, plant, or process. It gives users automatic tips and suggestions to fix any problems with efficiency and to make changes to procedures that can improve efficiency and effectiveness. This is done to avoid unwanted stops, machine underuse, major failures and energy waste.

Company B has made a customized PSS for one of its most important customers. This allows it to remotely monitor and control operations and their performance, reducing downtime and improving lead time while lowering material and energy use. It is a full cloud-based platform for managing machines that are connected to each other. It includes a virtual assistant based on Natural Language Processing that makes it easy to get production data and sends reports automatically. The system connects machines to computers and keeps track of all performance and maintenance data. It is the foundation of a full-service system. performance-based contract (PBC) that keeps customers' efficiency rates high: from the beginning of 2016 to the end of 2019, the supervised plant had an overall line OEE of above 90%, up from 75% before. The system monitors more than 200 parameters per line in real time, reacting quickly to even the smallest problem and collecting valuable data about how the machine is used. This makes it possible to keep the same level of efficiency for a longer period of time (up to 16–20 years; TCO is about 6%). With more control over the plant, the overall energy consumption index for the key customer has gone down from 3.87 to 3.68. Company D

has also looked into a solution for a large customer in the food and beverage industry that needed a way to manage a large fleet of mobile refrigerated devices for soft drinks. D's Research and Development division for plug-in devices has chosen a digital solution that uses IoT technologies a lot to find out where the device is, how well it is working, and what other alarm data is important for it. D analyzes the data coming from the distributed devices and gives the customer's sales and field service organizations the information they need to manage the multi-located devices, improve the rate of use, reduce energy use, lower maintenance costs, and find and replace devices that have been stolen or lost. They use IoT telemetry to connect to retail e-commerce platforms, and they use state-of-the-art data hardware and software infrastructures (like fiber and 4G) to allow remote condition monitoring and after-sales support. This makes sure that operations keep going and that problems are fixed in a timely manner 24/7. This technology improves the efficiency of plug-in devices by an average of 10% of the total amount of energy used each year, and it cuts the costs of wasted materials and broken devices by 15%.

The empirical study shows that manufacturers' new digital services have positive effects on the long-term health of their clients. In fact, the smart digital applications that the sampled companies offer can have a big impact on the overall efficiency of a customer's processes, helping them use less energy, make better use of resources, and waste less materials and consumables. These benefits are a result of products being watched and controlled in real time and all the time. The study also adds to the growing body of research on digital sustainability and sustainable BMI (Evans, 2017; Geissdoerfer et al., 2018; George, Merrill, & Schillebeeckx, 2020) by showing how manufacturing firms in highly resource-intensive sectors use DS and change their business models and value

networks to offer customers, among other things, positive outcomes and benefits related to sustainability.

1.5.1 Digitalization and Sustainable Development Goals (SDG)

The relationship between digitalization and Sustainability has been made even stronger by Sustainable Development Goals.

What are the SDG? In the last few of decades, environmental deterioration and social conflicts have placed countries under immense pressure, with population growth and rising per capita consumption serving as the primary drivers. 193 countries signed the United Nations Sustainable Development Goals for 2030, often known as the so-called SDGs, in September 2015 in response to these kinds of demands. In 2000, the UN member states reached an agreement on global development when they agreed to the so-called Millennium Development Goals (MDGs). These goals were meant to drive global development from 2000 to 2015.

The MDGs focused on eight key areas: poverty, education, gender equality, child mortality, maternal health, disease, the environment, and global cooperation.

MDGs were successful in many ways, and they are now known as the most successful global effort to fight poverty in history. Governments, international groups, and civil society groups from all over the world worked together to cut the number of people living in extreme poverty by more than half. Thanks to the MDGs, there are a lot more girls in school and a lot fewer children dying from diseases and not getting enough food. However, despite the success of the MDGs, it became clear by the middle of 2015 that the MDGs were not going to solve all of the world's biggest problems. During those

years, many new and very serious problems arose in society, which called for a much bigger scale of global action.

Most people agreed that the many environmental and social problems caused by the fast growth of industrial production, consumption, and urbanization were important new problems. When the earnings of huge corporations exceed the GDP of many countries and supply chains span the globe, the private sector plays a crucial role in achieving environmentally and socially sustainable global development.

It was widely acknowledged, including within the UN system, that the agenda for sustainable development could only be achieved with major participation and contributions from the private sector. The SDG formulation process was officially launched during the Rio+20 Earth Summit in Brazil in 2012. The intention was to construct a new set of global goals to address the mounting obstacles to sustainable development and to continue the work begun with the MDGs.

From 2013, when the OWG was officially set up, to 2015, a lot of people from the private sector, including the biggest business groups, contributed to the process of making the SDGs. Since September 2015, when the goals were signed, all 193 UN Member States have started to make and use SDG plans at the national level. In July 2016, 22 countries were the first to offer to show their plans¹.

In July 2017, 44 more countries shared their plans, and the rest of the UN Member States are expected to do the same each year until 2020. The SDG implementation plans are meant to guide and drive country-specific focus areas, policies, regulations, financing, stimulus programs, awareness campaigns, and many other activities that will help achieve the SDGs at the national level. Every 5 years, the UN will look at the national plans and report on how they are going.

Most likely, the SDGs are the best long-term market strategy that has ever been put in front of business. Some people may think that it will take a long time, be hard to predict, and be too much to handle before high-level political agreements have real effects on the market. But even if only half of what the SDGs predict will happen by 2030, the SDGs are still the best long-term market guidance we have ever had.

SDG Agenda asks businesses, governments, and people in civil society to all work towards a more sustainable future. Many companies seem to agree with this, and they have already shown their support for the SDGs in many ways. That is good news and a good place to begin. To reach the SDGs, however, most companies will have to change how they do things and, in many cases, do different things. Some companies' businesses will be more at risk because of the SDG agenda. This could be because of new rules or bad will from customers who do not like products or business practices that are not "SDG-fit." Other businesses will have to pay more because of the SDG agenda. Many businesses continue to struggle with getting it right and defining their next steps for aligning their plans with the SDGs and measuring and managing their impacts. Several free online systematic tools are available to support these procedures, such as the SDG Compass, which was developed by the Global Reporting Initiative (GRI), the United Nations Global Compact, and the World Business Council for Sustainable Development (WBCSD). Regardless of the SDG motivations (risk, cost, and opportunity) or the industry or region in which a firm operates, these systematic techniques will be applicable. The final piece of good news is that the SDGs are not a brand-new agenda. In essence, the SDG agenda is the "old sustainability agenda" simplified. Now that the SDGs are in place, we have a clearer set of long-term global priorities with political momentum, as well as a much stronger alignment between policymakers, civil society,

and the commercial sector. All UN Member States agreed to the 2030 Agenda for Sustainable Development in 2015. It gives a shared vision for peace and prosperity for people and the planet, both now and in the future, and makes plans for global sustainable development.

At the heart of the agenda, there are the 17 Sustainable Development Goals, which are an urgent call for all countries to take action. The SDGs came from the Millennium Goals, which were signed by the leaders of 189 countries in 2000. The goal of the Millennium Goals was to build a better world for people and the planet by 2030.

Adopted by all UN Member States in 2015 to promote prosperity while protecting the environment, recognizing that ending poverty must go hand in hand with strategies that build economic growth and address a wide range of social needs like education, health, equality, and job opportunities.

Through the role of business, SBMs have the chance to combine economic, social, and environmental value. They can change larger systems and solve important problems. Businesses could help reach goals like GOAL 13, GOAL 11, and GOAL 16.

The advent of digital technologies is a ray of hope on the horizon that can guide and catalyze the change towards achieving all the holistic 17 SDGs.

The development of smart systems connected to the internet of things can open up new ways to solve problems related to the Sustainable Development Goals (SDGs) of the United Nations. The SDGs aim to create a society that is fair, healthy, and good for the environment. This point of view talks about the ways in which digitalization can help build the sustainable society of the future. In particular, digitalization can assist in attaining SDGs in different sectors such as food, water, energy, citizens' health and wellbeing, climate change and biodiversity protection.

Here, we can report the application of digital technologies in water and health sector. In recent years, artificial intelligence (AI) technologies have been used more and more to turn passive data into knowledge that can be used to improve the operation of WTSs and help people make decisions (Al Aani et al., 2019; Corominas et al., 2018; Haimi et al., 2013; Li et al., 2021). The first time AI was used to improve the design and control of water treatment systems was 30 years ago (Krovvidy et al., 1991; Zvi, 1992). The first time AI was used to improve the design and control of water treatment systems was 30 years ago (Krovvidy et al., 1991; Zvi, 1992).

In a recent study, the design of WWTPs was optimized using data mining and artificial intelligence (AI) techniques like artificial neural networks and fuzzy logic. This was done by following an integrated process that included data collection and cleaning, data warehouse, data mining, and web user interface (Qiu et al., 2018). To get the most technical benefits and cost savings from WTSs, it's important to control and run them in the best way possible.

Advanced information extraction and human-interpretable information extraction based on AI and datamining techniques are being worked on to turn data into useful information and knowledge for controlling and optimizing the operation of WTSs (Corominas et al., 2018).

Digitalization is changing healthcare by making it easier to get health services and bringing care to places that are hard to reach. E-health has the potential to make health care more affordable, sustainable, and good (Bucci et al., 2019; Krick et al., 2019; Ossebaard and Van GemertPijnen, 2016). Telehealth and telemedicine are two examples of new technologies that are part of digital health. Telehealth is the use of electronic information and telecommunication technologies to support and promote long-distance

clinical health care, patient and professional health education, public health, and health administration. Telemedicine, on the other hand, is a way to get treatment from a professional at a distance through videoconferencing (Weinstein et al., 2018). But the World Health Organization uses the term "e-health" to refer to all of these different ways that the Internet of Health Things (IoHT) is improving healthcare in the Digital Age (Larson et al., 2018; Ossebaard and Van Gemert-Pijnen, 2018).

CHAPTER 2

CIRCULAR ECONOMY- The solution for a Sustainable Future

2.1 Circular Economy: the solution for a sustainable future

In this first chapter, it has been possible to analyze in deep the evolution of traditional business model over the years and its increasing incompatibility with the current business environment. In particular, an increasing market demand, an increasing scarcity of resources and higher environmental pressures imply a strong need: the urgency of abandoning the unsustainable current *linear economic productive system*- based on principles of *production, usage and waste*- and developing new and innovative economic systems based on the usage of energy sources, renewable materials and on the recycling of components. In this meaning, “Circular Economy” might represent a suitable solution; indeed, this system is based on a virtuous and synergic usage of all the resources, which regenerate, through a renewable process, the production-consumption system with evident positive environmental, social and economic impacts. These impacts derived from the adoption of practices of recovery, recycling, re-usage, sharing and collaboration, able to substitute resources along the different phases of value chain thanks to innovation in concept and design phases. The urgent development and adoption of these new innovative approaches require a radical cultural revolution; not only firms, but also local, national and international authorities need to be involved in this process to gain new competitive advantages and create social value and impact.

For sure, this transformation will require a huge effort for companies and organizations in rethinking and redesigning value proposition, internal and external processes. However, at the same time, they might benefit innumerable new opportunities and

advantages from Circular Economy, such as potential advantages in value chain (through a better management of resources); benefits of system (through the spare primary energy, reduction in waste production and emissions in the atmosphere); spare in the stock of virgin raw materials. Moreover, according to the program “For a zero waste Europe” of the European Commission, it is estimated that a more efficient usage of resources along the entire value chain might reduce the need of a productive materials by 17-24% by 2030, with a spare for European industry of 630 milliard of euro per year.

2.2 The end of “Linear Economy” System

Nowadays, the need to shift from the traditional linear economy system to the circular economy model is more urgent than ever. In order to understand better the reasons that bring to this transformation, it might be useful to analyze the elements that characterize the current “linear economy” system. In particular, the term “Linear economy” describes the current economic growth model, based on principles of “extracting resources-producing-throwing away”. This model found fertile land in a historical period characterized by abundance of raw materials, an almost inexistence attention to environmental impacts and lack of incentives in reducing waste during production processes. Characteristics that have put natural resources and ecosystems of our planet under a huge pressure. We are closer and closer to a point where due to social and economic factors, this model will be no more sustainable and no more able to satisfy the increasing demand. In particular, three characteristics make this incompatibility significant:

-Finite nature of not renewable resources: in 2000, the demand of not renewable

resources increased by 50% respect to 1980 and, in 2014, there was an increase of 80% respect to 2000 due to a rapid growth of the middle class. According to experts, there is a reasonable risk that the fundamental commodities will be exhausted by 50-100 years.

- *Overcoming of fundamental planetary limits*: in 2009, twenty eight important scientists identified and quantified nine planetary limits, whose overcoming would have brought to irreversible environmental changes. Our planet has already overcome three of them: the rate of extinction, the concentration of carbonic dioxide and the level of nitrogen in the atmosphere. The excessive usage of not renewable resources- such as fossil energies- represent a serious threat for atmosphere, ocean and forests.

- *Huge amount of waste generated by linear model*: more than 11 billion of tons of waste per year and only the 25% of them are recycled and inserted again in the productive system. The remaining parts represent an astonishing loss that fills landfill. Waste does not represent a problem only under the environmental aspect, but also an economic loss of billions of dollars; indeed throwing away big quantities of products might mean throwing away a potential profitable flow of revenues under the form of materials that, if re-worked and regenerated, they might represent a value for other companies.

Actually, the main defect of this model is its incapacity in extending products' life cycle and ensure that components, materials and energies inside the products, once concluded products' useful life, maintain the same value they had originally at the beginning of productive process. According to Janez Potocnik, European commissioner for the environment in 2010, "maintaining the linear economy model adding gradual improvements is no more sufficient. Today, we must move away from this model and

develop new sustainable models able to use the same resources more times and obtain higher value”.

In substance, today, the linear economy approach creates a bigger and bigger difference between demand and offer and uncontrollable environmental devastations. Companies that continue to depend strongly on scarce natural resources might be subject to a catastrophe; indeed, when the offer of resources will be exhausted, they might be forced to suddenly interrupt the production.

In this meaning, *Circular Economy* might represent the right solution. By the term “Circular Economy”, we refer to a system where growth is not dependent on the usage of scarce resources. In this model, there are two kinds of materials used: biological materials -projected to be reused at the end of their life cycle or they return in the biosphere without environmental consequences- and technical materials– projected to pass cyclically from the production process to the usage with a minimum loss of value or quality. Companies that adopt Circular Economy model focus on value creation by optimizing resources management inside all the market- not only in the productive process. In this way, Circular economy generates “zero waste” value chains, fed by renewable energies and natural resources are used inside connected circuits-not consumed, and thrown away as the linear flows.

Therefore, linear economy is based on abundance of resources, stable price and lack of interest in recovering and recycling them. On the contrary, circular economy, aware about the fact that resources are not infinite and about the environmental impacts of resources, aim to exploit their productivity as much as possible without quality or value loss. In order to understand better the principles, characteristics and the thought of

circular economy model, it might be extremely useful to recall its origin and evolution over time.

2.3 Circular Economy: origin and evolution

Despite the fact that the term “Circular Economy” has been used for the first time in 1990 by David Pearce and R.Kerry Turner in the book “Economy of natural resources and of the environment”, the first idea of a circular economy approach dates back to the end of XVIII century. In particular, when, in 1798, Thomas Malthus, worried about the rapid world demographic increase, published his famous opera “Essay on population’s principles”. His thoughts were radically opposite to the thought of the time. Malthus strongly believed that the demographic increase would have reduced the capacity of the planet to feed itself. John Stuart Mill and Hans Carl von Carlowitz were other important figures of the same time, who proposed theories on the management of natural resources.

However, the environmental movement had a strong development thanks to the protests against pollution at the end of XIX century, as testified by Adam Rome in the “Journal of American History”. The debate on the depletion of resources and economic development has gained attention in 1972, thanks to the book “The limits of development”, based on the finite nature of resources and on the risk of depletion-this book argued that, in absence of controls, the ecological human footprint would have overcome the capacity of “sustainable limits” of our planet. After years of debate related to the problem, leaders started to shift the attention toward solutions. In 1998, Ernst Ulrich von Weizsacker published “Factor 4”: how to reduce the environmental impact multiplying by four the production efficiency, believing that the growth and

sustainability could coexist and that society can grow without abandoning natural resource.

The advent of the new millennium has been characterized by an increasing interest about the modalities of extraction and usage of resources, generating a stronger movement toward the change; in particular, in 2002, the book “From cradle to the cradle” of Michael Braungart and William McDonough relieved a wave of interests toward new models. According to the authors, the eco-efficacy and not the eco-efficiency- the fact of having a major positive impact, and not the reduction of damages- has to stimulate the economic development. The authors encourage a philosophy of projection bio-inspired, based on “waste=feed”- resources enter again in the environment in a safe way or they return to the production processes. The XXI century has been characterized by a deep interest in ideologies that emphasize an economic growth accompanied by a reduction at the minimum of resource consumption. An example is “The performance Economy” of Walter Stahel, published in 2006; this book proposes to separate the economic growth to the resource consumption, believing that innovations can represent a crucial pathway to ensure the development of models of sustainable growth.

Today, people, companies, organizations and governments share the same fear for the environment; all of them are focused on the goal to leave the lightest footprint on the planet and using natural resources with more respect in order to ensure to live well and longer in the future. Nowadays, there is more awareness on the weakness of our planet; Companies want to get rid of the need to get raw materials and cut down on the amount of harmful substances. Always in the same year, “Ellen MacArthur Foundation” was born, giving significant contributions to the adoption of circular economy principles.

Indeed, not only this foundation has developed the *definition* of Circular Economy that still today is in use-“Circular Economy is a systems solution framework that tackles global challenges like climate change, biodiversity loss, waste and pollution”- but also the *circular economy principles*, which are:

1. *-Eliminate waste and pollution:* Currently, our economy works in a take-make-waste system. We take raw materials from the Earth, we make products from them, and eventually we throw them away as waste. Much of this waste ends up in landfills or incinerators and is lost. By shifting our mindset toward circular economy, we need to make higher effort in ensuring that the materials re-enter the economy at the end of their use. By doing this, we take the linear take-make-waste system and make it circular.
2. *-Circulate materials and products:* it means keeping materials in use, either as a product or, when that can no longer be used, as components or raw materials. This way, nothing becomes waste and the intrinsic value of products and materials are retained.
3. *-Regenerate nature:* By shifting our economy from linear to circular, we shift the focus from extraction to regeneration. Instead of continuously degrading nature, we build natural capital. We employ farming practises that allow nature to rebuild soils and increase biodiversity, and return biological materials to the earth.

The Ellen MacArthur Foundation develops economic reports to quantify the benefits that circular economy can generate for organizations and companies.

In addition, ONU is on the front line for a transition toward circular economy; in this meaning, it is important to remember the ONU+Rio20 Conference in 2012, where it has established a set of clear measures to implement the sustainable development through

member States of the organization. These measures aim to Sustainable Development Goals and revolutionary guidelines on green economy policies.

Nowadays, a higher attention to the usage of precious resources, reduction at the minimum of toxic and noxious substances and reduction of waste represent central themes in the current society, due to the higher awareness of the fact that our planet is no more able to satisfy the needs of the current population. This awareness has generated the circular economy model, where companies' goal is no more the competitive advantage, but the *circular advantage*, achieved by growing without depending on the extraction of and usage of natural resources, without waste of energies and without damaging the surrounding environment.

2.4 Circular advantage: What is it? How to get it?

According to Peter Lacy, Jacob Rutqvist and Beatrice Lamonica (2016), we can define the “*circular advantage*” as the competitive advantage got by firms that operates according to circular economy principles, innovating their business model both in terms of resources' productivity and in terms of value for the customers along the entire product's life cycle. In this meaning, Nike, company leader in the sport wear, can represent a good example; this company has spent years to understand how to find a balance between resources' productivity and value for customers. This effort has brought to the development of innovations able to increase products' performance and, at the same time, to reduce environmental impact. One of these innovations is Flyknit™, through which it is possible to produce new pair of shoes from few loose filaments; in this way, the production process generates the 80% of waste less, providing more comfortable and lighter shoes. Moreover, Nike is investing high amount of monetary

resources in R&D to improve the recyclability of its products and to develop vegetal materials at 100%, reducing its dependency from scarce resources deriving from oil. As said at the beginning, in order to benefit of a circular advantage, it is necessary that an organization or company adopt the circular economy principles. The transition toward this new model would imply a radical change in the logic of the offer based on a linear economy. In particular, it would imply the need of a significant larger amount of renewable energy, biomaterials, and biochemical agents to decompose outputs. Products need to be developed such a way to use second hand materials and to allow a low cost recycle at their end-of-life. These are the main challenges in circular economy. However, the efficient usage of resources does not represent the principle business driver in a circular model. Indeed, the real power lies on the demand side: indeed, circular economy starts from a deep analysis and comprehension of the demand to arrive at the characteristics of the needed resources. Therefore, companies need to understand well to what customers attribute value; what is their behavior during and after the usage of a product; how customers interact with products. This understanding represents a crucial passage also because, nowadays, customers develop a higher loyalty toward companies seriously interested in circular issues and they are more willing to create a transparent and longer relationship with these kinds of companies. Doubtless, it represents a great change in companies' modus operandi; it is no more a debate only related to the reduction of production costs, but now companies need to develop a more holistic view on the entire market. More precisely, circular models require that companies now play an active role in relation with the usage and disposal of products, optimizing performance along all the value chain. Now companies do not design

products that intentionally damage or become obsolete or without considering environmental impacts.

Nowadays, more and more companies are achieving circular advantages thanks to the adoption of circular principles. Moreover, over the last few years, companies are developing new and innovative successful circular business models in order to realize a more efficient transition and become leaders in a new greener world. In particular, five circular business models have been gaining a significant relevance: the *“Circular Chain” Business Model*; *“Salvage and Recycle” Business Model*; *“Extension of product’s life cycle” Business Model*”; *“Sharing Platform” Business Model* and the *“Product Service System” Business Model*.

2.5 The five successful Circular Business Models

In the book “Circular Economy: from waste to value”, Peter Lacy, Jacob Rutqvist and Beatrice Lamonica analyzed five successful Circular Business Models through which companies and organizations have been achieving astonishing results.

2.5.1 Circular Chain Business Model

In the past, manufactures had few alternatives available for the energy and raw materials needed to produce their products- expect for those deriving from virgin resources that often were toxic, polluting and not recyclable. It because companies that provided these input were strictly linked to the liner economy model- providing energy from fossil combustible and toxic substances. Today, manufactures can rely on much better alternatives, thanks to the fact that more and more companies are adopting the “Circular

Chain” Business Model.

This model

offers access to renewable inputs, recyclable or biodegradable, in substitution to those linear. Renewable energy is an example in this meaning, because it represents an essential resource for circular value chain for almost all the products, in substitution of non-renewable energy. Moreover, biological materials such as biochemical or bioplastic products can substitute toxic and non-renewable products. As explained by Micheal Braungart, “this model does not consist in reducing at the minimum the bad materials, but creating something new with an economic value”. Therefore, the “Circular Chain” Business Model becomes crucial in our world of finite resources. Moreover, this model offers a competitive advantage on demand; it is highly probable that clients, willing to give their contribution for the planet, become long-term partners with companies that adopt this model- nowadays more and more clients would choose a sustainable alternative rather than a traditional one.

The Circular chain model presents also two possible variants:

- Producing sustainable solutions for other agents
- Producing sustainable solutions for its own activities

Usually, companies produce and provide other agents with circular resources such as energy and renewable materials; CRAiLAR Technologies represents an example in this meaning. It was founded in 1998 and produces resources of renewable biomass; in particular, this company produces a soft and durable textile similar to cotton, reducing at the minimum environmental risks that characterize the production of the cotton. For instance, while the production of 1 kilogram of cotton requires between 2000 and 29000 liters of water, CRAiLAR uses only 7 liters per each kilogram of product- a savage of almost 99%. Another important company that is providing significant sustainable

solutions is Natureworks. It was born as joint venture between Cargill and PTT Global Chemical and it provides biopolymers deriving from renewable resources at 100%. A company that produces circular inputs for others might gain value working closely with its clients also for combined projects; this is the case, for instance, of AkzoNobel, leader in the varnish industry and producer of special chemical inputs, its products are sold in many sectors- transport, real estate, and energy production. AkzoNobel has developed a material derived from vegetal oil and bottles of plastic recycled; this material is the main component of the first paper cup completely recyclable and compostable in the world.

Nowadays, the adoption of this model has showed a rapid increase – especially in the bioenergy and chemical sectors. The bioenergy sector is the most mature- here there has being an interest for 10 years. Many chemical companies are shifting from fossil resources to organic ones to produce high quality chemical products. In this meaning, the biotech company “Novozymes” represents an important example. This company applies innovation to the bio-refinery to help Unites States to leave its dependency from non-renewable oil, in favor to materials and combustible deriving from plants. Novozymes’s managers strongly believe that, through bio-refinery, it is possible to regenerate thousands and thousands of daily products to make them more circular, reducing energy and raw materials’ costs. An important demonstration of Novozymes’s effort in this field is represented by an initiative with the European Union called “Bio-Based Industries” which implies an investment of 3.7 billion of euro between by 2024 in favor of the development of bio-economy in Europe. Other important sectors in the Circular Chain model are the mineral extraction and iron and steel sectors. Indeed, also in these sectors there is an increasing attention towards products’ optimization in order

to be recycled and wrought again. Little by little that Circular Economy will grow, also the Circular chain will find more adopters.

Despite the important benefits that this model would bring, there are some challenges to face that limit the adoption of this model, such as the significant costs required to change production system and the time of execution. Indeed, typically, this model requires long cycles of R&D and high amount of monetary resources to change the current linear production system and to produce on large scales. For instance, Natureworks took 14 years of intensive R&D to develop biopolymers that today commercializes. Moreover, this model requires being active partner in the circular network, where actors help among themselves to maximize the profitability of resources- indeed many companies enter in this model by founding a joint venture, sharing costs and benefits of innovation and creating the conditions for a faster growth. Moreover, another important condition to take into consideration is the awareness needed about the principles at the basis of the model: companies need to ensure that components used can be recycled and that they can return in the atmosphere in total safety.

2.5.2 Recovery and recycle Business Model

While global competition is higher and higher and new virgin resources are becoming more and more expensive, companies try to safeguard, recover and re-use resources hidden inside their own products and in wasted products. This research is at the basis of the “*Recovery and Recycle*” Business Model. By this model, companies and organizations search value not only when they analyze the final products, but during all the material processes. Here, all by-products and flows of waste are optimized in order

to maximize their potential in terms of revenues. In particular, according to this model, all that previously was considered as waste now it is reinserted for other usages, eliminating not only wastes, but also directly the concept of waste. Through digital technologies, recovery's chains transform waste in value through the recycle and the upcycling- transformation of old product in something new with a higher value; in this way, companies can recover every typology of resource released as output at a level equivalent to the initial investment. This model provides different solutions, such as the *sectorial symbiosis*- namely, the share among sectors of by-products as resources for other products- or the *integrated recycle at close circuits* or models "*cradle to cradle*"- through which products are continuously re-worked in order to obtain something new without any loss of resources. Companies that adopt this model believe that maximizing profits by waste has the same importance of the maximization of profits through selling of products.

Historically, the recovery of products has always implied high costs and big logistic difficulties due to the lack of monitoring, selection and tracking technologies. Today, the situation is different thanks to new and innovative digital tools, through which companies can recover millions of products that, in the past, would have been lost forever.

This typology of business model might generate several *benefits*, such as the reduction of costs linked to the compliance and waste management, increase in revenues from undesirable products' selling, the decrease of environmental impact thanks to a lower demand of new virgin materials and energy or new interactions between companies and customers that promote disposal.

In order to achieve a more efficient circular transition, companies that have already adopted this model to recycle materials might set a more ambitious goal: “zero waste”: this goal would require redesigning all the processes such that all the residual materials might represent a potential resource. In particular, there are two companies that represent a virtuous example of this model, aiming to the ambitious “zero waste” goal: Procter&Gamble (P&G) and General Motors (GM). Indeed, all the wastes generated in their headquarters are recycled, took again for other uses or transformed in energy. Recently, Forbes McDougall, responsible for the reduction of waste around the world, observed that, over the last five years, P&G’s effort in creating value from waste produced a value higher than one billions of dollars for the company. This model not only provides incredible benefits to the environment, but also to the affairs. GM launched the program “zero waste” already in 2011; today, it recycles the 90% of its productive wastes around the world, this company has 102 headquarters that do not resort to landfills and it declares to generate one billions of dollars per year through the recycle and the usage of by-products.

Through the analysis of this business model, it is possible to observe its two variants:

- Recover of products at the end of their useful life with the aim to re-appropriate of their value in close or open cycles
- Recover of wastes or by-products of productive process with the aim to re-appropriate of the their value.

Regarding the first variant, in order to recover value from products at the end of their useful life, it is needed to dismantle them. The higher the value extracted from products, the higher the value that companies can give back customers in the form of better

service. An example in this meaning is Ricoh, a technological producer for documents management, which tries to reuse components of scanners and printers when they achieve the end of their useful life. This company has a particular program that enables its customers to give back ink-cartridges; then the company dismantles these products to recover and reuse materials and energy. “Interface” is another interesting business example; this company produces carpets and participates to the initiative “Healty Seas”, aimed at the re-usage of nets. For years, nets have been thrown in the sea, damaging seriously marine ecosystems; today, Interface uses the nylon of nets recovered from the Ocean in order to realize new carpets.

Regarding the second variant of the model, Gunter Pauli, the author of Blue economy, offers some examples of companies that generate new value through by-products. In particular, there are players in the paper industry that are producing paper by mineral wastes rather than fibers from trees. This innovation model produces several benefits such as the protection of the environment, reduction of production costs and the creation of a new material- the mineral paper- that lasts 400 years, while the traditional paper can be recycled only four times. At the same time, Kroger Company, leader in grocery industry in US, represents a successful example in transforming its own wastes in renewable energy. Today, wastes of Kroger Company enable to generate clean energy at a low price that power a campus of 49 acres. It is possible to indicate also Walmart as a virtuous example, since it has declared that the 80% of its waste does not go to the landfill, but somewhere else and, thanks to its effort in recycling, the company has been able to recover a value of 230 million of dollars.

One of the main characteristics to manage at the best this model is the capacity to take advantage of *technologies of support*. These technologies help to localize and to monitor

materials and components, which identify specific properties inside products. The online service “Diversion and Recycling Tracking Tool (DART) of waste management represents an important example of these innovations. In particular, it enables companies that manage complex products to integrate in their articles a chip that act as “passport”, gathering information regarding the contents- even potential toxic or dangerous substances. The European Resource Efficiency Platform (EREP) strongly recommends using these tools since that they might solve the problem of “inadequate information, shared between companies, about resources inside products. These tools might help who recycles to be informed about the resources and about potential risks.

Through this model, companies are able to reduce costs and generate and a new turnover through the selling of waste, that in the past remained unused, to other companies as value materials. Considering that a recovered material has a value equal to the one it has as new, companies need to face two challenges: to preserve the quality of resources and keeping property rights related to that material. It means that companies need to find a way to exercise the control on flows of return and maximize the increment of the quality of resources recovered.

The recovery of products is much easier in B2B markets, where companies can rely on contracts, negotiation information to keep track of the amount of products gone in the hands of each client and where. In B2C markets, monitoring this information is much more difficult to monitor. This is the reason why, for example, the British retail colossus Marks&Spencer chose to collaborate with the no profit organization “Oxfam”; in particular, customers can bring used Marks&Spencer shoes, clothes and bags in Oxfam’shops and, in exchange for it, Marks&Spencer offers vouchers to its customers, in order to encourage them to participate to this initiative.

Managing the return and re-work phase of products is essential for companies to preserve cost advantages. Over the last years, important companies in the textile sector are showing an increasing interest toward this model, even in cases when life cycle is extremely short.

There are important practical examples of companies that have adopted this model, for example Timberland, leader in production and selling of outdoor clothes; this company wanted to reduce significantly the environmental footprint over the entire life cycle of its products, even beyond the selling. This is the reason why, Timberland designed the new ankle boot “Earthkeeper”, easy to dismantle, with regenerated and recycled components. The company encourages its customers in giving back the ankle boot in whatever shop, increasing the engagement and loyalty level of customers. By this new approach, Timberland has avoided 500 tons of emissions of carbon dioxide for each 40.000 ankle boot produced.

2.5.3 “Extension of the life cycle’s product” Business Model

For decades, producers have focused their attention on volumes: producing the highest possible amount of products in order to increase revenues. This strategy might make sense in a context of abundance of natural resources, without big environmental pressures and price stability. The disadvantage of this approach consists in encouraging consumers to substitute constantly their products, even when they are still perfectly functioning- it happens mostly in consumer goods and electronics. Often companies develop products such that voluntarily they will stop to function or become obsolete. What would happen if producers tried to obtain the highest possible value from each ton of resources consumed? If they tried to extend life cycle of a product, maximizing its profitability over the inter life cycle and not only in the moment of selling? If they

developed products able to last for a decade or more? If, instead of encouraging consumers to change their products even if perfectly functioning, they tried to develop products able to be easily repaired?

If producers applied all these initiatives, they would apply the “*Extension of product’s life cycle*” *Business Model*. In particular, this typology of business model tries to extend life cycle of product, generating revenues through the longevity rather than through volume of resources. Indeed, this model gives more value to characteristics such as the *capacity to last, quality and functionality*: the more it lasts and the more intensively it is used, the better is for the firm that provides it.

Often, products sold based on this model require a huge initial investment and it represents one of the main barriers to application of this model.

If correctly implemented, this model can help companies to increase revenues reducing their dependency on physical sales and their environmental footprint.

There exist several methods to extend the useful life of a product to generate additional flow of revenues:

-Building for a long duration: producing high quality outputs with an astonishing capacity to last. In this case, the target would be represented by customers willing to pay a higher price.

-Recondition: bringing used products to their original state: here, the target would be customers sensible to the price and willing to buy products “as new”.

-Recover, Exchange and Rebuy to re-insert in the market: recovering products sold in the past and exchange them or sell them again is a common practice called “reCommerce”. The target, in this case, would be customers searching for a “good affair”.

–Updating: adding new characteristics, functionalities or trend details rather than substituting the main product. Here, the target is customers interested in consuming contents and functions rather than the product itself.

–Repair: Repair a broken product: here, the target is customers satisfied of performance.

Companies and organizations are perfectly aware that, at a certain point, it is inevitable that customers want to separate from their current products; however, what companies need to understand is that product's life does not have to finish in the moment, since producers and providers can recover the product, regenerate and sell it to another customer. China, for instance, has been aware of it, highlighting the advantages of regeneration in the circular economy context. Xie Zhenhua-Vice President of the national Commission for the development and reforms- observed how regeneration is able to reduce the 60-70% of resources than the creation of new products and it provokes positive impacts on environment through significant reduction in polluting atmospheric agents.

This model might generate several benefits; some of them, even if extremely important, are not quantifiable. For instance, when a company extends the life cycle of a product, it increments the number of interactions with its customers, consolidating more and more the relationship with them. Companies that adopt this model want to interact with their customers as much as possible, strengthening the sense of loyalty and trust with customers, making them understanding that the company wants to provide them with adding value.

Like the previous Business Models, also this one presents some challenges to face for companies that decide to adopt it. In particular, industrial companies need to design

products such that they have a long life cycle, which consists in different updates, improvements and the recovery phase at the end. At the same time, considering the central role of customers for the recovery phase, companies need to build a strong relationship with them by establishing multiple interactions over time. Moreover, companies should be very good in *predictive maintenance* and in the *identification of efficient approaches of selling*, offering a spare part before it breaks. Furthermore, producers should also build a network with local partners, which provide assistance and activities planned by chains of recover.

One of the main challenges in the adoption of this model refers to identify the ideal situations and products; in particular, products that have the highest potential for the extension of life cycle typically have a life cycle that last five years and the model has higher probability of success in the B2B context. It is important to observe that not all the products are suitable for this model; for instance, there are products that cannot be designed to be easily dismantled; others present complex requirements in terms of materials; this model is not suitable for companies that want to enter in a “take-produce-throw” market. Neither companies whose products are exposed to the rapid change of customers’ tastes; this is the reason why, this model would not be suitable for instance, for fashion companies.

Despite the innumerable obstacles, nowadays, more and more companies are adopting this model, since it reduces the demand of new virgin resources, avoids that waste goes in the landfill, preserve valuable components that remain inside products even after years and years of usage.

Following, we can analyze a practical example:

-Caterpillar: This company is world leader in production machines and has been practicing the regeneration of components since 1973. In particular, today, his business unit “Cat Reman” employs 4000 people in 17 headquarters around the world. Very soon, the management found out that the production line of the company was suitable for this model, considering that only the 10% of their components requires regeneration- the remaining components can remain in the same state- and Caterpillar already had a strong network of support and assistance for its products. Caterpillar decided to adopt this model when it realized that materials represented the 65% of costs. The company had to find a new area of growth with a lower employment of resources and, considering that regeneration can provoke a reduction up to 100% of materials, creating a significant competitive advantage, they immediately found out that the adoption of the model would have been the right choice. In this way, Caterpillar started to encourage its customers to give back products used in exchange of a “core credit” that they can exchange with a voucher for a regenerated product core. From company perspective, this incentive reduces costs of materials and enables the company to get again the control on products; Caterpillar sells regenerated products at 50% less than the new ones, but with the same insurance. Each regenerated product consume 85% of energy less than a new product and it is highly appreciated by customers, which want to minimize their footprint.

2.5.4 “Sharing Platform” Business Model

The “Sharing Platform” Business Model provides products’ owners with a platform to be in contact with people, companies or organizations interested in them. In this way, this model allows that more people can use the same resources, reducing significantly

the demand of new productive activities and it enable the increase of consumptions without the need to manufacture new products. Main benefits of this model are the *flexibility* and *availability*- through the platform provided by the model, indeed, people have the possibility to access to thousands and thousands of products with different prices, rather than being limited to a smaller pool of products provided by a single retailer.

Therefore, this model facilitates the rental, sharing, exchange or the donation of resources. It is important to specify that platform's owner does not offer products, but he or she creates a flow of revenues through the connection between demand and offer of unused resources' capacity. In particular, often it is required the payment of a fee on each transition made on the platform- an example in this meaning can be Uber, that holds the 20% of each transition occurred on the platform.

Of course, the concept of sharing is not something new; the novelty is represented by the progresses made in the technological field. Indeed, digital technologies create new, better and faster opportunities of sharing in more efficient way an on large scale. Today, all sharing platform exploit potential of technology to perform their activities, such as social network, mobile apps or delocalization services.

More and more consumers are showing a strong interest towards these systems; for instance, according to a research of Nielsen Company, more than 1 out 4 of the participants has showed the willingness to share its own electronic devices in return of monetary compensation. In particular, younger people seem to be more exited in adopting this model; they are more open-minded and ready to share or rent goods rather than own them. Another interesting indication is that this model is more likelihood to be

successful in metropolitan cities with a high population density, where there is a higher demand and offer, lower distances to bring or deliver goods.

Unlike many other business models, it was born as C2C model, called also “Peer-to-Peer” (P2P), and not as B2B model. However, with the increasing development of the model in the C2C context, there is a higher visibility also in the B2B context. Important realities are “Storefront”- a company that offers the rent on short-term basis of retail space for pop-up shops- or “FLOOW2”- another B2B sharing platform for tractors and similar unused machines; this company allows the meeting between demand and offer of 25000 types of goods and services of different sectors. Its aim is to reduce the excess capacity around the world through the achievement of an equilibrium between profits, planet and people. Kim Tjoa, founder of FLOOW2 believes that the difficulty in the adoption of the model in the B2B context is given by the higher difficulties of companies in sharing among themselves productive capacity or their own goods- companies are still unaware of the great potentials of this model in terms of profits and resources’ usage.

According to recent research, there are four main reasons why people choose the sharing: *higher comfort, lower price, higher quality of products/services and loyalty.*

-Comfort: customers appreciate the sharing platforms because they broaden the pool of available resources; thinking for example about the bike sharing system: by this model, people would pass from the possibility to rent a bike among tens of shops to the possibility to rent a bike in thousands and thousands points where a person can bring a sharing bike. Moreover, people that adopt this model resort to an easy and safe payment system, which allows people to consult all the available resources in a given moment and have access to them in every moment and from every position. It implies that,

companies motivated to adopt this model need to be able to monitor how people use the platform and analyze their behaviors; communication needs to be rapid and efficient.

-Price: One of the main reasons that encourages people to adopt this model is the economic access to products, that, otherwise people would be forced to rent or own. This is the reason why, the best strategy linked to this model is to maintain costs lower than those needed to rent or buy new products.

-Quality: Today, customers want to live personal experiences and often they resort to sharing platforms to find unique products or services. Since here customer experience is crucial, it is important to fix formally high quality standard levels needed to be respected.

-Loyalty: Despite the fact that majority of sharing platforms work hard to transmit a sense of safety, problems related to frauds and to the lack of loyalty represent a serious challenge. It is important to overcome this challenge in order to reach a wider mass for this model. In order to implement a successful sharing platform business model, it is essentially that people trust each other; in order to get loyalty, many platforms resort to social media and reviews of customers. Other platforms provide services and goods with an insurance policy to transmit more safety to their customers.

At the same time, it is important to analyze some critics moved toward this model. One of the main critics relates the financial aspect of this model. In particular, companies that adopt this model are accused of being more profits-oriented than being motivated to develop of communities and sharing between people. Actually, the aim of the model is to ensure innovative modalities for the property shared and co-access to goods and services; the word “sharing” does not imply that exchanges need to be free, but it is allowed that there are transitions in return of some typologies of remunerations.

Therefore, this critic is not reasonable. A second critic relates the fact that this model is generating a new typology of poor people, who work with an unsure wage rate and few benefits. This critic is reasonable and deserves attention. Companies need to ensure that rules and company's ethic are far from mistreatments and bad working conditions; actually sharing platforms reduce significantly the need of workplaces and they do not guarantee fair compensations and an adequate number of benefits to those remain in the companies. An example in this meaning is Uber, a platform that links people who provide a ride with people who search for a ride; many drivers sustain to earn higher wages than traditional taxi drivers, but many other denounce mistreatments and wage rates significantly lower than the minimum salary.

The last critic towards this model relates its unfair competition and fiscal evasion. In particular, when a person goes to a hotel, he has to pay a touristic fee, but often this fee is not paid by people who decide to share their room. The same situation occurs between taxi drivers, forced to pay high fees, and car sharing drivers.

Two important examples of companies that have adopted this business model are Rent Tycoons and Peerby. In particular, Peerby has developed a platform that enables people to share goods in an easy and safe way. This company works in all the main cities of Holland and Belgium, offering its service also in United States. In substance, this company helps people to borrow goods unused in many families' houses of the same neighborhood. A registered user can ask an online good by his mobile phone; then the platform send this request to hundred registered users that live closer to the applicant and if they have this good, the platform sends a notification to the applicant and establish a contact. In order to increase a sense of trust toward this start up, Peerby is

developing a system of feedback where users can give an evaluation regarding the transition. Since this platform is completely free for users, Peerby receives funds from important institutions such as DOEN Foundation, Clinton Foundation and Sanoma Media.

2.5.5 “Product Service System” Business Model

Over the last years, we have been observing a new tendency of customers’ behavior: more and more often, they prefer buying a specific function or desirable performance rather than a product. Around the world, customers are renouncing to property of a vast amount of products, choosing to buy the access to them for short-medium term. Companies are able to capitalize this new mentality by the implementation of “*Product Service System*” *Business Model*. Unlike the “Sharing Platform” Business Model, here companies maintain the property of products, offering them to one or more customers. There, in this case, customers become “*users*” rather than consumers of a product. A crucial characteristic of the model is the strong alignment needed between provider’s objectives and those of the client in relation to the product. In this model, provider and client want the same thing: high quality products that last for long periods, frequently used, with an efficient maintenance, high performance. All these aspects help to reduce the property’s cost for clients and to increase turnover for providers. This strong relationship between providers and customers represent also one of the main advantages of the model: the continuous interactions of clients often imply a stronger loyalty of clients. Another relevant characteristic of the model is represented by the fact that is compatible perfectly with the majority of the other circular business models; more than

the 80% companies that follow this model combine it with another one. Usually, the combination occurs with the “Extension product’s life cycle to repair products and update them.

Several research have showed how this model has the potential to reduce the environmental footprint by 50%- in certain cases by 90%.

Providers that adopt this model offer to their customers the improvements in terms of costs, performance and risks. In particular, this model can be very economical convenient for customers that need a specific product only for a short period, avoiding the higher costs of a purchase. At the same time, this model can offers better performance of a product if the owner guarantee the functionality, the maintenance and availability when users are not able to. Financial risks are lower for the customers that do not have to manage the property, maintenance and the final dismantlement of the products.

Actually, there exist company that have been using this model for years, but a wide adoption has occurred only over the last ten years. For instance, Rolls-Royce, in 1962, introduced “Power-by-the-Hour™” offering a jet with a payment system per hour of usage. Today, many car companies follow this model, offering the possibility to lease its products. “Michelin Solutions”, a new business area of Michelin, represents an innovative program that allows customers to lease pneumatics rather than buying them and customers pay a price based on the kilometers covered. Thanks to this model, Michelin Solutions is encouraged to develop pneumatics that last longer periods; moreover, since it is recover used pneumatics, the company is encouraged to ensure, through the design and materials selection, that the products are easily re-worked becoming valuable inputs for the production of new pneumatics or for completely

different products. Nowadays, more and more companies are adopting this model, also in the luxury sector, where for example, TurningArt offers the possibility to lease exclusive artworks rather than buying them; Girl Meets Dress™ in United Kingdom makes expensive high fashion accessible to everyone.

After having analyzed the nature of this business model, it is possible to comprehend that not all products are suitable for it; indeed, for example, products that imply high costs of management are not attractive to be bought, but for a leasing. This model is ideal for customers that need a specific product only for once or in rare occasions or if they do not have enough resources and knowledge for the maintenance of them.

Another important aspect of this model is the fact that it requires a *mix of physical and digital channels*. At the beginning, usually clients want to meet providers to discuss how offered solutions might satisfy their needs; once the agreement is reached, clients resort to digital channels to monitor the usage, the cost and performance levels of the products. Here, we can understand very well the importance of machine-to-machine communication, mobile technology and data analysis that have put companies in the condition to manage efficiently the assets to make the model highly competitive. Thanks to digital technologies, companies can monitor products remotely to ensure that they have been used in the correct way and to analyze customers' behavior to prevent future needs in terms of maintenance and reduce at the minimum inactivity periods.

In implementing this model, companies need to analyze carefully all the economic aspects both from its own point of view and from the customers' point of view. For instance, it might be difficult to find the proper model for low valuable products, due to the alternatives that customers might choose at the same price. This is the reason why, products with higher value are more suitable for this model.

As in the previous cases, also here there are some challenges that companies willing to adopt this model need to face. Until a company is not fully digitalized, it has to be able to interact physically with its customers and products, when and where customers need help. In this case, local partners would represent a valuable resource especially when a company has to manage services in different geographical positions. Moreover, the bigger and the more developed is the model, the higher is the importance for a company to have available information on the position and state of its products. Imagine for example, how many difficulties car and bike sharing companies would have if they did not know where their products are and if they are available or not or if they are in good conditions or not. Of course, it would imply high logistic costs, but fortunately, technology can represent a solution; for example, regeneration cycles can be carried out according to a centralized model. Furthermore, as said before, the model requires that the company build solid relationships with its customers. Sometimes, it might happen that customers ignore some costs related to the maintenance and final recovery; for this reason, the company has to be very clear in indicating all the costs related to the product. Another issue regards the fact that often, people do not pay high attention to a product that is not theirs; it implies a faster strain; companies should develop mechanisms that attribute responsibilities to the users and, in the meantime, teach them how to use correctly the products.

Now, we might analyzed better a practical example: *Daimler- mobility as service through car2go*: People will always need transport; however, not all find comfortable and convenient buying a private cars or resorting to taxi. These people represent the

main target of “Car2go”. In 2008, Daimler, a German car manufacturer, has launched a new business unity, offering to its customers the instant access to transport services without the need to own a car or to find a taxi. Users can register to the online site and, once Car2go has verified all the conditions, gives the authorization to benefit from the service. Customers pay a price based on the usage time, without any adding fee for deposit, oil or parking. People really appreciate the possibility to use a car for one way, bringing it in a point and parking it in another indicated. Customers are encouraged to participate to this project, making the service better and better, through different incentives such as free minutes. The company exploit data collected on the paths and on customers to improve the quality and reliability of the service. The secret of success for Car2go is the creation of a flexible, comfortable and affordable price; it implies that cars are easy to find, to use and to give back. In substance, Car2go has created a new revenues flow and, at the same time, has given a significant contribution to an economy less dependent to resources; indeed, car-sharing services reduce the number of vehicles and parking needed in an urban center, using efficient vehicles regarding the energy consumption.

2.6 How to implement a circular business model: strategic choices

As said previously, more and more companies –both startups and multinationals- are adopting these circular models. Some of them with important results, others less. In particular, according to Peter Lacy, Jacob Rutqvist and Beatrice Lamonica (2016), there are specific factors that determine the success of the model, such as the control of the basic elements: *choice of the circular business model and the choice of strategy implementation.*

Choosing the right model represents the first critical choice for a successful transition toward circular economy. In particular, this choice implies several passages; first, a company needs to understand very well how it uses resources. It has to know precisely which types of energies and materials go in each product, in which moment and how customers use and waste these resources. More precisely, a company needs to know where it is vulnerable relatively to scarce resources and risks associated to them. It has also be aware about the value chain's points where there is not a productive use of resources due to wastes in productive, usage or in dismantlement processes. In this phase, a careful analysis on potential impacts of changes in the revenue account might be highly useful in helping companies in understanding what materials might have a higher negative impact on business if their offer reduced significantly. Only later, in a second phase, company should focus its attention on how to improve resources' productivity.

In this first analysis, it might be useful to concentrate on four types of linear economy's wastes:

- 1- Waste resources: energies and materials that cannot be continuously regenerated, but they are consumed and lost forever.
- 2-Products with a waste life cycle: products with a short functioning life cycle or products thrown away even if there is still a market demand.
- 3-Products with a waste capacity: products that remain unused even it is avoidable- a clear example in this meaning are cars, unused for the 90% of their existence.
- 4- Wasted valuable components: parts, components and energies not recycled.

Companies can resort to the five circular business models as framework to orient themselves in the exploration of possible ways to transform the usage of resources and value proposition in order to capitalize the elimination of waste. The goal should be to ensure that the company is *as proof of future* respect to the impacts on revenues, costs, risk and on reputation. This goal is achieved by two passages: separating the growth of the company from limited resources and ensure that flows of revenues are linked to the new modus operandi. The second passage is to decide which approach to follow: a “pure” approach- where only one business model is chosen- or the “mixed” approach where the company uses two or more models together. The latter is more complicated to implement than the former, but it generates more value because the company can exercise a higher control on a larger part of the value chain.

After having chosen its own model or models, the company has to *choose the right approach*; actually, there are different alternatives to implement it (or them). The right approach depends on many factors, such as the company’s ambitions, the risks that the company would run, the amount of available financial resources, the political and legislative context and its own current capacities. There are cases in which, for the company, it is better starting from a small and focused initiative, using just one model for a pilot project in a specific business unit and only in a second moment apply it on large scale. Even if this approach reduces the risk, at the same time, it limits the measure in which the new model can have a positive impact on the business. In other situations, mainly when the company wants to become rapidly a leader in the adoption of circular principles-or when it is exposed to an imminent threaten for the scarcity of resources- it might be better to start with a wider implementation phase. A third possibility is

launching the new business model through a joint venture, founded with another company- in this way, companies avoid to expose to risks their core business.

In order to implement successfully the model chosen, the company needs to involve external partners to fill the existing lacks. Usually, companies do not have inside all the capacities and technologies required in order to realize this passage. This is the reason why, many companies resort to external facilitators- namely, other companies that help them to apply circular models by providing correlated services. In particular, these facilitators help in reducing time, costs, complexity and risks during the implementation of a new business model. The majority of facilitators provides services along the logistic chain of recovery, allocating products that return to the company from markets. The management of the logistic chain is the area where company suffer the lack of capacity and experience. A good example in this meaning might be H&M. Actually, this fashion chain has been putting effort in recovering used clothes in order to recycle or resell them for years, with solid logistic capacities. However, when the company decided to create inside its shops different collection centers, it needed help to sort the clothes returned. The solution was I:CO, leader in collection, sort and recycle of textiles. H&M sells the clothes to I:CO and then I:CO sells or recycle them.

In addition to the recovery chain, there emerging facilitators willing to assist companies in previous phases of the value chain, offering services that help companies in designing products in order to increase the efficiency in terms of re-usage and recyclability. Or, another typology of facilitators provide financial services to facilitate the implementation of circular models.

By time, companies go beyond the simple usage of facilitators and start to manage themselves a set of independent activities; in particular, they start to analyze their own

value chain to involve a set of different customers, providers and key partners. In this meaning, an example can be Carlsberg, which in 2014 launched Carlsberg Circular Community with six global partners. This initiative is generating an optimized packaging for the recycle and re-usage. For a long time, Carlsberg has been using solutions to reduce its dependency on natural resources, such as selling re-usable bottles of glass, its cans that can be recycled at the infinite; the company sells its by-products to local farmers.

2.7 Circular Economy and Technology

These new business models offer to companies important possibilities of choice for a transition toward circular economy. However, this huge evolution would not be possible without the support of *revolutionary innovative technologies* such as social, mobile, analytics and cloud-based technologies; indeed, in the past, sharing of consumer goods, information costs, requirements for workforce and obstacles to collaboration created barriers for the application on large scale- now the technology is demolishing these barriers. Today, more and more companies are trying to automatize these logistic activities mainly through software. In particular, companies are gaining more and more success thanks to ten disruptive technologies, which belong to three categories: *digital, engineering and hybrid technologies*.

2.7.1 Digital Technologies

Digital technologies enable sharing of information in real time among users, machines and management systems. These technologies offer the modalities of contact needed to

maintain solid the relationship after the selling. The five most common digital technologies are: *mobile technology, social technology, cloud computing, machine-to-machine communication (M2M) and big data analytics.*

-*Mobile technologies*: For “*mobile technologies*”, we refer to a mix between hardware, operative systems, networking and software that allow users to have access to some contents where and when they need. These technologies encourage the adoption of circular business models by the creation of conditions for a universal and convenient access to data and applications. Little by little that consumptions’ behavior transfer in a mobile and online context, there is a strong reduction in the demand of virgin materials. Moreover, mobile technology is crucial for circular economy also because they ensure a more accurate management of material products; it happens in two ways:

-It enables the meeting between demand and offer in an easier way: users can verify in a simple way the availability, location and the price of goods and they can also communicate directly with the provider.

-It facilitates and improves the user experience through the remote interaction among clients, providers and goods. In particular, mobile apps have reduced significantly management maintenance costs that, in the past, represented the main obstacle in promotion of recovery goods.

-“*Machine-to-machine Communication technologies*” (“*M2M*”): they represent technologies of communication and they enable machines to exchange automatically information without any human intervention.

Actually, the concept that machines can communicate among themselves is not a novelty; this technology has been using for a long time. This technology plays a key role still today mainly for “Sharing Platform” and “Product Service System” Business Models because it enables companies to manage goods without the costly human assistance that, historically, represented a barrier to the adoption of the models. Managing remotely goods enables a reduction in maintenance and assistance costs by 30%, reducing risks linked to efficiency.

-“*Cloud Computing Technologies*”: for “dematerialization”, we refer to the process of substitution of a material object with a digital alternative; cloud computing is crucial for this process. Indeed, it enables companies to transmit online contents and applications to more devices connected to Internet and encourage clients to interact through social technology. In this way, a company can enable consumers to buy or use services from whatever place and in every moment, transferring their data to the cloud; of course, customers are highly attracted by the possibility to spare time and money by buying goods or services directly from home. Cloud computing technology offers benefits also for companies because, for instance, usually, cloud-based services imply a lower initial investment than traditional shops and digital assets do not require storehouse’s costs.

-“*Social technologies*”: despite the fact that social networks were born as tool to enable people to make new friends or find relatives, today they have been evolved in something more. Social technology is essential in a context of sharing-consists of communicative and interactive tools that build a contact between users

it enables companies to receive rapidly and at lower costs, feedbacks from customers to improve products or services offered. This technology is essential also to create a climate of trust among consumers; it creates a relationship between them and generates a community where people meet, share their experiences, exchange reviews in order to reduce the risk of delusion from customers. Moreover, companies might use their online customers to develop new ideas to strengthen value proposition.

-“*Big Data Analytics technology*”: in Circular Economy, many companies generate their revenues through the usage of their products-not through the selling- and their growth is based on the capacity to understand customers’ behaviors and the different modalities of usage of products. It implies monitoring and analyzing data in a completely new way; this is the reason why, analytical technologies can represent important tools to optimize the value proposition for the clients. In particular, data analysis through software and hardware is extremely useful to forecast customers’ behavior and to spare significant amounts of financial, human and natural resources. In this meaning, the company “Digital Lumens” represents a practical example: this company, that provides solutions for the illumination of offices and public buildings, offers a mixed service of LED lights and software able to optimize energy performance by a deep analysis of consumers’ behavior, sparing up to 90% of energy consumption.

2.7.2 Engineering Technology

As explained also by Peter Lacy, Jacob Rutqvist and Beatrice Lamonica (2016), it is important to analyze also the *engineering technologies*.

While digital technologies are relatively new, engineering technologies, born by scientific research, have been using for decades. In particular, there are three typologies of engineering technologies, crucial for an efficient implementation of the circular business models:

-technology of modular projection: it enables the creation of goods from single components that can be easily removed and applied. This approach makes easier and more convenient substituting, repairing, regenerating and recycling components. This kind of technology is revolutioning not only the function modalities of the products, but also their duration and the relationship between customers and products. Indeed, when a product created by modular projection breaks, only the defected component is repaired such that the product remain available longer for users, with a longer life cycle. This mechanism facilitates also the continuous updates of capacities and functionalities required by customers.

-Technologies of advanced recycle: Even though recycle is not s novelty, it has benefited from different innovations and rapid and significant returns generated by investments related to circular economies. These technologies enable companies to recycle materials from complex sources as electronic articles. In particular, the usage of sensors is important; they are able to identify and classify the different components and materials of a product. Previously, we have seen the crucial role played by technology of advanced recycle for the company “Desso”, able to recover fibers from carpets at the end of their useful life in order to generate new flows of materials that can be recycled.

-Technologies of biological science and materials: these technologies deal with chemical aspects of life, focusing on the structure and on the property of materials at molecular and atomic. They play a crucial role in promoting the substitution of inputs on

large scale and they will provide new ways to transform output making them usable as inputs- an example is the conversion of carbon in renewable methane.

2.7.3 Hybrid Technology

The most important hybrid technologies are *recovery and tracking systems* and *3D prints*. Recovery and tracking systems support in many ways circular business models; they are physical and digital systems that enable the tracking of products and interact with customers-for this reason they are crucial to facilitate the recovery on large scale of used goods at convenient costs in order to control, repair, recover and reuse them. In this way, they make more convenient the recovery of used products aimed to their control, repair and recycle. An example in this meaning in “2 Revolution”, a waste management company, which has studied five typologies of logistic solutions called “Recyclogistic”, able to collect data to track all the materials recycled in every place and client.

The 3D print is becoming one of the most important components of the industrial world and one of the main drivers of the circular business models. First, it facilitates repairs- it is possible to print only the needed components with the right dimension and it creates opportunity to use circular inputs-biodegradable inputs or inputs recyclable at the infinite. Moreover, not only it enables to spare a huge amount of resources over the production system- since it uses the precise amount of resources needed, avoiding waste- but also shorten the designing, the development and the time-to-market of products.

2.8 Barriers to the adoption of circular business model: the role of Institutions.

Despite the fact that circular economy is gaining more and more importance, there are still different barriers that threaten to lessen the circular transition. Barriers such as the discontinuous quality of products projected without the application of a circular approach, value chains based on obsolescence of products, the scarcity of tools to monitor and check products along the entire value chain and the lack of valid infrastructure to recover in an efficient way resources from the market. In order to accelerate the circular economy's growth, it is needed a strong synergy among *politics, technology, investments and consumers*.

In particular, there is a common vision according to which institutions can play a key role in the removal of barriers and in the promotion of the circular business models' adoption. According to many CEO, governments should do more in order to create the needed conditions, especially in the private sector. They can be considered as an essential *enabling factor* for the growth of markets based on circular economy through the combination of three elements: *financial incentives* in order to encourage companies in focusing on the productivity of resources; *regulations* to discourage waste production and promote *information and material infrastructures* that facilitate the flow of circular resources.

In this regards, over the last years, European Union has given an important contribution toward the sustainable challenges to face for instance by the creation of "European Resource Efficiency Roadmap" and the relative "Resource Efficiency Platform"- a commission aimed to provide European Commission, member states and private organizations with high level guidelines for the transition toward a more efficient economy regarding management of resources.

Over the last years, European Commission has always reaffirmed resources' efficiency as a pillar of its economic politics, setting as goal becoming an intelligent, sustainable and inclusive economy. More precisely, EU policies regarding waste are inspired to the "hierarchy of waste" approach, according to which, first it is needed to prevent waste production and then reuse, recycle and recover resources. In particular, Denmark has developed the strategy "Denmark zero waste", focused on the improvement of the exploitation of valuable components of resources, reduction at the minimum of environmental impacts and the improvement of recycle through new partnership between the public and private sectors. At the same time, it is important to recall also the initiative of the Scottish government, called "Safeguarding Scotland's Resources", which aims to reduce the usage of materials and virgin resources by substituting them with recycled resources. Furthermore, outside Europe, China has designed the "Law of promotion of circular economy of Chinese Popular Republic"; this law is aimed at the promotion of circular economy, at the improvement of resources' usage and environmental protection.

All these initiatives show the strong and increasing ambition of political exponents in sustaining circular principles. However, the path toward a real and systematic change is still long and, mainly, it is important that politicians continue to maintain promises done in the past. In particular, there are three main measures that governments need to implement soon:

-Creation of *equal conditions* for a circular and linear business model: current norms attribute to the linear model an unfair advantage, since they make more convenient under the financial aspect the growth through the exploitation of resources' usage. In this meaning, it might be useful to transfer taxes from people to resources, because the

current system encourages exploiting resources' extraction rather than investing in people and processes to obtain a higher productivity from resources already in usage. A possible solution might be represented by the "*Who pollutes, pays*" principle: today, there are still incentives in using linear resources, such as fossil combustibles; in order to invert this trend, governments should punish companies that waste resources by the principle "who pollutes, pays". Governments might tax companies that resort too much to landfills or incorporating the cost of environmental impact directly on the final price of the good.

-Accelerating the progress toward "zero waste" goal: it represents another issue which governments should focus on. In order to achieve this goal, preventing the creation of waste should be the approached on long term. How? Developing international standards and public databases able to inform companies and local people on the nature of waste's flows might help to improve the collective management of waste- developing programs that increase the awareness among local authorities and local communities regarding the benefits of reduction of waste and benefits of a more efficient resources' usage. In addition, developing updated regulations that facilitate the international commerce of waste would represent another important contribution.

-Ensuring the maximum exploitation of assets: it represents the third and the last initiative suggested which governments should focus on. As we know, recycling is not the only possible solution; one of the best solutions to avoid that products go to landfill is maintain products in usage as long as possible. To adopt this solution, governments should update the current policies on recycling; for instance, norms related to vehicles at the end of their useful life that attribute benefits when vehicles are recycled, but not if

they are regenerated. Governments need to develop new regulations that recognize benefits deriving from regeneration- in some cases, even better than those deriving from the recycle.

In conclusion, it is important to be aware that huge progresses have been made in the circular transition through the adoption of new and innovative business models. However, there are still many things to do.

Circular Economy's application on large scale requires an astonishing synergy between companies and governments- if one of the parties is absent, it is likely that progresses remain limited and slow. Governments need to do more - inside and outside their boundaries, developing international contexts that encourage circular transition.

CHAPTER 3

AQUACOMBINE PROJECT: How to meet the future world food demand?

3.1. Research objectives and methodology

After carried out a literature review about Business Model and the challenges that sustainability issues have brought to the BM concept, in this chapter a practical case of a Circular Business model is presented.

The research is based on a qualitative analysis of a single case study, the Aqua-combine project. Given the novelty of the topic, qualitative analysis appeared to be the suitable solution in order to understand the complex phenomenon in its real-life context

(Eisenhardt, 1989; Yin, 2009). The aim of the research was to better understand the implementation and managerial challenges of developing a circular model as the Aquaponics systems, as well as analyze its commercial viability.

Data were collected through different methods. First of all, the author actively participated in the implementation of some activities during his curricular internship in “IrRADIARE, l&d engenharia e ambiente, lda”, a company directly involved in the project. Particularly, he participated in the market analyses on organic products in Finland.

Then additional data was collected through interviews with some key informants. First, Joana Good da Silva, International Communication Officer and Elsa Nunes, the Owner of IrRADIARE company were interviewed in order to understand the role played by the company in the project. Then, Joao Cotter, the CEO of “Aquaponics Iberia”, a young Portuguese start-up that has developed an interesting aquaponics system called “Fish N’Green” was interviewed to gather additional data on the process of developing the circular solution.

The interviews were done face-to-face, starting by explaining the purpose of the thesis and the different topics. The interviews were carried out in an informal and open way by presenting relevant questions and encouraging for free conversation. The questions for each interview were planned beforehand to clarify all the main aspects of the project. Moreover, more specific questions about the discussed issues came up during the interviews.

Then additional sources, such as books, publications, videos and articles about Aquacombine project and aquaponics systems, were used to triangulate the data.

The data collection and the period of observation lasted from 01.11.2022 to 31.01.2023

3.2 Case description: Aqua-combine project

3.2.1 The soil salinity worldwide challenge

As analyzed in the previous chapters, companies and organizations will face many challenges in the future due to the continuous changes in the environment. One of the most important challenges of the 21st century will be to meet the growing demand for food, which is expected to rise by 50% by 2030. Actually, facing this challenge will be more and more difficult if we consider one of the main problems that currently is affecting many regions around the world: *soil salinity*.

Soil salinity is one of the biggest problems that many regions around the world are facing right now. It is considered the major cause of farmland degradation: 24% of the world's usable land is degraded, costing an estimated \$490 billion USD per year; in the EU, 6.7 million hectares are affected by salt, and 72 million hectares are sodic, which is twice the size of Germany. In the south, along the coast, where salty water is used a lot for farming, desertification is the biggest threat. An EU ComCoast study pointed out that rising sea levels pose a threat to the coasts of Northern EU countries because salt water is getting in. Moreover, the US Department of Agriculture says that improper irrigation causes salt to build up on 10 million hectares of arable land around the world every year. In fact, the main reasons for the significant rise in soil salinity are over-irrigation of agricultural land, inefficient use of water, and poor drainage of soils. This is why it is so important to come up with innovative circular solutions to this worldwide problem as soon as possible. Many projects have been made in this way over the past few years, and Aqua-combine is one of the most interesting.

The Aqua-combine project represents a new circular business model, which aims to provide sustainable solutions to meet the future world food demand through the exploitation of an innovative technique, called “Aquaponi”: a synergic combination between *aquaculture and halophyte farming*-farming of saline tolerant plants such as *Salicornia* or *Crithmum*- using the principles of circular economy. The project proposes an integrated model on farm-aquaponics system that recovers and re-uses waste within the system to create both internal value and co-production of multiple products such as fish, halophyte vegetables, and pure bioactive compounds, as well as biogas from the final residues of the plants. Moreover, combining aquaculture, farming, and bioprocessing can help desalinate salt-affected areas and is easy to combine with sustainable management of natural areas and use of marginal lands to create value and jobs in rural, remote, and salt-affected areas. A Consortium of partners from seven different countries developed this ambitious project. It started on October 1, 2019, and is expected to last 48 months. Each partner of the Consortium is presented in Table 3.1:

Table 3.1 Partners of the Consortium

3.2.2 Aqua-combine project: What is it?

As previously anticipated, in order to develop innovative circular solutions to meet the future world demand, the Aqua-combine project focuses on the cultivation and bio-refining of a new type of salt tolerant plants able to produce more food and plant material for bioenergy and biochemical resources on marginal land. One of principal plants cultivated is *Salicornia*, a halophyte energy plant that can grow on saline lands without requiring fresh water for irrigation. Halophytes are able to grow at high salinities above 200 mM (11.68 g/L NaCl) because they can protect themselves from excess of salt from the soil and water - the level of tolerance depends on the species. Thus, some halophyte species such as *Tripolium pannonicum*, *Salicornia* spp., and *Crithmum maritimum* are considered salt-tolerant species with a promising potential for use in soils degraded by salinity. Their productivity depends on several factors including agronomic management weather, soil salinity, and plant species.

These types of plants present both fresh food and non-food parts. The tasty fresh food tips of Haophytes - such as *Crithmum maritimum*, *Portulaca oleracea*, *Salicornia* spp., and *Aster tripolium*- have been used as food by humans for hundreds of years, and they are still often gathered from the salt marshes and salt pans of Europe. A wide range of cultivation systems for using halophytes to grow gourmet vegetables for salads and

clean saline effluent have been developed and put on the market. Moreover, these species are known for being able to make large amounts of bioactive secondary metabolites. Halophytes have simple and complex sugars, amino acids, quaternary ammonium compounds, polyols, and antioxidants as secondary metabolites (e.g. polyphenols, b-carotene, ascorbic acid and ureides). These compounds could be used in functional food, which is defined as food that can help prevent disease or improve health. Modern awareness of the importance of a healthy diet opens up new markets for halophytes with high nutritional value. This is clear from the fact that people are eating more products made from some halophytic plants (e.g. Salicornia and quinoa)

However only about the 20% of the Salicornia plant is suitable to eat and the remaining plant cannot be used in traditional means because of the high amounts of salt in the plant. Considering that the leftover plant mass still has innumerable interesting possibilities as it contains proteins, sugars and other components that are easily extracted and could provide additional revenue after the harvest, the Aqua-combine project focuses on the non-food component of these plants- or residues- which represent almost the 80% of the halophyte plants. In particular, residues consist in a *woody part*- a dry halophyte straw (investigated as a source of pharma- and nutraceutical products due to its high content of phytochemicals e.g. hydroxycinnamic acids) and a *non-food green halophyte biomass*. The Aqua-combine project aims to increase significantly the value of this fraction in line with the principles of circular economy. How? Combining the cultivation of salt tolerant plants with aquaponics systems. More precisely, plants are grown in a watery solution containing all necessary mineral nutrients for optimal growth, a so-called hydroponic culture. Growing plants in hydroponic culture has several advantages including efficient use of nutrients, higher yields, use of less space,

higher water use efficiency, among others. Different halophytes including *Salicornia Europaea*, *Tripoliumannonicum* and *Crithmumaritimum* are successfully cultivated in hydroponics in a greenhouse, exposed with artificial light, as demonstrated at the Leibniz University Hanover.

Here, excess nutrients from the fish production will be used as fertilizer for the halophyte plants and filtered through a microbial water treatment system to enable recirculation of the water back into the aquaculture tanks. In particular, the recirculatory aquaculture system (RAS) consists of a water treatment unit (NanoRAS) and two culture tanks (3 m³ each) with a total system volume of 7.5 m³ and water is recirculated >96%. The water level is adjusted constantly in each tank with tap water to compensate for evapotranspiration - each container hosts eight plants. According to the results, high amounts of biomass can be produced under hydroponic conditions - however, the productivity depends on the salinity in the medium and on the plant species.

3.2.3 Aqua-combine project: Halophyte properties

Once the halophyte plant has grown, it is important to separate the eatable parts, which go straight to the market, from the non-eatable parts, which go through many processes and analyses to get circular values. In particular, looking at non-food biomass, the lignified part can be bio-refined to get, on the one hand, extractives rich in antioxidants, antimicrobials, and anti-inflammatory compounds that are very useful for medicine, and, on the other hand, free fibers that can be used to make biogas and feed products. Moreover, it is possible to obtain a green juice from the green non-food compound. This juice has many nutrients, but it also has a lot of salt. Centrifugation is the best way to

concentrate the nutrients and reduce the amount of salt. This is a process in which we spin a liquid to apply force to it. This makes protein-rich chunks separate from the liquid and sink to the bottom. After spinning, both the liquid and the salt are taken out.

The green juice is full of proteins, lipids and carotenoids- and a green pulp useful for the production of *biogas, cosmetics and feed production*.

It is important to highlight the potential role played by the green halophyte juice for the production of *bioactive and protein-rich feed supplement for aquacultures and livestock*. Indeed, not only it contains a good protein percentage, but also this *Salicornia* co-product may potentially serve as a source of carbohydrates in fish feeds, allowing for a reduction on the use of cereal edible crops like wheat. The European seabass (*Dicentrarchus labrax*) is one of the most representative species from the aquaculture industry in the Mediterranean Sea, and therefore, the potential of incorporating *Salicornia ramosissima* biomass replacing wheat meal in diets for juvenile seabass was evaluated.

The protein is separated from green juice by acidification, which is done by fermenting the juice with lactic acid bacteria. During the fermentation, the produced lactic acid decreases the pH of the green juice, which makes protein insoluble in water and allows it to coagulate. Therefore, the protein-enriched concentrate can be easily separated, for example by centrifugation. As the produced cell mass is also present in the concentrate, it is desired to perform the fermentation using probiotic *Lactobacillus* strain. Halophyte species considered in Aqua-combine project are relatively rich in protein, for example, the crude protein content of green juice dry matter from *Tripolium pannonicum* (sea aster) is up to 36.7 % which is comparable to common legumes, such as lentil and chickpea. *Tripolium pannonicum* juice also has high concentration of available sugars,

thus additive feeding of micro-organisms is not required. Probiotic protein-enriched concentrate could also be a source of some other health beneficial compounds, such as phytochemicals and healthy fatty acids. The liquid fraction after separation can be utilized in biogas production, leading to zero-waste process. Overall, this method is cost-efficient and safe, and does not require high process temperatures or use of hazardous chemicals. Required fermentation time is also short, and processing requires only a few equipment.

Three diets containing *S. ramosissima* biomass at 2.5%, 5%, and 10% inclusion levels were tested versus a commercial diet. After 62 days of feeding, fish growth performance, survival and feed digestibility were similar among all diets. Additionally, *Salicornia* incorporation seemed to provide some antioxidant supplementation to fish and improve their response to an inflammatory insult when compared to the commercial diet. Data from this study suggests that *S. ramosissima* biomass can be included in diets for juvenile seabass up to 10% of their composition with no detrimental effects on growth performance or survival, while providing some beneficial effects to their antioxidant and innate immune response and promoting DNA integrity. This is the ideal scenario for adding value to halophyte production and potentially improve aquafeeds sustainability by replacing wheat meal, which is a valuable resource for human consumption.

In addition, there is also an economical reason that pushes the integration of halophyte residues in the fish diet. Indeed, the white leg shrimp (*Penaeus vannamei*) is the most produced crustacean species worldwide; however, feed associated costs are substantial.

In fact, cereal prices have been increasing over the years, making the creation of more economical and sustainable formulations essential for the success of shrimp farming.

Moreover, it is important to highlight also the pivotal role played by the *pharmacological activities* in bioactive plant extracts in sustainable biomedical applications. Bioactive phytochemicals, including natural compounds, secondary metabolites and their derivatives, have attracted significant attention for use in both medicinal products and cosmetic products. Such potential beneficial dietary factors in small doses and complex combinations (e.g., polyphenols, fibers, polyunsaturated fatty acids, etc.) for lifestyle changes can lead to reduced inflammation and improved health. Several studies have proved antimicrobial effectiveness, pain relief and anti-inflammatory activities of halophytic plants. This is the reason why, in particular *Salicornia* has been used as folk medicine and functional feed for many years. It is important not to underestimate the potential medical effects that might represent a significant value in order to solve future world health challenges. Especially, if we consider that the increasing bacterial resistance to antibiotics has developed due to different factors such as overconsumption of antibiotics against bacterial and nonbacterial infections and unregulated use hereof.

Actually, the properties of *Salicornia* bioactive extracts, for modulation of pain and itch sensation, remain unclear. The Consortium carried out an exploratory study, obtaining ethical approval to test 30 healthy volunteers for treatment with 10% *Salicornia* cream or inert vehicle cream for 24 or 48 hours. On day 0, and 24 or 48 hours post cream application thermal detection and pain thresholds, mechanical pain thresholds and sensitivity, and micro-vascular reactivity were assessed to evaluate the effects of cream

containing *Salicornia*. Data indicate an overall effect of the bioactive cream to reduce histamine induced itch although the study design and time-frame selected also show need for further assessment of the long-term effect after prolonged use. Future use of green technologies and renewable ingredients, as the *S. ramosissima* infused skin cream, as a putative primary treatment to reduce symptoms like itch and pain in different skin diseases, such as psoriasis and atopic dermatitis, could be favorable.

Finally, the Aqua-combine project investigates the full valorization of halophytnutre plants to produce bioenergy and bio char. An integral use of the halophyte plant is of key importance for the overall profitability of this innovative crop and enables reaching a close to zero waste-balance.

One important barrier to reach this goal is to deal with the most recalcitrant components of the plant. Lignin is, by weight, the major recalcitrant fraction of the halophyte plant that cannot be directly transformed into biogas. The solution might be represented by a separate process of treatment at high temperature (i.e., pyrolysis) under carefully selected conditions is used to transform the lignin granulates into a porous carbon material known as activated carbon. This product finds commercial application as filtering media for purification of water and air streams. As such, it can be used as filler media in filters for the purification of water streams generated in the hydroponic systems that are used for the cultivation of the halophyte plants. This approach not only provides a circular economy approach to the halophyte crop, but it also contributes to develop a commercially viable product obtained out of the main recalcitrant component of the plant.

3.3 Aqua-combine project: the role of Business Model Canvas

As a results of the period of observation and interviews data analysis it was possible to define the Business Model Canvas of both the Aquaponic Project for the Finland market and the Fish N' Green farm. Business Model Canvas was developed by Osterwalder and Pigneur in 2010, and still today, it represents one of the most important and interesting visual tools to represent and highlight all the main aspects of a Business Model.

3.3.1 Business model Canvas of the Aqua-combine project

Following, it is possible to analyze the nine components for the Finnish market:

- *Customer segments*: It is important to highlight that Finland is recording a higher and higher growth in organic market- in 2019, it was the 11th EU organic market, reaching a value of 366 million of euros; in 2021, EUR 407 million in organic products were sold in grocery stores. Year by year, more and more Finnish consumers are becoming interested in responsible food choices, trying to avoid products with pesticides and antibiotics. However, according to Stata (2020), the income level also has a significant impact on organic food consumption, as individuals with an annual income of over 60,000 euros eat organic food more often than individuals with lower salary levels. Moreover, according to a study (Suurkeittiötutkimus 2014), organic ingredients are used at least once per week by more than one fourth of the professional kitchens and, at the same time, the use of organic ingredients in the catering sector has exponentially grown. These are the reasons why, the Aquaponics business might be particularly useful to

satisfy needs of several specific customer segments, such as professional kitchens, catering sector and needs of high-income family.

-Value proposition: many researchers demonstrate that demand for organic food is significantly increasing; at the same time Finnish consumers are becoming more and more careful to responsible food choices, preferring biological and healthy products. This is the reason why, the value proposition of A Aquaponics farm systems might consist in providing fresh vegetables, free from pesticides and antibiotics, and local fish rich of proteins.

-Channels: companies might reach out potential customers interested in fresh vegetable products through many channels. In particular, in 2019, around 81% of 38 Finnish customers totally rely on ordinary grocery stores whereas 27% and 13% depend on specialized organic markets and farms simultaneously. In the same way, 4% of Finnish customers buy organic products online. (ProLuomu, 2019.).

This data suggests that direct channels are more effective than indirect ones.

-Customer relationship: Nowadays, Finnish consumers have significantly increased the level of attention toward daily food choices; they want to know precisely how a product has grown, where, what it contains, its nutritional values, etc. The main aim of companies is to develop a solid customer relationships based on trust and customer loyalty. In this meaning, personal assistance relationship can be considered as a key factor, establishing an easy and direct communication channel with consumers, in order to provide them with all the information required developing a sense of clarity and transparency.

-Revenue streams: according to Proluomu (2019), the population of Finland is mostly attracted towards the vegetables, fruits, and dairy products. The total sales of organic

vegetables are 4.5% followed by 7.5% of organic fruits and 4.5% of dairy products. In aquaponics farms, the most targeted product can be green leafy vegetables or profitable fruits such as strawberries, tomatoes as well as fish. The revenue of the farm can be generated by selling vegetables and fish to the grocery store, professional kitchen, farmer market and ordinary market.

-Key Resources: key resources of aquaponics farms can be divided into four sections: *human, intellectual, physical, and financial resources.*

Human resources of the aquaponics farm are the proprietors who are developing their farm by maintaining the premium quality of their outcomes. In the same way, the laborers, or experts producing their outcome to delivering the product to the targeted consumers are also considered as a human resource.

Intellectual resources: the knowledge and skills to run an aquaponics farm efficiently and effectively is the vital intellectual resources. The experts want to get the higher yield in less time to meet the demand. Therefore, having a higher understanding and production of the high-quality product using the quality equipment leads to gaining the brand reputation which makes the farm unique, among others.

-Physical resources: in order to establish a successful aquaponics farm, land and various equipment necessary to run the aquaponics system are the major requirements, which can be acquired according to the initial capital of the business. This equipment varies according to the crops and types of fish, which are grown to generate revenue.

Finance resources: in order to operate such aquaponics farms efficiently, strong financial structure is needed, since the different technologies used to set up aquaponics farm indoor require a high investment. Mostly, the financial resources consist of the

proprietor's own investment as well as different loans from different sources such as government or private.

-Key activities: the main activity of aquaponics farms is to figure out the most valuable crops demanded from the market and offer those crops and fish in a superior quality to the market as well as the knowledge to grow the food indoors. Since, the demand of different crops varies according to the seasons, the demand should be pre identified and delivered to the sales channels.

-Key Partners: in aquaponics farms, the key partners are the suppliers of the vegetable's seeds and feed for the fish in the farm. In the same way, the supplier of packaging boxes for the vegetables is crucial in order to maintain the premium quality of the product for a longer time. Similarly, some technical support teams as well as consultants are another key partner of the aquaponics farm. Another valuable key partner of an aquaponics farm can be a law firm to guide the farm according to the policies, patents, trademarks, etc.

-Cost Structure: in order to operate aquaponics farm, the finance should be observed carefully and spent precisely to acquire the land and facilities, heat energy, light energy, controlling and maintaining the whole aquaponics system, to operate the distribution channel, to run the own physical store and online store, marketing cost and whole production cost. The ultimate aim of business to minimize the possible cost and maximize the profit.

3.3.2 Fish N'Greens Business Model

Fish N'Green is a urban aquaponics farm, located in Torrevedas, near Lisbon, that produces and delivers fresh food to consumers. It has the capacity to provide 130 tons of local and fresh vegetables and fruits per year, without pesticides or syntethic fertilizers;

combining high tech and nature, it grows also the healthiest and freshest fish with the best quality without medicines, heavy metals, micro plastics or other contaminants, in a fully sustainable way. Here, technology increases productivity and safety, reducing maintenance, water and other resources. This reality has been generated by Aquaponics Iberia, a young Portuguese start-up that is revolutionizing the current food productive system through innovative and efficient aquaponics systems.

Fish N'Green has been able to conquer a significant credibility and loyalty not only among Portuguese consumers, but also around Europe- many reviews demonstrate the excellent job done over the last years. In particular, it has been possible thanks to the development of a precise Business Model Canvas as following:

-Customer segment: Fish N'Green provides solutions for many and different segments, such as food retailers (supermarkets, organic and gourmet food stores), restaurants, hotels, ecommerce (home delivery to consumers or company's offices), schools canteens, universities and companies in general. More precisely, the company identified the following consumer targeted archetypes: healthy consumer (looking for healthy and organic food); green consumer (looking for sustainably produced food, with small environmental footprint and animal welfare), local consumer (looking for locally grown and trustable food sources).

-Value proposition: Fish N'Green solution solves precise consumer needs: to find quality fresh food from trustable sources. Regarding seafood, the finfish satisfies consumers, restaurants and retailers by delivering a sustainable and responsible ASC certified local fresh product, free of medication, chemical usage and heavy metals. Regarding greens, the farm satisfies a trending demand by delivering a large variety of

fresh organic vegetables, not subject to seasonality constraints, locally produced and guaranteed not to contain pesticides. Intense tasty herbs is a significant value for chefs.

-Channels: Fish N'Green intends to communicate directly with B2B customers. The company will have its inside sales force and distribution logistics, also linked to other carriers through partnerships. Home and office delivery of fresh food baskets will also be assured.

-Customer relationship: Fish N'Green develops different ways to conquer trust and loyalty, depending on the different customers segments: providing, for instance, food product samples; guided tours to production facility; promoting products at fairs, exhibitions and on sales points of food stores; digital marketing; developing food events with cuisine chef.

-Revenue streams: The sources of revenue result from the sale of fresh food products produced by the company, namely the local certified fresh fish, organic vegetables (loose, packaged or in baskets), including leafy greens, herbs, fruits and also the sale of by-products, such as fish waste, organic compost and organic liquid fertilizer.

-Key resources: existing key resources include the team experience, knowledge, partners and developed technology. At operational level, input resources are fish feed, plant seeds, fish fry, seedling substrate and additional supplements. Virtually almost no water and energy inputs.

-Key activities: After implementing the aquaponics system, operating and exploring the aquaculture and hydroponics components, to deliver certified fresh fish and organic greens, including feeding, germinating, processing, packing, germinating, procurement, sales and distribution.

-Key partners: Partners include local municipalities (T. Vedras and Lisbon, to coordinate schools and other groups guided tours), an insect protein manufacturer, MARE (involving 2 universities and internships research team, for R&D and also to train and grow the team), a sustainable fresh food packaging company, a fish feed manufacturer and food retailers

-Cost structure: Cost structure is mainly composed of fish feed, seeds and germination substrate, packaging and fish fry, representing 26% of total operating costs and 11% of sales value. Human resources represent 58% of operating costs and 24% of sales value. Supplies and services represent 16% of operating costs and 7% of sales value.

3.4 Aquaponics system: Environmental, social and economic benefits

Despite the fact that the Aqua-combine project is still in phase of execution, it is already possible to highlight some benefits and advantages deriving from this project, and, in general, from aquaponics systems.

First, it is important to analyze the *environmental benefits* deriving from these systems, such as:

-Water reduction: aquaponics systems use approximately 90% less water than conventional agriculture systems. Here, the water is rarely changed or discarded since it is recycled repeatedly through the entire system- indeed, here there is no soil to absorb water, and aquaponics continuously uses the same recycled water. Therefore, there is no extra water involved unless the water becomes significantly stagnated. The only water lost in aquaponics is through evaporation, which is very little and will require you to replenish the water from time to time.

-Less soil degradation: aquaponics systems reduce potential erosion by eliminating the need to turn or plough the soil. The backbreaking work of turning soil and pulling weeds is gone, reducing the cost compared to a conventional horticultural farm.

-Reduction of chemical products: fish are not given growth hormones and feeding them with a natural fishmeal and fish oil diet. Some growers also use alternative fish food like duckweeds, worms, insects, and leftover vegetables to feed their fish. At the same time, in treating fish diseases, administering antibiotics may also disrupt the system's overall health. So most growers apply the common method of treating fish disease, which is isolating sick fish in a separate tank and using a salt bath solution. Moreover, in these systems, unlike the traditional agricultural systems, here plants are cultivated without the use of pesticides or chemical fertilizers.

Regarding the *economic advantages*, Aqua-combine project, but in general aquaponics systems, not only represent a huge opportunity to protect our planet regarding environmental aspects, but they offer also incredible economic opportunities. In particular, this project aims to create 20.000 direct and 100.000 indirect job opportunities for the development, engineering, fabrication, installation and operation of Aquaculture, halophyte cultivation, and bioproducts processing plants with distribution throughout EU. Aquaponics systems present a ROI in 2/3 years after the implementation, while, usually, the traditional agriculture after 8 years. Moreover, not only aquaponics systems are able to guarantee a constant production level over all the year, but also, according to Nelson & Pade, aquaponics produces eight times more food

per acre in one-sixth of the space required by traditional agriculture by 4/5 times faster than traditional agriculture, requiring one third of energy consumption than traditional agriculture.

Furthermore, it is extremely important to highlight the social benefits that aquaponics systems might generate. Indeed, these systems might represent useful tools in the education system to transmit knowledge and competence in natural sciences at the primary and secondary school levels (Hofstetter 2007, 2008; Bamert and Albin 2005; Bollmann-Zuberbuehler et al. 2010; Junge et al. 2014) and in vocational training to develop awareness topics related to Sustainability. An aquaponic classroom model system provides multiple ways of enriching classes in Science, Technology, Engineering, and Mathematics (STEM), but also also be used for teaching subjects such as business and economics, addressing issues such as sustainable development, environmental science, agriculture, food systems, and health (Hart et al. 2013).

More important, Aquaponics offers an innovative form of therapeutic horticulture, a nature-based approach that can promote well-being for people with mental health problems through using a range of green activities such as gardening and contact with animals. Over the past decade, a number of social enterprises have emerged that provide therapeutic horticulture programs for improving the well-being of local communities. The social enterprise approach builds on “social firms” by facilitating people with mental health problems to develop new skills and re-engage with the workplace.

Moreover, aquaponics systems might represent a real breakthrough not only in order to satisfy the future world demand for food, but also to achieve many Sustainable Development Goals among the twelve ones set by United Nations:

In particular, aquaponics systems might give a huge contribution in achieving the following goals:

-*Zero Hunger*: Aquaponics systems provides intensive production of fish and vegetables, allowing regions and cities to increase nutritional food self-sufficiency and local availability, including fresh fish protein and vegetables, even in adverse climatic or epidemic conditions

- *Quality education*: It is possible to organize educational courses, workshops and school guided tours in order to teach students about healthy and sustainable food and train new professionals and receive internships in partnership with universities.

-*Clean water and sanitation*: Aquaponics systems imply the growth of fresh food in a sustainable way without wasting water, continuously recycling it in a 100% closed loop and without effluents discharge. Innovative technologies enable a solid waste management system that generates water savings of over 95% compared to conventional farming.

-*Industry innovation and infrastructure*: The systems involve innovative design in integrating new technologies to generate high quality fish protein and vegetables. These systems can be replicated in different cities and regions, extending the benefits to many communities.

-*Sustainable cities and communities*: Through innovation in aquaculture and smart technology, aquaponics systems provide fresh food to close population, in densely

populated areas, avoiding transportation and making cities greener and more self-sufficient.

-Good health and well-being: Each new facility has the capacity to produce and deliver pure, fresh, tasty, local and healthy food (110 tons of fish and 400 tons of diversified vegetables), without the use of pesticides, herbicides, synthetic fertilizers or medicines. In addition, fish protein is of high quality without any contaminants such as heavy metals or micro plastics.

-Decent work and infrastructure: Aquaponics system offers the opportunity to create and train teams of professionals who will work in an innovative, challenging, ergonomic, collaborative and fairly remunerated environment, rewarding productivity and results.

-Climate Action: Aquaponics systems not only mitigate climate change, but they are also climate adaptive, being able to keep producing in catastrophic or adverse climatic conditions. The production occurs in environmental protected and controlled conditions, not influenced by seasonality, external weather conditions, prolonged drought or extreme water scarcity. In an eventual pandemic situation (e.g. closure of logistical circulation and supplies), the production system manages to continue to maintain production levels.

Compared to conventional farming, these systems saves more than 20 tons of CO₂ emissions per ton of food produced.

-Responsible consumption and production: Aquaponics systems ensure:

- Locally grow and deliver sustainable fish and organic vegetables.

- A very efficient use of resources (extremely high water savings; rational and optimized use of energy, as well as renewable energy; use of circular economy processes).
- Ensuring that no effluent is discharged to the outside of the system.
- Ensuring a reduction of about 20 tons of carbon emissions for each ton of food produced (in relation to conventional farming).
- Ensuring food safety through new technological techniques and organic production.
- Ensuring that fresh, natural and healthy food is made available to local consumers.
- For not occupying fertile land (greater availability for biodiversity and native species) and using a small, highly productive footprint close to urban areas.
- For education and awareness about environmental sustainability, sustainable food production and healthy food consumption.

3.5 Final Discussion and Conclusion

The careful analysis present in this thesis has been carried out for several purposes; first, it wants to highlight the crucial importance that Business Model has been always playing for companies and organizations' success. Indeed, used for the first time in 1957, year by year, Business Model has always gained more and more attention in practice and literature. Researchers and authors have developed innumerable and definitions of Business Model, until to arrive at a shared one, according to which it is

seen as a simplified and aggregated representation of the relevant activities of a company.

The thesis highlights how, over the decades, external factors such as higher competitiveness, a deep globalization and stronger unpredictability have changed deeply the business environment, making the traditional Business Model an outdated and inappropriate tool. Therefore, these external factors have forced companies to rethink and redesign their business models, resorting to innovation and digital technologies, which have lead companies and organizations toward the development of Business Model Innovation. The thesis has showed that Business Model Innovation might imply the change of the most important parts of a Business Model or just one single aspect. Moreover, it emerges clearly how BMI does not lead automatically to successful performance; it implies that managers need to pay high attention to mediator and moderator factors to reduce uncertainty lead by innovation. In addition to the external factors previously mentioned, the thesis analyzes also environmental factors such as climate change, the increasing growth population and the resource scarcity that are forcing companies to make their Business models more and more sustainable. In particular, through precise studies, it results evident how, through useful tools such as the Triple layered Business Model and Sustainable Archetypes, companies might be able to develop successful Sustainable Business Models in order to reduce their environmental footprint for a more sustainable future.

In addition, the thesis explains in detail how, due to the current environmental conditions, the traditional Linear Economy productive system, based on extracting resources-producing-throwing them away” principles, is no more a sustainable solution. From the analyses conducted, the urgency to develop new and innovative productive

models results being more and more evident. In this meaning, Circular Economy- based on a virtuous and synergic usage of all the resources, which regenerate, through a renewable process, the production-consumption system with evident positive environmental, social and economic impact- might represent the right solution. In particular, through the adoption of one of the five successful Circular Business Models and Circular principles, companies and organizations might have huge opportunities to exploit significant circular advantages. The examples showed in the chapter 2 of thesis clearly demonstrate the effort of companies in making a radical change toward a sustainable transition. However, the results make evident that the development of a circular economy cannot however be left in the hands of businesses alone, but has to be followed by policy instruments to make sure that, on a systems level, we decrease the economy impact on the planet.

As analyzed in the thesis, there are many environmental challenges that companies and organizations will face in the next future. One of the most critical challenges surely will be meeting the future world demand for food. Maintaining the current agricultural system, with the expected population growth rate, is no more a sustainable solution for many reasons. Not only, the traditional agriculture system requires too long production times, but also it leads to soil-quality degradation, excess water usage in irrigation and alteration of the ecosystem. Moreover, soil salinity and a rapid urbanization process are reducing significantly the amount of arable lands in the world. All these factors make evident the need to develop innovative and technological farming solutions. In this meaning, the Aquacombine project, based on aquaponics systems and developed in 2019, might represent the right solution for a sustainable future. In particular,

aquaponics systems consist in combined aquaculture and halophyte farming (farming of saline tolerant plants) using the principles of circular economy, where waste is recovered and utilized within the system to create both internal value and new products, beside avoiding the wastes. Residues are utilized within the system to create both internal value and new products.

Here, excess nutrients from the fish production will be used as fertilizer for the halophyte plants and filtered through a microbial water treatment system to enable recirculation of the water back into the aquaculture tanks. All parts of the halophyte biomass will be used for production of multiple products such as food, feed, botanical extracts and pure bioactive compounds, as well as biogas from the final residues to produce energy and a nutrient rich residue to bring essential nutrients (e.g. phosphates) back to farmland. This combined aquaculture, farming, and bioprocessing can easily be combined with sustainable management of natural areas and/or use of marginal lands to create value and jobs in rural, remote and salt affected areas. The bioprocessing will create added value to the combined farming and diversify products.

These systems present incredible characteristics through which it is possible to achieve astonishing results; in particular, capacity to be implemented everywhere; not to be subject to climate conditions; the capacity to provide a constant production during all the year and not only in specific moments; lead to the generation of potential economic, social and environmental advantages

For all these reasons, there is an increasing hope in considering aquaponics systems a key factor in ensuring a more and more sustainable future for our planet. Analyzing the

recent studies, this hope seems to be shared around the entire world. Indeed, according to Zion Market Research study, the global aquaponics market was worth around USD 872.7 million in 2021 and is estimated to grow to about USD 1807.29 million by 2028, with a compound annual growth rate (CAGR) of approximately 12.9 percent over the forecast period. More precisely, North American area has the largest market share in the worldwide aquaponics industry. Asia-Pacific region has the second-largest market share in the aquaponics industry, thanks to ongoing technological advancements. European region has the third-largest market share in the aquaponics market due to the presence of a well-established infrastructure. Moreover, due to rising demand for low operating costs combined with high yields, the aquaponics industry is expanding also in Latin America, the Middle East, and Africa.

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