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INSIGHTS ON THE PERFORMANCE OF CIRCULAR BUSINESS MODELS: RESULTS FROM A CONFIGURATIONAL ANALYSIS

RELATORE:
CH.MA PROF.SSA SILVIA RITA SEDITA

LAUREANDO: MARCO GAMBARO

MATRICOLA N. 1207024

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INTRODUCTION

At a historic time like the one we are experiencing today, where environmental pollution is increasingly growing and social inequalities are only exacerbating, a strong and resolute step towards a sustainable economy is the most plausible solution to better address the challenges that the future presents us.

Circular economy approach represents a step forward towards sustainability, following the principles of cyclical and restorative life cycle of products, elimination and conversion of wastes into resources, and auto-sufficient economic system. This theory represents an innovation of the traditional and linear economic system based on the "make-use-disposal" life cycle of the products. The transition, other than reducing the negative impacts of the linear economy, constitutes a radical change that creates new business opportunities and provides relevant environmental and social benefits.

It is thus reasonable to research if, adopting a business model that is based on circular economy, a company can achieve better performances, managing to reach better strategic objectives through the adoption of practices that favour the environment and the society.

The thesis has the objective of searching a significative and positive correlation between the adoption of a circular business model and indicators of successful business performance, such as the Return of Investment, the market share, and the number of people employed.

The sample of this study is derived from the questionnaire called "L'economia circolare nelle imprese italiane e il contributo di industria 4.0", made by Legambiente and Laboratorio Manifattura Digitale of University of Padua, in 2017; after an analysis of the total answers, a final number of 47 firms was chosen to be the reference sample.

The data are processed with fsQCA, a statistical software that employs a configurational approach that uses Boolean algebra to implement principles of comparison used by scholars engaged in the qualitative study of macro social phenomena, applying a mixtures of fuzzy (continuous variables) and crispy (binary variables) sets (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

The originality of the work is the application of a configurational analysis to accomplish a specific outcome; with fsQCA, a set of conditions is processed as a whole, resulting in combinations of them that reflect the reference outcome.

In practical terms, the study consists of finding different configurations of circular business models, intensity of breadth and depth in business relation, total years of adoption of circular economy activities, and size of the company, that present an increased value of Return of Investment, market share, and employment rate.

The thesis is structured in four chapters. In the first, there is a presentation of the theme of circular economy, with a description of the positive and negative aspects that derived from this approach. In the second, it is outlined the business model theory, with a focus on sustainable business models. In the third one, it is delineated the methodology of the work and the presentation of the results found, while, in the last one, there is the conclusion of the thesis and the analysis of the results.

CHAPTER 1: THE CIRCULAR ECONOMY

In this first chapter, it will be explained the core concept of the thesis: the theme of sustainability.

After having initially introduced what sustainability has meant in the past and what it means nowadays, outlining the positive aspects of approaching this strategy in a business environment, there will be exposed the theories of Triple Bottom Line and Corporate Responsibility, underlining their contribution in increasing the awareness of adopting sustainability policies and making more easier measuring.
Subsequently, it will be described the theory of circular economy and all its benefits.
Lastly, in the final part of the chapter, there will be presented some of the main criticisms and limitations about the concept of circular economy, based on two papers made by Zink & Geyer in 2017 and Korhonen and others in 2018.

1.1 THE SUSTAINABILITY APPROACH

"The sustainable capitalism transition will be one of the most complex our species has ever had to negotiate" (Elkington, 1997).

Nowadays, in view of issues like environmental degradation, climate change, over-consumption, population increment, and a huge economic growth, the guarantee of a sustainable future remains increasingly uncertain. Every year the "Overshoot Day", the date when humanity's demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year, fell on a date slightly closer to the beginning of the same year, marking a huge wake-up call for everybody.

That is why the concept of sustainability has become increasingly relevant in the past several years, in an economic, social, and environmental way.

The most common and prominent definition of sustainability is given by the well-known Brundtland Report in 1987. Sustainable development is described as “the development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland, 1987).
This concept focuses on long term objectives, like the reduction of production of wastes or overall carbon emissions, instead of short-term ones, as next quarter’s profit or loss.

However, approaching a sustainable business behaviour is a complex challenge for every company, because of problematics related to high investments and low short-term returns, the persuasion of shareholders about the long-term benefits of the sustainable approach, and the re-organization of the overall strategy and internal structure of the company, that has to be adapted to the change.

From 1960 to nowadays, three great waves of public pressure have pushed the actions and the way of thoughts of everyone through a more sustainable behaviour.
The first pressure wave began in the early 1960s and was intensified by a series of environmental laws from countries belonging to the Organisation for Economic Co-operation and Development (OECD) region.
The second one, and most significant, began in 1988 after the publication of the report called “Our Common Future” by the Brundtland Commission; issues such as ozone depletion and rainforest destruction helped to fuel a new movement: Green consumerism.
The third wave began in 1999 thanks to the growing trend of Globalization; after that, it has emerged a sustainable global economy through an era of intense technological, economic, social, and political metamorphosis (Elkington, Enter the Triple Bottom Line, 2013).

Since the 1990s, the sustainability sector has grown rapidly, at around $1 billion in annual revenues globally; nowadays, market research suggests that future markets for its products and services could be huge: with the U.N. Sustainable Development Goals forecast expected to generate market opportunities of over $12 trillion a year by 2030 (Elkington, 25 Years Ago I Coined the Phrase “Triple Bottom Line.” Here’s Why It’s Time to Rethink It, 2018).

Success or failure on sustainability goals cannot be measured only in financial terms of profit and loss, it must also be measured in terms of wellness of the people and health of the planet. In fact, after the outbreak of the crisis caused by the COVID-19 pandemic, it has been possible to observe an acceleration to reach a unified vision, capable of developing and implementing an appropriate strategy for economic, social, and environmental development.

A path towards sustainability has set to be a priority in Europe and especially in Italy; the goals to reach a constant sustainable development need to be revisited considering what old and new problems the pandemic has brought to light.

That is what has been emerged from the Sustainable Development Goals Report 2020 (SDGs 2020), an agenda for sustainable development that was launched in 2015 with the objective to end poverty and set the world on a path of peace, prosperity, and opportunity for everyone on a healthy planet (UnitedNations, 2020).
It is composed by 17 Sustainable Development Goals, like, among the others, no poverty, zero hunger, quality education and economic growth. Using a new index that measures the effectiveness of the response to Covid-19 of 33 OECD countries, including health and economic parameters, it was possible to detect how some countries, coming from the Asia-Pacific region, have succeeded more effectively than others to contain the virus and minimize the damage caused to their economies. Moreover, facing the crisis caused by Covid-19, the report underlines the strategic role of international cooperation and partnerships, Goal 17 (Partnership for the goals), which are fundamental to accelerate the identification of rapid solutions for a long-term recovery from the effects of the pandemic.
Italy confirms last year's position, ranking in 30th place in the SDG Index 2020, behind other OECD countries besides the Nordic ones, France, Germany, and Spain. The situation in the peninsula does not show significant changes compared to the precedent year, with a substantial positive trend towards achieving the sustainable development goals (Agosti, 2020).

1.1.1 THE TRIPLE BOTTOM LINE

The term “Triple Bottom Line” was coined for the first time in 1994, by one of the pioneers of the global sustainability movement, John Elkington, after the analysis of promising results of a survey in Corporate Social Responsibility and Sustainable Development.

The Triple Bottom Line is a sustainability-based accounting method that is different from other types of reporting activities because it also includes aspects that are difficult to measure, like environmental and social ones.

The idea of the theory is to be a valuable marker of how well a business is meeting its sustainability goals, encouraging every business to track and manage social, environmental, and economic value-added activities (*Figure 1*); particularly, measuring the positive and negative impact on stakeholders, on the natural environment, and on the local, national and international economy (Kraaijenbrink, 2019).

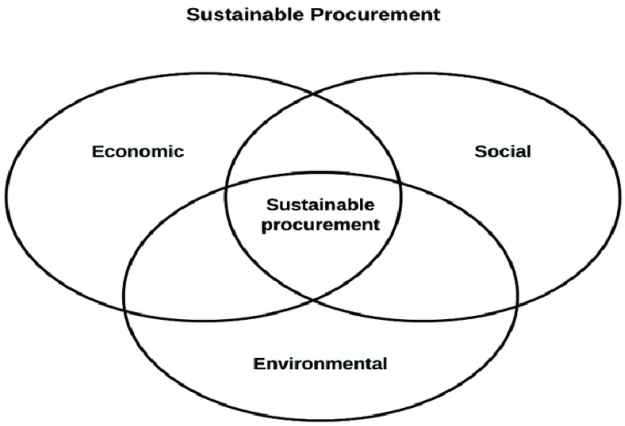


Figure 1 The Triple Bottom Line (Elkington, Cannibals with Forks: The Triple Bottom Line of 21st Century Busines, 1997)

Talking about the social side, this theory can, for example, enhance to provide quality healthcare benefits and flexible working time to employees, offer opportunities for career advancement, create a no stress and pleasant work environment, and establish fair labour treatment.

On the environmental side, it involves the reduction of consumption, wastes, and emissions, using renewable energy sources, reducing energy use, disposing of toxic materials safely and adopting a set of green corporate policies.

Moreover, under an economical point of view, a firm can give a fair remuneration to its workers, establish strong connection with local suppliers and buyers, to make them grow faster, generate innovation for its industry, and paying its fair share of taxes.

In the idea of its creator, the theory was not designed to be just an accounting tool, but, unfortunately, it was used mainly for this scope; accountants produce annual reports that are not result of a clear aggregation of data and an accurate analysis of them, resulting thus in an ineffective way to influence decision-takers and policymakers to track, understand, and manage the systemic effect of human activity.

The Triple Bottom Line was originally intended as a genetic code, a triple helix of change for tomorrow's capitalism, with a focus on breakthrough change, disruption, asymmetric growth (Elkington, 25 Years Ago I Coined the Phrase "Triple Bottom Line." Here's Why It's Time to Rethink It, 2018).

1.1.2 THE CORPORATE SOCIAL RESPONSIBILITY

Corporate Social Responsibility is a set of policies, practices, and behaviours adopted by the company, in favour of the community in which it operates as well as of the company itself.

It is a form of voluntary responsibility that companies tend to assume towards their main social partners, the stakeholders. Doing so, the firm adopts a policy that can harmonize the economic objectives with the social and environmental ones, in a sustainability view, in order to preserve the environmental, social, and human heritage for current and future generations.

Approaching a proactive behaviour, defined also Corporate Social Commitment, maximizes the benefits and minimizes the downsides (Slack, Brandon-Jones, & Johnston, 2016).

Various studies about that theory have been applied focusing on the ethical or business side of the theory.

Mintzberg, for example, affirmed that CSR can appear in four forms, from the purest, to the most inducted one. The first and purest one is when it is practised for its own sake; the firm thus becomes socially responsible because it retains that this is the noble way for corporations to behave. The second form is when the company beliefs that CSR pays in some way, tangible or intangible, undertaking this policy for "enlightened self-interest". The third form seen CSR as a sound investment; therefore, associating socially responsible activities to direct reactions in the stock market. The fourth one retains that CSR is practised only in order to avoid interferences from external political influences. Mintzberg argued that Corporate Social Responsibility can only survive, and should be practiced, in its purest and proper form, without any expectation of paybacks (Wan-Jan, 2006).

Other authors, instead, analysed this theory in a strategic and business way.

Carroll, for example, says that the first and foremost social responsibility of a business is the responsibility of the firms to sell goods at a certain profit. He also introduced the "Pyramid of CSR" (depicted in *Figure 2*), claiming that economic aims are the major and fundamental part of this theory. Firms, in his opinion, should not pursue the discretionary element of CSR (called philanthropic in the model), if the other three elements (economic, legal, ethical) are not fulfilled and pursued (Wan-Jan, 2006).

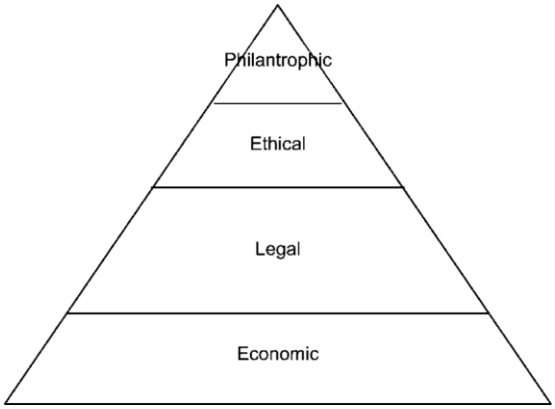


Figure 2 Carroll's pyramid of Corporate Social Responsibility (Wan-Jan, 2006).

1.2 INTRODUCTION TO CIRCULAR ECONOMY

An economy defined circular has the objective of turning goods that are at the end of their life cycle into resources for other ones, minimizing wastes and changing the economic logic, replacing production with sufficiency. In this way, it is possible to close loops in industrial ecosystem.

Starting from the collection of resources engaged in the production, the manufacturing process, the distribution and the after-use of the product, this type of life cycle is traditionally a finished one, but, with innovation in term of sustainability, this cycle can be closed and make return to previous phases with the reusing and repairing, or start again with the recycling and taking-back of goods (as described in *Figure 3*).

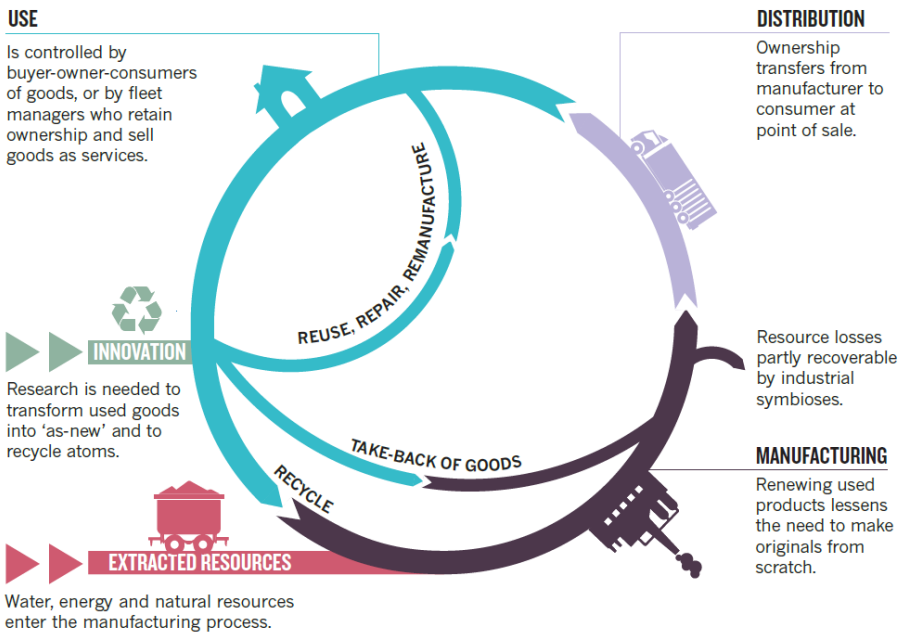


Figure 3 Closing Loops with the Circular Economy (Stahel, 2016)

This kind of business model could be defined in two ways: the activity of enhancing the reuse of products extending their life cycle, and the process of turning old goods into new resources by recycling the materials.

To further justify it, there are plenty of studies, one of them, analysing seven European nations, has found that a shift to a circular economy would reduce each nation's greenhouse-gas emissions by up to 70% and grow its workforce by about 4% (Stahel, 2016).

Speaking about practical terms, nowadays the switch from a linear type of consumption to a circular one is long and difficult. In a report about circular economy provided by McKinsey, it is assumed that there could be a chance that the concept of circularity could go mainstream in business enterprises and activities towards 2025 or further (MacArthur, 2013).

The economic scenario, since its beginning, has been based on the linear model of resource consumption: the firms collect resources, use them in the production process, create products, sell them to the market and the final consumer discard them when he/she does not need them anymore. Over the years, there have been progresses and innovations about resource efficiency and the usage of new forms of energy, but less efforts have been made in improving the process itself, towards a self-generating model based on the recycling and not on the production.
The result of that is an increase of significant loss of company's value and negative effects all over the value chain; real prices of natural resources has begun to climb upwards and the price volatility levels for metals, foods and non-food agricultural output, in the first decade of the 21st century, were higher than in any single decade of the previous century (MacArthur, 2013).

In spite of this apparent lock into a linear model of production and consumption, powerful disruptive trends are attending to turn the situation around, in favour of a circular economy system. Resources are becoming increasingly scarce, environmental standards always stricter and more stringent to discourage buy-use-discard businesses, the discover of advanced and innovative information technologies and a pervasive shift in the behaviour of consumers, that are preferring access over ownership (MacArthur, 2013).
It is with these premises that an auto sufficient and regenerative system like the one of circular economy can arise. It highlights the concept of restoration, pushes the use of renewable energy, eliminates the use of toxic resources and re-designs materials, products, systems, and business models, under the assumption that waste is not created.
The resulting net material savings would result in a shift down of the cost curve for raw materials and there will be created a "user centric economy" that will lead to increased rates of innovation, employment, and capital productivity (MacArthur, 2013).

1.2 CIRCULAR ECONOMY REBOUND AND LIMITATIONS

In the past years, institutions have made significant legislative efforts, trying to find and improve new and better ways to increase the so called "secondary production" (that refers to the activities of repairing, remanufacturing, and recycling).

In 2016, the European Commission, the executive branch of the European Union responsible for proposing legislation, implementing decisions, upholding the Europe treaties, and managing the day-to-day business of the EU, has committed over 6 billion euros to help making the transition from a linear to a circular model of economy (Zink & Geyer, 2017). This switch was driven by private firms and consumers, thanks to economic incentives, assistance, and regulatory frameworks issued by the governments. The same institution has recently estimated that circular economy-type of economic transitions can create 600 billion of euros of economic gains every year, for the European manufacturing sector alone (Korhonen, Honkasalo, & Seppälä, 2018).

After having outlined the positive and beneficial effects of a circular economy system, it is fair also to underline the criticisms that have been raised around this theory. The main one is called "Circular Economy rebound".

Circular economy rebound refers to the increment of the overall production (and, therefore, of the use) of products, derived by the increase in efficiency thanks to sustainability measures, that results in an over-production and in a decrease of environmental benefits.

In a study made by Greening and colleagues, in 2000 (see Zink & Geyer, 2017, page 595), the authors describe four types of rebounds, each of them leading to different effects.

The first is the direct rebound, that is the direct growth in consumer demand attributed to lower prices from increased efficiency; then, there are the secondary effects, that are increases in demand of other goods attributed to increase in customer savings after the lowering in prices; the third one is the economy-wide effect, that refers to wide and unpredictable effects that increased efficiency has on prices and demand; the last one is the transformational effect, related to large scale effects, like change in consumer preferences, technological innovations, and regulations made by institutions.

To this extent, Borenstein, in 2013 (see Zink & Geyer, 2017, page 595), provided a useful framework that combines these four types of effects to the microeconomics concepts of price and substitution effect. In particular, the first two effects, the direct and indirect ones, collectively refer to an income effect (the shift in level of usage attributed to a perceived wealth increase), while a substitution effect is connected to the change in consumption choices caused by the price downgrade of a product subjected by a circular economy flow; the consumer, in this case, uses the cheaper product more, and the expenses reduce the consumption of some other goods for which the income effect could have been used.

A graphical example of the circular economy rebound has been given by the work of Zink and Geyer in 2017, combining and relying on some contributions of other different authors in this regard. The researchers calculated the net environmental benefit of recycling, when the market is included, with a simple equation:

$$E_{net} = e_r \Delta Q_r + e_p \Delta Q_p$$

With e_r and e_p being respectively the environmental impact of producing one unit of secondary (recycled), or primary material; ΔQ_r is the change in secondary production, and ΔQ_p is the market-mediated change in primary production. Any circular economy activity with $\Delta Prod = \Delta Q_r + \Delta Q_p > 0$ is deemed to experience circular economy rebound (Zink & Geyer, 2017).

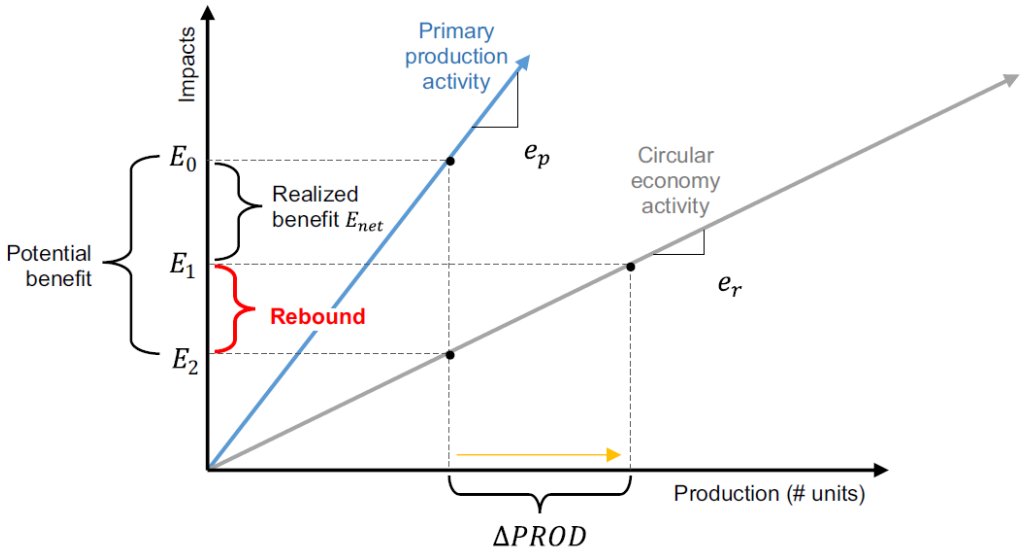


Figure 4 Circular economy rebound attributed to increased production (Zink & Geyer, 2017)

As showed in *Figure 4*, if no rebound occurs, the potential benefit is realised, and impacts fall from E_0 to E_2. However, $\Delta Prod > 0$ reduces the net benefit by $E_1 - E_2$, called in this case circular economy rebound. If rebound is sufficiently large, the benefit is eliminated entirely (therefore $E_0 - E_2 = 0$), or backfire can occur (thus $E_0 - E_2 < 0$).

There are two main events that create a rebound from secondary type of production. One is when secondary products are made of inferior quality, or are less desirable in respect of primary ones, becoming so insufficient substitutes. Another mechanism is when increased secondary production affect prices in the market, lowering the equilibrium price and increasing the production, raising the income of the consumers that will now spend their excess wealth with unpredictable results.

In these cases, to avoid circular economy rebound and create a significative environmental improvement, the authors suggest three conditions: that the secondary products are truly substitutes of the primary ones, that the circular economy activities have no effects on demand for goods, and that the secondary production actually draws consumers away from primary production (Zink & Geyer, 2017).

Talking about other type of criticisms moved on this concept, in a work made by Korhonen and others in 2018, are exposed six type of limitations for a circular economy system (showed in *Table 1*): thermodynamic limits, system boundary limits, those posed by physical scale of the economy, those posed by path-dependency and lock-in, limits of governance and management, limits of social and cultural definitions.

Thermodynamic limits	Cyclical systems consume resources and create wastes and emissions
System boundary limits	- Spatial: problems are shifted along the product life cycle - Temporal: short term non renewables use can build long-term renewable infrastructure
Limits posed by physical scale of the economy	Rebound effect, boomerang effect
Limits posed by path-dependency and lock-in	First technologies retain their market position despite of their in-efficiency
Limits of governance and management	Intra-organizational and inter-organizational strategies and management
Limits of social and cultural definition	The concept of waste is always constructed in a certain cultural, social and temporal context

Table 1 Six Limits and Challenges for the Circular Economy concept (Korhonen, Honkasalo, & Seppälä, 2018)

Starting from the first, the authors explained that a cyclic flow does not always ensure a sustainable outcome. The example that is outlined, is the activity of deforestation to obtain sources for renewable energy: in this case, nutrient rich parts of the trees, twists, needles, bark, and branches are removed from the forest ecosystem, and this activity requires machines that run on energy. Thus, the sustainability contribution of circular economy projects is a question that needs a case-by-case analysis (Korhonen, Honkasalo, & Seppälä, 2018).

System boundary limits are connected to spatial and temporal concepts. In spatial terms, there are many examples of environmental and social improvements in local and regional economies that have resulted, either directly or indirectly, into difficult problems in other locations; the biggest environmental and social problems tend to affect the poor developing countries worst (see Welford, 1998b, in Korhonen, Honkasalo, & Seppälä, 2018, page 42), and therefore this phenomenon has to be minimized.

Talking about the temporal boundary limit, the issue regards the product durability. Within a circular economy system this characteristic is increased, and the need for resource extraction

for new products is reduced; however, due to the fact that most of the impacts of material flows generate in nature are currently unknown, extending product lifetime might create economic and organizational structures that risk unsustainability in the long-term. In this situation, short-life goods and continuous innovation of products might have an environmental advantage (Korhonen, Honkasalo, & Seppälä, 2018).

Other types of limitation refer on the already cited circular economy rebound and on the "boomerang effect". The latter happens when a rich country increases its environmental sustainability levels through national environmental policies, and the harmful production is transferred to the poor bordering countries; after this event, when the reduced biodiversity of the poor countries reduces the export of certain scarce resources on which the rich countries are dependent, nature protection in the rich country will be not achieved (see Mayer, et al., 2005, in Korhonen, Honkasalo, & Seppälä, 2018, page 43).

Path dependency and lock-in effects express that the circular economy model has to compete with other types of traditional and deeply rooted recycling models (even if less efficient), like the combustion, or the linear flow ones.

Limits of governance and management, according to the authors, consists in the long and challenging conversion, not only of the organizational and strategical aspects of a firm, but also of the main players and stakeholders along the value chain, towards a circular economy system. Process that could be rapid and easy for a new and environmentally friendly firm, could also become hard and slow for historic suppliers that have not embraced sustainability activities yet.

To conclude, the last limitations that Korhonen and others outlined in their work is the definition of physical flows. It substantially tells that before of every analysis, every country, history, culture, community, and society decide by itself what material flows are good and bad, and the definition will always be changing and dynamic. Given that the circular economy is a relatively up-to-date theory, the data and studies supporting this concept are largely missing from existing statistics used by environmental administrations globally; therefore, it is difficult to define and implement policies, legislations, or other public policy instruments for these type of activities (Korhonen, Honkasalo, & Seppälä, 2018).

CHAPTER 2: THE BUSINESS MODEL THEORY

In this chapter it will be described the literature behind the business model theory, focusing on the concept of sustainable business model. Together with the circular economy, these two theories are the core of the thesis, because they are the fundaments of the questionnaire that will be analysed in *Chapter 3* with the software fsQCA.

Talking about the structure of the chapter, initially there will be a presentation of the business model theory, starting from the history of the literature's innovations, to then explain the importance of the concept and the various declination of it given by different researchers.

The last part of the chapter is dedicated to the sustainable business models, outlining the innovations that have brought to their creation, the definition of the theory, the strategies and archetypes that refer to it; finishing with a description of the Triple Layered Business Model Canvas, a strategic tool that integrates the economic, environmental, and social sources of value creation of a company.

2.1 DEFINITION OF THE CONCEPT

According to Slávik and Bednár (2014), the business model is a system of resources and activities, which create a value that is useful to the customer and the sale of this value makes money for the company.

The first time that this terminology became relevant, is in an article of the financial journalist Michael Lewis in the fall of 1999, in a prediction about the hypothesis that, in the future, companies will be based on business models connected only with Internet; in those periods, business model theory became almost synonymous with e-business and the emergence of the so-called new economy (Nielsen & Lund, 2014).

Around 2001-2002, this concept started assuming a much more general and comprehensive meaning in management literature. In fact, from 1995 to 2011, there have been at least 1177 articles published in peer-reviewed academic journals in which the notion of business model is addressed (Zott, Amit, & Massa, 2011).

Nowadays, in a dynamic business environment characterized by instability and increasing competition, companies change not only their product or services, but also culture, internal organization, and strategy, in order to pursue a competitive advantage in the long term.

Recent discoveries in communication and information technologies, such as the rapid and natural expansion of the Internet and the relevant downfall of computing and communication costs, have allowed the development of new ways to create and deliver value. These developments have opened new horizons for the design of innovative business models, by enabling firms to change fundamentally their organization and engage in economic exchanges, both within and across firm and industry boundaries (Zott, Amit, & Massa, 2011).

Graphic representations of business models cannot be limited in organization diagrams like the ones showing the hierarchy and interactions between functions and divisions inside a firm; instead, business models should be illustrated in "organigraphs" (Nielsen & Lund, 2014), more useful tools to outline the strategy, the structure, and the critical interactions among people, products, and information to create value for the company.

To conclude, the business model represents a potential source of competitive advantage. The novelty presented by new, effective models can result in superior value creation and replace the old way of doing things, playing a central role in explaining firm performance.

2.1.1 TIPOLOGY OF BUSINESS MODELS

The literature explaining the theory about business models is wide and variegated. The approach has not a fixed definition and many authors have tried to define it according to their research and studies. Hereafter, there will be described different concepts of business model, to have a general and heterogeneous point of view of the theory, following the work "Analysis of Business Models" made by Slávik & Bednár, in 2014.

A first model, idealized by Mullins and Komisar in 2011, is composed by five parts: the revenue model, the gross margin model, the operating model, the working capital model, and the investment model.

In the idea of the authors, the success of this type of model is in the harmony of all five models; a successful company is the one which has still money available after paying the gross margin, operating costs, operating capital and investments (Slávik & Bednár, 2014). This model could be useful for an evaluation of the financial health of the company, but it gives little attention to the value offered to the customer, making it not proper for a complex analysis.

Another model is the one of Alan Afuah (2003), which is divided in 4 components, determinants of profitability, that impact in all the activities of a company (*Figure 5*). These ones are industry factors (like competitors, barriers to entry, consumers), resources, costs, and positions (that refer to the activity of looking for new markets where the company can offer new values for the customers). In the view of the author, the cooperation of these components will develop an efficient business model and a source of competitive advantage.

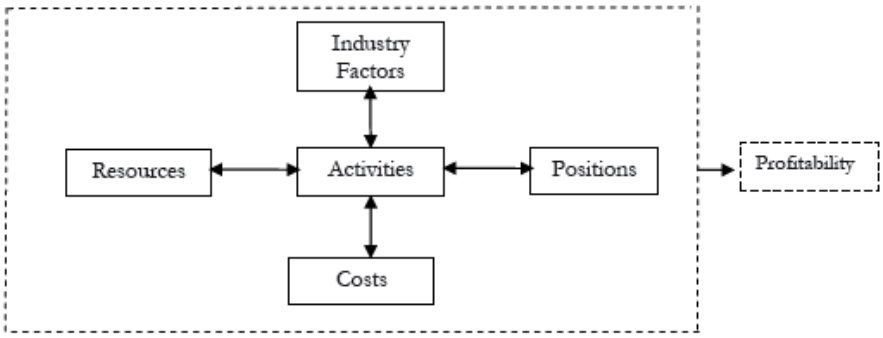


Figure 5 Components of Afuah's Business Model (Slávik & Bednár, 2014)

Following the analysis of Slávik and Bednár, this model does not account the company to be a complex system (also because it is missing the analysis of the external environment in which it operates), and it is not explained deeply the connectivity and the causal relation between the components.

The typology of business model created by Watson (2005) increases the number of components, to give a more complex scenario of the company. These are six: competitors, customers, economy of company, management, products, and suppliers. The singularity of the model is that it takes into consideration sector factors (like competition), which belong to the business model's environment, but is not part of the business model components (Slávik & Bednár, 2014).

Another concept, made by Johnson, Christensen and Kagerman in 2008, describes a business model as composed by four interconnected pillars: value for a customer, profit, key resources, and key activities. The success of a company, according to the authors, is related to its ability of creating value for consumers and generating profits; a necessary condition to achieve it, is having the right resources and doing the right activities.

Osterwalder and Pigneur's model, called Canvas (2009), is probably the most known and utilised (*Figure 6*). It is characterised by nine components, presented clearly and intuitively thanks to the powerful visualisation of the canvas' layout.

The nine components proposed are: customer segment, customer relationships, distribution channels, value proposition, key resources, key activities, key partners, cost structure, revenue stream. Customer segment represents the type of market where the company operates (mass, segmented, niche, diversified, multi-sided); customer relationships refer to the types of relations that the company has with its clients (personal assistance, automated services, co-creation); distribution channels could be direct (through the sale network of the firm) or indirect (through intermediators); the value proposition is the mission of the company and describes the core product or service that the firm sells to the customers (Slávik & Bednár, 2014); key resources, activities and partners are the most important ones involved in the creation of value for the company; cost structure and revenue stream, ultimately, delineate a framework of the sources of costs and revenues.

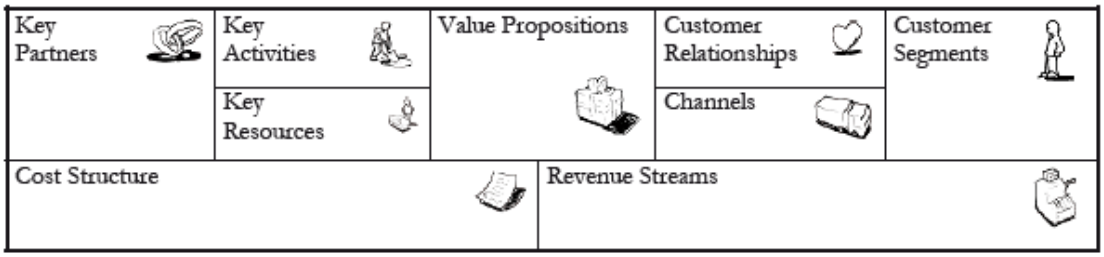


Figure 6 Business Model Canvas by Osterwalder & Pigneur (Slávik & Bednár, 2014)

The latter model, according to Slávik & Bednár (2014), is the most complex, analytical, flexible, and general. Its intuitive scheme helps to clarify the processes and visualize better the components, analysing their features and outlining their connections; it can also be used for market research of companies in any industry.

2.2 SUSTAINABLE BUSINESS MODELS

The literature about business models has been focused mostly on strategies that generate, offer, and obtain a substantial economic value. Only recently, the theory has started to be linked to social and environmental values, shaping and creating a new concept: the sustainable business model.

In the past years, it can be distinguished three different periods of time that correspond to a significative social and sustainable approach of large corporations, known mostly to be guided by self-interest and the pursuing of economic profits.

The first wave can be collocated in the early 1970s, where big companies, for the first time, started to adopt voluntary measures and report framework to react to environmental and social crisis.

In the late 1990s can be collocated a second wave, when large firms got used to behave in a more proactive way toward sustainable practices.

With the arrival of the twenty-first century, a third wave can be visible, characterized by a growing globalization that forced corporations to face new environmental and social challenges.

These developments have paved the way for sustainable businesses, pursuing the triple bottom line and gaining business opportunities while resolving social challenges. Sustainable business models, along with new product design, technologies, and value chains, are at the core of transforming the way business is done (Ritala, Huotari, Bocken, Albareda, & Puumalainen, 2017).

In order to put the basis for the creation of sustainable businesses, researchers found that the importance of innovations plays a crucial role.

Sustainable innovations consist not only in technologies, but also in processes, operating procedures and practices, business models, systems, and thinking (Evans, et al., 2017). In respect of this, business models are emerging as a potential mechanism to integrate sustainability into business; they are in fact considered a vehicle for innovation, as well as a subject of it (Evans, et al., 2017).

Through changes in the way business models are idealized, a company could obtain a more social and environmental characterization, for example by engaging more the stakeholders in strategic decisions improving the relationship with them, or by adopting more sustainable process and activities in each aspect of the business.

Greater stakeholder engagement, alongside greater trust and innovations to their business models, are among the big changes that firms need to undertake in the pursuit of a long-term aim of sustainability (Evans, et al., 2017).

2.2.1 BUSINESS MODEL INNOVATION

Sustainable business models are not necessarily achieved through technology, new product introduction to the market, or adherence to sustainable policies, but also through the innovation of the business model itself. The latter can help the company to reach incremental incentives and revenues to leverage the subsequent investments in sustainability.

Business model innovation is defined, by Geissdoerfer, Vladimirova, & Evans (2018), as the conceptualisation and implementation of new business models. This type of innovation can comprise the development of entirely new business models, the diversification into additional business models, the acquisition of new business models, or the transformation from one business model to another.

These innovations are also expected to yield higher returns than innovations of product or process; the resulting sustainable business models can thus mitigate the risk and add diversification to the existing business of the company.

Depicted to be a process of business model exploration, adjustment, improvement, redesign, revision, creation, development, adoption, and transformation (Geissdoerfer, Vladimirova, & Evans, 2018), business model innovations are divided in four different types (*Figure 7*).

- Start-up: when a new organization that adopts a sustainable business model is created.
- Business model transformation: a change in the existing business model that results in a sustainable one.
- Business model diversification: alongside the existing business model, a sustainable one is established.
- Business model acquisition: when an additional sustainable business model is identified, acquired, and integrated in the organization.

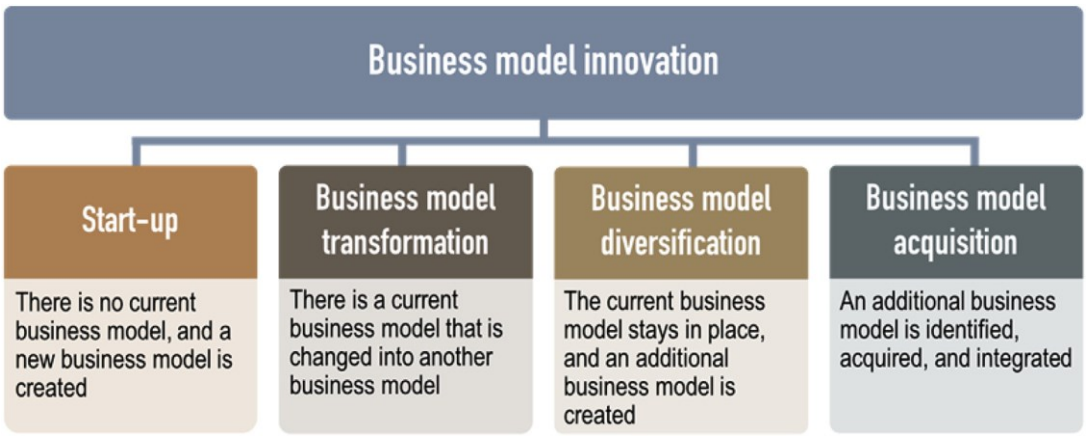


Figure 7 Types of business model innovations (Geissdoerfer, Vladimirova, & Evans, 2018)

2.2.2 SUSTAINABLE BUSINESS MODEL DEFINITION

A starting point for the development of this kind of business model, is the management awareness that this change is not only a new way to analyse and study the relation between the firm and the environment, but also an effort to integrate economic strategies and sustainability research, designing thus a new business architecture within the company.

Substantially, a sustainable business model is about creating significantly increased positive effects and/or reduced negative effects for the natural environment and society, through changes in the way a company and its network create, deliver, and capture value (Lüdeke-Freund, Carroux, Joyce, & Massa, 2018).

When the theory was first idealised, the initial aim was to help the companies to accelerate their shift towards a more sustainable economic system, helping them to reach their respective environmental and social objectives.

With the past of the years and the increasing adoptions of it, sustainable business models are starting to be considered a source of competitive advantage, pursuing sustainability goals and integrating social and environmental activities within the firm.

A comprehensive definition of the concept is given by Geissdoerfer, Vladimirova, & Evans (2018). According to the authors, sustainable business models are business models that incorporate pro-active multi stakeholder management, the creation of monetary value for a broad range of stakeholders, and hold a long-term perspective.

Circular business models, moreover, are business models that promote solutions to enhance the circular economy; they focus especially on the life cycle of resources: intensifying, dematerialising, closing, slowing, and narrowing it. A clear design of the aforementioned definitions is depicted in *Figure 8.*

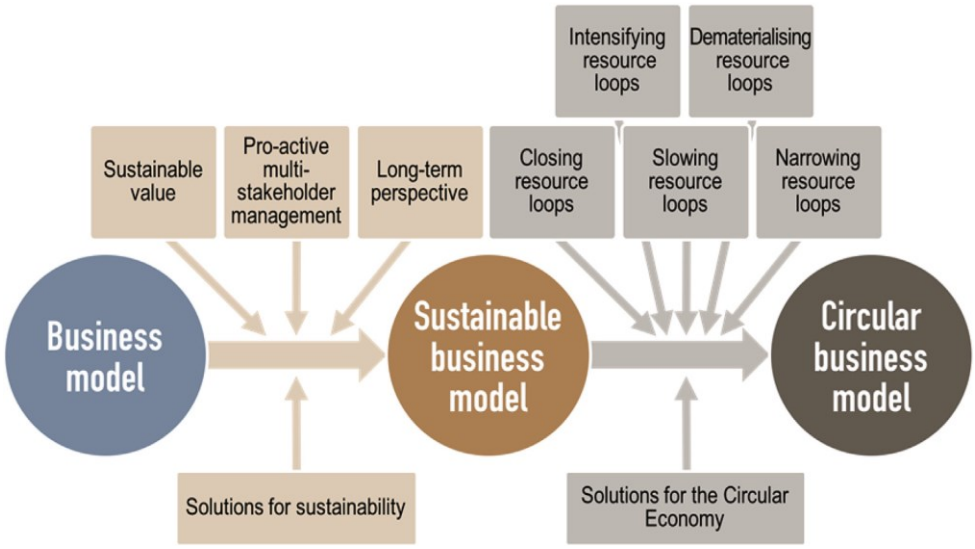


Figure 8 Definitions of Sustainable and Circular business models (Geissdoerfer, Vladimirova, & Evans, 2018)

2.2.2.1 Business Model Strategies

The circular business model approach represents a step forward in an economic framework characterised by the traditional linear business model of production, where the typical flow is take-make-use-disposal; the adoption of it represents a radical change that require an innovative way of thinking and doing business (Bocken, de Pauw, Bakker, & van der Grinten, 2016).

This new sustainable attitude can propose numerous ways to continually reuse products and materials, through the use of renewable resources. In particular, the two most adopted strategies are the ones that slow and close resource loops. The first one is about designing long life goods and product-life extension, extending and intensifying the utilisation period of the products, slowing down the flow of resources. The second one is essentially based on the recycle activity; through it, the cycle between post-use and production of a good is closed, and the flow of resources results circular and cyclical. According to a paper of Bocken, de Pauw, Bakker, & van der Grinten of 2016, circular business model strategies can be categorized in those for slowing loops and those for closing loops, as summarized in *Table 2*.

	BUSINESS MODEL STRATEGIES	**DEFINITION**	**EXAMPLES**
Business model strategies for slowing loops	Access and performance model	Satisfying user needs without giving him the propriety of the product (sharing economy)	- Car sharing - Leasing of products
	Extending product value	Exploiting the residual value of products	- "White goods" - eBay
	Classic long-life model	Offering long-life products, designed to be durable and with an efficient repair service	- Luxury products
	Encourage sufficiency	Promoting durability, upgradability, services, warrantees, and reparability to reduce end-user consumption	- Premium, high service and quality brands - Patagonia

Business model strategies for closing loops	Extending resource value	Exploiting the residual values of the resources	- Firms committed to turn waste materials to new useful goods
	Industrial symbiosis	Using residual outputs from one process as feedstock for another process	- Sugar refiners

Table 2 Sustainable business model strategies (Bocken, de Pauw, Bakker, & van der Grinten, 2016)

"Access and performance model" strategy refers to the provision of a service to satisfy user's needs, without giving him the physical propriety of the product. This approach is related to the sharing economy, where the value proposition is focused on the delivery of the service rather than the ownership, like, for example, the recent phenomenon of car sharing.

With this type of strategy, additional costs for life extension are offset by additional revenues, because the company can use the product longer; furthermore, it can introduce economic incentives for slowing resource loops, both for manufacturers and users, potentially reducing the total need for physical products (Bocken, de Pauw, Bakker, & van der Grinten, 2016).

"Extending product value" is a strategy that aims to exploit the residual value of the products, for example by recovering products that have stopped to work, with no new net consumption of resources; examples of that are refrigerators and other white goods in the EU, or online platforms that allow users to offer products that are no longer useful (like eBay).

In this case the company can experience a reduction of production costs, while potentially increasing labour and logistic costs.

"Classic long-life model" strategy is concerned with a long-life cycle of products, supported by a high quality of materials and high level of customer services. The downside is a high premium price, that testify the high quality of production and services offered, other than the reliability of the brand; all these aspects as a whole, link this strategy to luxury brands.

“Encourage sufficiency” is another business model strategy that promote the reduction of end-user consumption, in this case through a non-conventional approach to promotion and sales. The company produces goods that last more than usual ones and influences the consumers to hold them as long as possible, offering a price premium that justifies slower sales and higher level of services; an example of that is the case of the clothing brand Patagonia, who developed the iconic “Don’t buy this jacket” advertisement to support the launch of its Common Threads Initiative to encourage repair and reuse of its clothing sold (Bocken, de Pauw, Bakker, & van der Grinten, 2016).

“Extending resource value” is an approach where materials of waste are collected and turned to new forms of value. Hence, exploiting the residual value of resources, this strategy will make the final product more attractive to consumers very keen to environmental issues, other than generate, for the company, a reduction of the material costs.

“Industrial symbiosis” strategy consists of turning wastes from one process into new resources for another process or product line. The resulting sustainable advantage can be practically seen as jointly cost reductions and the potential creation of new business lines based on former waste streams. An example of this strategy is the sugar refinery “AB Sugar”, that was able to reinvent its business model focused on sugar refining, developing new business lines based on waste flows (Bocken, de Pauw, Bakker, & van der Grinten, 2016).

2.2.2.2 Business Model Archetypes

Categorization of sustainable business model archetypes is a difficult activity given the little presence of the literature of reference. The authors Bocken, Short, Rana, & Evans, with a paper of 2014, tries to solve this lack by relying on sustainability rankings (like Corporate Knights top 100, the Dow sustainability index, and Forbes top 100 sustainability leaders, among the others) and a comparation between practical examples and literature.

A list of eight archetypes is developed (*Table 3*), divided in three groups representing the main type of business model innovation: technological, social, and organizational.

The first refers to archetypes with a relevant technical innovation, such as process or product redesign, the second to business models with a crucial social innovation component, like influencing consumer behaviour, and the latter to archetypes with a dominant organisational innovation change.

Firms can use one or a selection of more business model archetypes for shaping their own transformation into a sustainable way of doing business; although each of them can be applied in isolation, different archetypes may be combined, because real sustainability, almost certainly, demands combinations of archetypes (Bocken, Short, Rana, & Evans, 2014).

Technological			**Social**			**Organizational**	
Maximise material and energy efficiency	Create value from waste	Substitute with renewables and natural processes	Deliver functionality rather than ownership	Adopt a stewardship role	Encourage sufficiency	Repurpose for society / environment	Develop scale-up solutions

Table 3 Sustainable business model archetypes (Bocken, Short, Rana, & Evans, 2014)

Maximise material and energy efficiency

This archetype is based on the reduction of wastes, emissions, and pollution, utilising less resources than before, maximising at the same time the material productivity and the efficiency in the use of resources.

The strategy in question comprehends concepts such as lean systems, eco-efficiency, and cleaner production approaches, that aim to reach better resource efficiency and reduction of wastes and emissions through product and process redesign (Bocken, Short, Rana, & Evans, 2014).

The negative aspects of adopting only this strategy are the generation of rebound effects and that relevant improvements in workplace activities could turn on elimination of traditional manufacturing jobs, generating thus unemployment issues. An optimal choice can be to adopt other archetypes in addition to it.

Create value from waste

This business model aims to eliminate waste flows by transforming wastes into inputs and resources for other processes, utilising in an efficient way the under-used capacity.

The archetype seeks to close resources loops, reducing the demand for inputs and the creation of wastes and emissions; in order to achieve these goals, new partnerships and alliances could be created, potentially across industries, to have a support in the transformation of waste streams. To contribute to an optimal level of resource efficiency, the company has also to reduce the frequency and speed of introduction of new products to the market.

Substitute with renewables and natural processes

Adopting this archetype, the objective is to reduce the environmental impact by substituting current production processes based on non-renewable resources, with renewable ones. Natural processes are introduced, and, by utilising renewable inputs, the company is able to survive within its resource constraints.

Deliver functionality, rather than ownership

This sustainable business model is mainly based on the concepts of Product Service Systems (PSS) and Servitisation, which are about shifting substantially the business towards the pure service model, delivering functionality on a pay-per-use basis rather than selling the ownership of a product (Bocken, Short, Rana, & Evans, 2014).

This scenario could radically change costumer's behaviour and consumption pattern; the customer experience, in fact, assumes more importance that the value of the product per se, that is, however, still relevant.

The expected benefits of adopting this sustainable archetype are the reduction of resource consumption caused by reduced levels of production, the improvement in the development of more durable products, and the growing attitude of the manufacturers to reuse materials and inputs in the production process. To reach these benefits, this type of business model has to be associated with innovations in terms of production efficiency and waste recycling, other than reducing the speed of introduction of products and services to the market.

Adopt a stewardship role

Adopting a stewardship role means behave in a proactive way with all stakeholders to ensure their long-term commitment and well-being with the strategies of the firm.

This archetype is focused on the social side of the sustainability goals and it aims to maximise the positive aspects raised by a high engagement between the company and all its stakeholders, from suppliers and buyers to employees and consumers. It can also increment the brand value and consequently generate a potential price premium of the product offered.

Encourage sufficiency

This archetype has the objective to reduce consumption and production in an active way, relying on a sufficiency-based business model.

These goals could be reached with an appropriate use of advertising and sales activities (especially with a lower use of high discounts that cause overselling), with a correct selection of business actors (for example by making partnerships with suppliers that offers durable materials), or with incentives to discourage the obsolescence of the products. The company also plays an educational role towards the consumers and the society.

Re-purpose the business for society/environment

This business model puts on a higher plane the delivery of social and environmental benefits rather than maximising the economic profits, through a close interaction with local communities and stakeholders.

The firms adopting this strategy are not no-profit enterprises, but the profit motives are simply secondary to social and environmental ones.

Develop scale-up solutions

Developing scale-up solutions refers to the creation of sustainable solutions at a large scale, to maximise benefits for the society and the environment.

This business model is especially addressed to large multinationals, which have the resources and capabilities to introduce and expand a certain type of sustainable business model across a wide geographical area, for example enhancing franchising, alliances or mergers and acquisition.

2.2.3 THE TRIPLE LAYERED BUSINESS MODEL CANVAS

The Triple Layered Business Model Canvas is a design tool that, built from Osterwalder and Pigneur's original business model canvas, integrates environmental and social aspects of a company with economic ones, communicating in a creative and direct way sustainable business model innovations.

By adopting this tool, a firm can present graphically a network of multiple types of value creation within a business model perspective, following a Triple Bottom Line approach, presenting at the same time three different layers of business model canvas: the economic, the environmental, and the social one.

This particular type of business model representation introduces two new dynamics for the concept: horizontal and vertical coherence. Horizontal coherence is reached because each layer of the canvas allows a significative level of deep analysis, making clear the origin and the definition of the different sources of value creation. Vertical coherence, instead, is given by the alignment of the three different layers, one above the other, highlighting the links and interconnections among different types of value creation.

The authors Joyce and Paquin, in a paper of 2016, have outlined in a clear way the theory of the Triple Layered Business Model Canvas, showing in details the innovative concepts of the environmental and social layers, to be added to the Business Model Canvas theory proposed by Osterwalder and Pigneur in 2010.

The Environmental Layer

The environmental layer of the Triple Layered Business Model Canvas (depicted in *Figure 9*) is based on the measurement and evaluation of the environmental impacts of different sources of value creation.

The concept follows the Life Cycle Assessments approach, which is a formal approach that assesses the environmental impacts across multiple kinds of indicators over the full life cycle of a product or service (Joyce & Paquin, 2016). The aim, in this case, is to outline where the company's biggest environmental impacts lie within the business model, assessing also if the firm generates more environmental impacts or benefits.

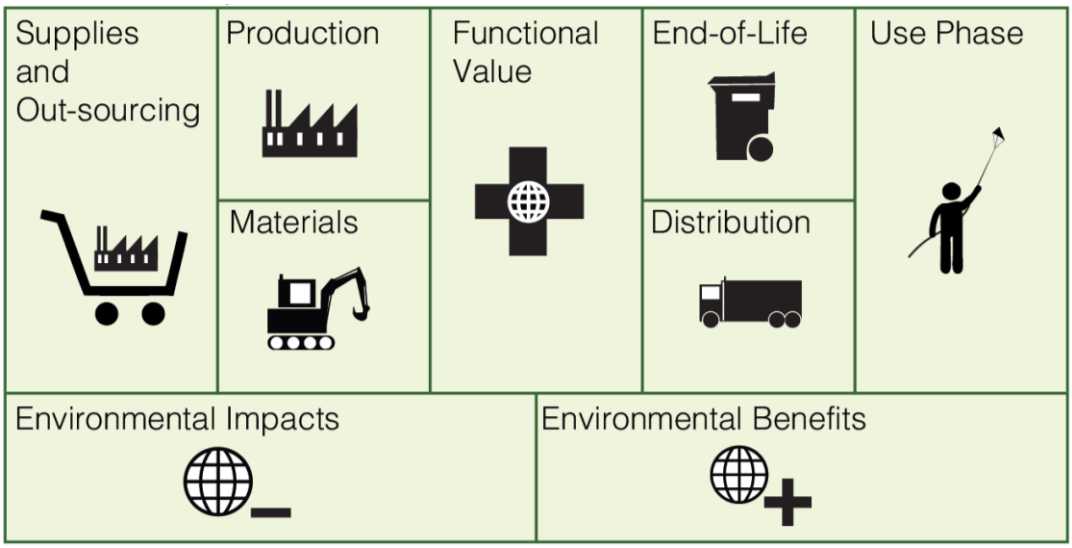


Figure 9 Environmental Layer of the Triple Layered Business Model Canvas (Joyce & Paquin, 2016)

This type of layer identifies, as the Osterwalder and Pigneur's model, nine different sources of value creation.

- *Supplies and Outsourcing* represents all the production activities that are necessary, but not unique, to create a competitive advantage for the organization; for this reason, they are not developed in-house, but outsourced to other external companies. An example of that could be the provision of energy resources like water or electricity, that are usually supplied by local firms.
- *Production* refers to activities with high environmental effect connected to the production process of a product or a service.
- *Materials* comprehends the bio-physical stocks used by the company to create value. In this section it is important to report the key materials involved and their environmental impact.
- *Functional Value* describes the main output of the final product or service. It represents a quantitative description of the service performance or the needs fulfilled by the product.
- *End-of-Life* refers to all the post-consumption activities of a product after its utilisation by the consumer; these are, for example, remanufacturing, recycling, disassembly, or disposal of a product. The goal of the firm is to extend its environmental responsibility even beyond the full consumption of its products, finding new ways to manage better their environmental effects, reducing the negative effects and improving the benefits.

- *Distribution* is the combination of the logistic activities, like transportation modes, the distances travelled, the weights of the load, and the packaging, that affect the external environment.
- *Use Phase* is a category that relates to the influence of the consumers towards the company. It includes the environmental impact of maintenance and repair activities, other than all other activities that involves the relation between the client and the firm in the utilisation of products or services.
- *Environmental Impacts* component notes all the ecological costs of the organization. In this section, to define where in the company's activities lies the main environmental impacts, are used indicators such as CO2 emissions produced, human health, ecosystem impact, natural resource depletion, water or energy consumption.
- *Environmental Benefits* area has the objective of detecting the activities that embody the main positive ecological value, with the mission of continuously supporting the financing and growth of them.

The Social Layer

The social layer of the Triple Layered Business Model Canvas (represented in *Figure 10*) is based on a stakeholder management approach, which aims to focus mainly on stakeholder's interests rather than simply reach financial and operating targets of the company as a whole.

The objective of this part of the concept, theorized by Joyce and Paquin (2016), is to capture the social impacts derived from organization's activities and to find innovative ways to develop new processes able to generate positive social effects within the company.

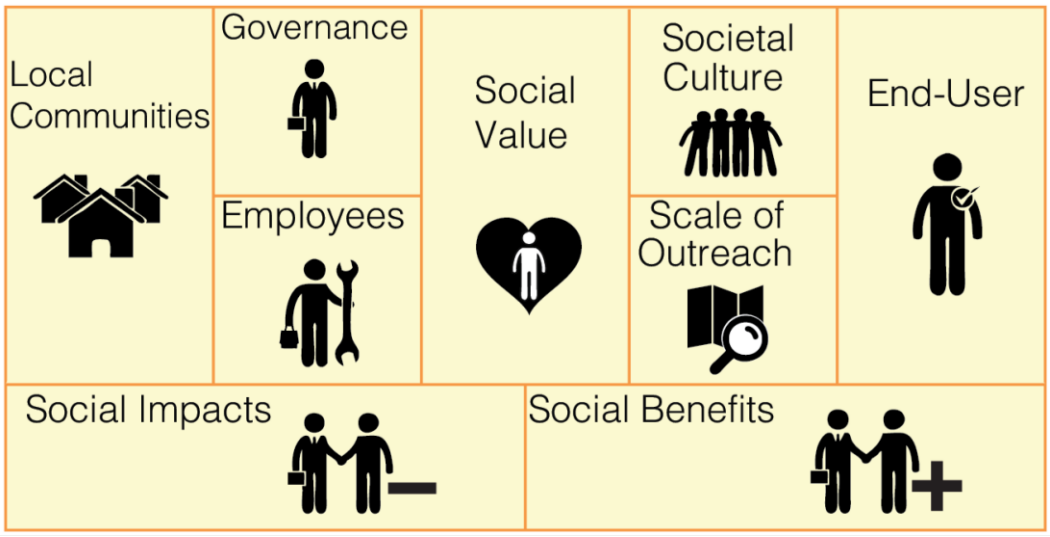


Figure 10 Social Layer of the Triple Layered Business Model Canvas (Joyce & Paquin, 2016)

Like the aforementioned environmental layer, this type of layer includes nine sections to assess the social impact of an organization towards its stakeholders.

- *Local Communities* section represents the relationships with suppliers and local communities. When a firm locates all its facilities in only one specific geographic area, it has to face only one local community, with the respective cultural needs and traditions; when a firm, instead, approaches the internationalization strategy and operates in more than one geographic area, the issue here is to relate in the most correct and respectful way towards all the different cultures, to develop and maintain mutual beneficial relationships with stakeholders.
- *Governance* refers to the internal organizational structure of a company and all the decision-making policies that aim to select the stakeholders to engage with.
- *Employees* component focuses on the role of employees, considered one of the most important branch of stakeholders. In this section it may be noted information about the number of employees, the gender, the age, the salary, other than programs to improve their formation or professional development.
- *Social Value* represents broadly all the aspects of the firm that seek to create relevant and positive effects towards the stakeholders and the society.
- *Societal Culture* comprehends all the activities of a company that impact in a positive way the internal organization and, more broadly, the society as a whole.

In this space, it can be included the non-governmental organization (NGOs), as they carry social agendas through their influence on businesses (Joyce & Paquin, 2016).

- *Scale of Outreach* delineates the depth and breadth of the relationships that a firm develops with its stakeholders.
- *End-Users* is the area where it has to be reported the relation with the final consumers, grouped by demographics measures, such as age, income, geographic area, etc. It is also focused the way on which the enterprise is able to satisfy the needs of them, contributing to improve the quality of their life.
- *Social Impacts* component refers to the social costs of an organization, implementing thus the financial costs of the economic layer and the bio-physical impacts of the environmental one (Joyce & Paquin, 2016). Even if there is not a solid literature that give basis to a qualification of social impact indicators, Benoît-Norris et al. (2011), in a paper of Joyce & Paquin in 2016, define them as working hours, cultural heritage, health and safety, community engagement, fair competition, and respect of intellectual property rights.
- *Social Benefits* correspond to all the positive effects of the organization's activities towards the stakeholders.

CHAPTER 3: THE METHODOLOGY

In this chapter, it will be presented in detail the methodology of the thesis' research.

Initially, it is described how the data were collected, relying on the questionnaire about Circular Economy and Industry 4.0 made by Legambiente and Laboratorio Manifattura Digitale of University of Padua in 2017.

Subsequently, it is outlined and analysed the reference sample of companies resulted from the questionnaire, with graphs useful to simplify and make clear the scenario.

Thereafter, mainly following the structure of the work made by Apa & Sedita, "How (do) internal capabilities and the geography of business networks shape the performance of contractors in public procurement tenders? Evidence from the construction industry", of 2017, it is depicted the fsQCA method of analysis that has been adopted, from a variables' overview of the model, to the discussion of the final configurations found. All the steps involved in the execution of the fsQCA software have been done following the instructions and advices present in Ragin, "User's guide to Fuzzy-Set / Qualitative Comparative Analysis", 2017.

In the final part of the chapter, it is elaborated a discussion and an analysis of the final results of the research.

3.1 DATA COLLECTION

The empirical part of this work is based on data collected during 2017 from a joint study of Legambiente and Laboratorio Manifattura Digitale of University of Padua.

Legambiente is an Italian association, born in 1980, composed by people who, through volunteering and direct participation, promote a change for a better future; the issues of waste management and circular economy have always occupied a priority role among its objectives, with the aim to put itself alongside citizens and companies and support them in the crucial step of changing and adapting production systems, economic organization, and social behaviour.

Laboratorio Manifattura Digitale of University of Padua studies the evolution of Italian manufacturing, starting from the transformations introduced by digital technologies (Industry 4.0). It promotes the research of models of adoption of digital technologies and their impact on the company's strategy and business model (Di Maria, De Marchi, Blasi, Mancini, & Zampetti, 2017).

The report has the scope of analysing the motivations and the results achieved by Italian firms that practice a circular economy business model; it also investigates the difficulties in the transition process of adopting these types of activities.

The research project has several objectives, in particular the main ones are:

- investigate the profile and business model of companies that practice the circular economy.
- Analyse the reasons, the results achieved and the criticalities of the process.
- Highlight the characteristics of the relationships developed.

The picture that emerges offers useful insights to define actions and intervention programs that make the approach to the circular economy faster and more effective (Di Maria, De Marchi, Blasi, Mancini, & Zampetti, 2017).

The study was conducted on firms located all over Italy that have already implemented one or more activities related to the circular economy. For the definition of the initial number of observations, the researchers selected companies that adopted a series of specific initiatives on the circular economy carried out by different and qualified entities, such as: Treno Verde of Legambiente, Enel-Symbola, ReMadeinItaly, MAINN Legambiente.

3.2 THE SAMPLE

The total number of observations consisted of 322 companies, from which it was derived a sub-sample of 231 manufacturing companies; the final and reference sample of this thesis is composed of 47 firms, located all around Italy, that are adopting a circular business model and are actively engaged in circular economy activities.

These companies are micro, small, and medium sized that have started to embrace circular economy activities in a period from 1978 to 2017.

Their production process, as described in *Figure 11*, is located mainly in the region where the company has its headquarters (74%), 20% of them locate the production in the rest of Italy, while it emerges a low reliance about locating the production sites abroad (only 6%), witnessing the deep-rooted and solid presence of their production in the Italian territory.

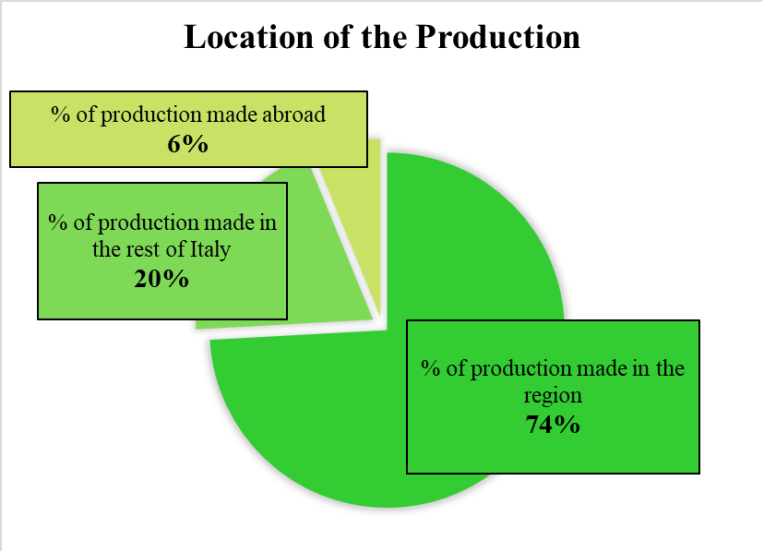


Figure 11 Location of the Production (own creation)

Talking about the type of activities adopted by the companies, as it can be seen from *Figure 12*, the prevention of waste production and reduction of waste is the most pursued activity among the reference companies (85% of them have adopted it), followed by the reduction in the use of resources (61%), the reuse of waste from own activities within the production cycle and the use of secondary raw materials and waste materials acquired from others (54%).

On the opposite, the use of renewable raw materials and the repair or reuse of products to extend their useful life are the least used (only 37% of the reference companies have embraced each of one).

Figure 12 Sustainable Activities adopted by the companies (own creation)

The reasons to undertake these sustainable activities and to follow a circular economy business model are many and various.

The questionnaire made by Legambiente and Laboratorio Manifattura Digitale of University of Padua tries to determine them by asking the firms to choose the level of relevance of each type of reasons (*Figure 13*) in a range from 1 to 5, where 1 stays for "Not at all" and 5 is "Extremely".

As described by the figure, the most important reason to embrace a sustainable strategy is related to "Ethics and Corporate Social Responsibility"; other relevant reasons are: to increase the value of the products offered, and to entry in new markets. On the other hand, the reasons that the interviewed firms retain the least important are: tax benefits, competition, and regulation alignment.

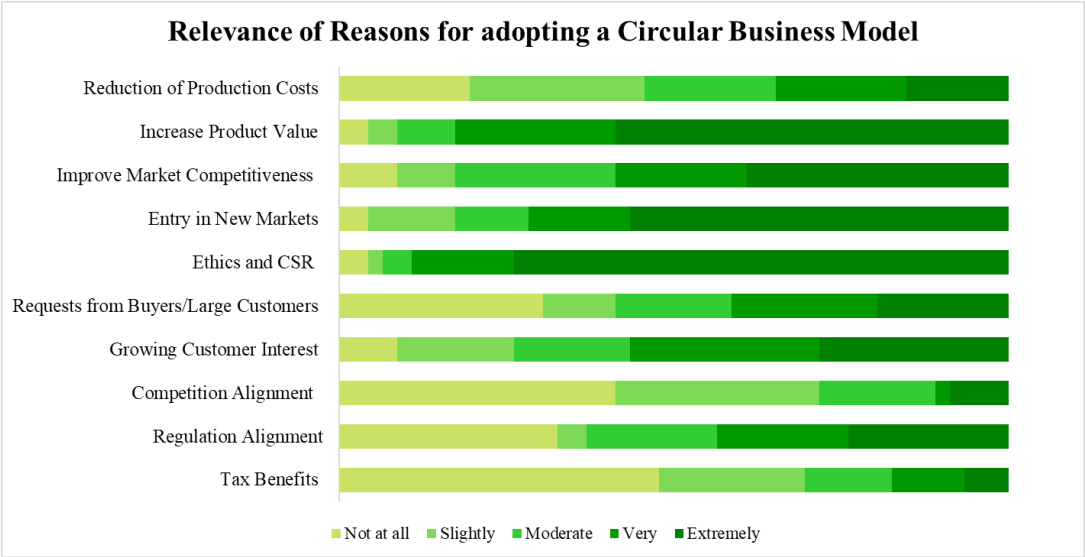


Figure 13 Relevance of Reasons for adopting a Circular Business Model (own creation)

In order to realize a circular business model, as it can be visualized in *Figure 14*, the reference firms have heavily invested in changes in the Marketing function. Other important activities that have incurred in relevant changes are: Research & Development, and the addition of new products in the firm's product portfolio; while after-sales services and the addition of existing products in the product portfolio are the functions that mainly remained the same in the process towards environmental sustainability.

The focus on Marketing, as a function and support activity to increase the sustainable side of the company, is related to the difficulties encountered in convincing and making conscious the consumers about the positive aspects created with the new offer, bearing and accepting, in the majority of case, an increase in price.

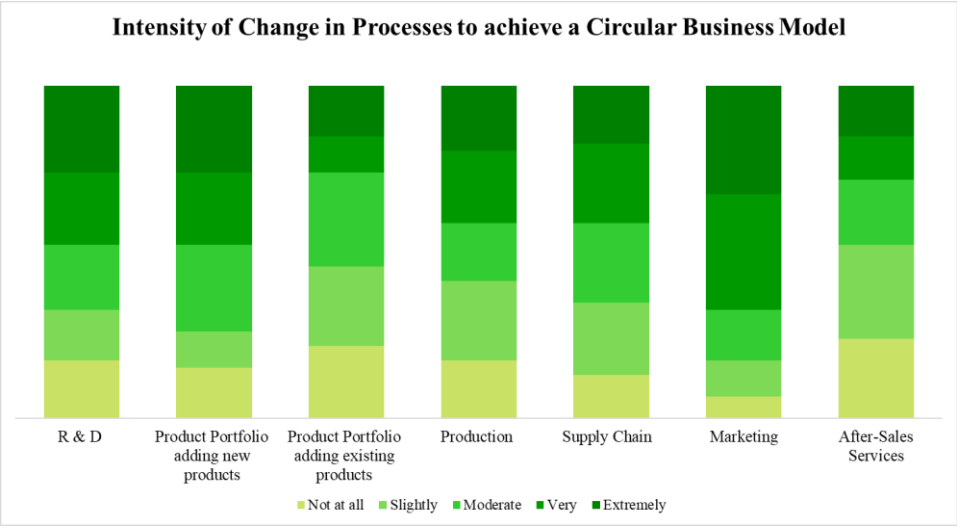


Figure 14 Intensity of Change in Processes to achieve a Circular Business Model (own creation)

To conclude, in the questionnaire are also depicted the benefits that the companies have experienced after the adoption and implementation of sustainable activities.

As it can be deduced from *Figure 15*, the benefit encountered in every firm (even if with different intensities) is an improvement of the company's reputation, followed by an improvement of the employees' motivation and company's culture. Entry in new markets, increase of market share, and increase of products and services variability are other relevant benefits found. Benefits such as alignment to competition and credit relief are the less experienced by the sample of reference.

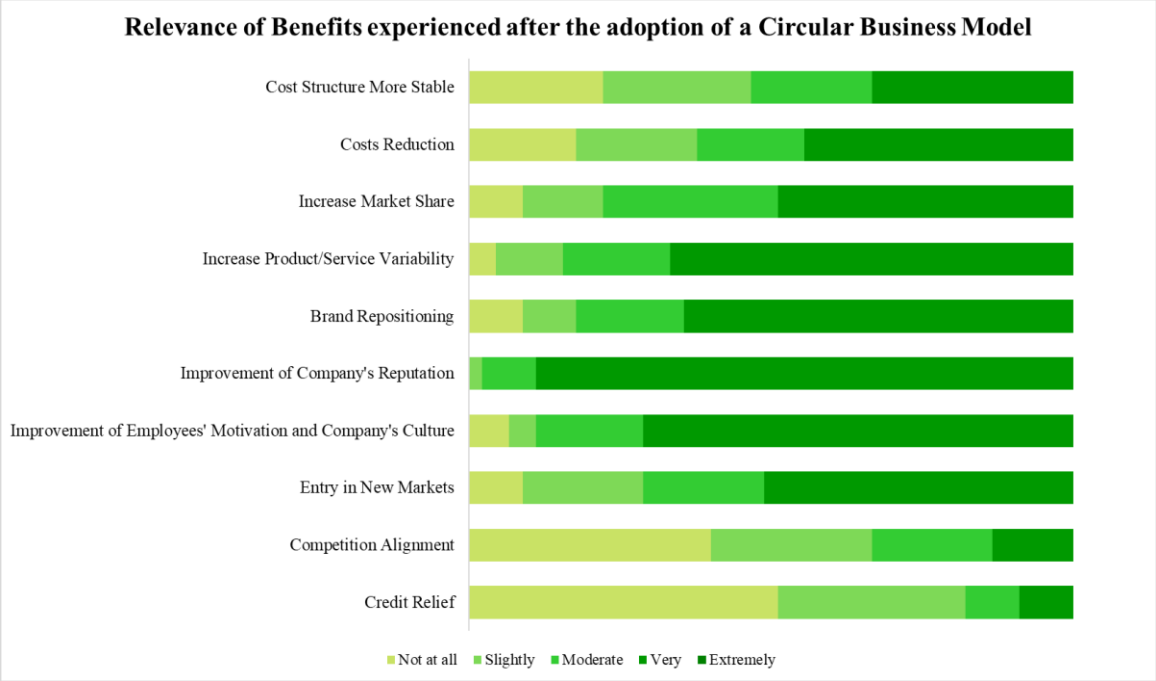


Figure 15 Relevance of Benefits experienced after the adoption of a Circular Business Model (own creation)

3.3 FUZZY SET QUALITATIVE COMPARATIVE ANALYSIS

The methodological and empirical part of the thesis is supported by a set-theoretic approach that analyses the combination of a set of independent and control variables that are associated with a significant and successful corporate outcome.

In particular, it has been used the analytic technique called fuzzy set Qualitative Comparative Analysis, fsQCA (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).
This methodology is known as an appropriate one to determine the relationship that different combinations and degrees of implementation of a set of variables has towards a specific outcome.

Furthermore, this approach is uniquely suited to analyse causal processes in typologies and can handle significant levels of causal complexity. The basic intuition underlying it, is that cases are best understood as configurations of attributes resembling overall types and that a comparison of cases can allow a researcher to strip away attributes that are unrelated to the outcome in question (Apa & Sedita, 2017).

Going more in practical terms, the method treats each variable as an independent set in which cases (that in this circumstance are the reference firms) are assigned with a set-membership score according to their membership degree in the attribute's set.
In the matter of fuzzy sets, the set-membership score can be set in an interval from 0, if the case does not possess the attribute (full non-membership), to 1, if the attribute of the case corresponds entirely to the ideal type (full membership).

A Fuzzy Set can be seen as a continuous variable that has been purposefully calibrated to indicate degree of membership in a well-defined and specified set; such calibration is possible only through the use of theoretical and substantive knowledge, which is essential to the specification of the three qualitative breakpoints (full-membership, full non-membership, and maximum ambiguity) (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

According to Ragin (2008), one of the greatest strengths of fuzzy sets is that they make set theoretic analysis possible, while retaining fine-gained empirical gradations.

It is possible to determine if one set is a subset of another, determining whether the cases sharing a specific combination of conditions shares the same outcome. By contrary, with crisp sets (nominal-scale measurement assuming only the values of 0 if the case is "fully-out" and 1 if the case is "fully-in"), it is a simple matter where the researcher simply examines cases sharing the relevant combination of conditions and assesses whether they agree in displaying the outcome (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

In addition to that, as described by Galeazzo and Furlan (2017), fsQCA has also three other advantages over traditional methods.

Primarily, the main task of this approach is not to capture the net effects of an independent variable on an outcome without considering other variables or their combinations, but to analyse complex relationships in the form of conjunctural causation (meaning that a single attribute may not produce any effect in isolation but only if it is combined with other attributes).

Secondarily, this methodology assumes equifinality. By allowing that multiple, equally effective, sets of attributes result to the desired outcome, fsQCA enables a fine-grained analysis of the qualitative and quantitative differences among sets; as such, it is possible to distinguish which attributes are relevant and how they combine to achieve the outcome, overcoming the limitation of traditional configurational approaches such as cluster analysis and factor methods, that consider each set as a black box, as cited from Fiss, P.C. (2007), "A set-theoretic approach to organizational configurations", in (Galeazzo & Furlan, 2018).

Lastly, this type of approach allows for asymmetrical relations, which means that a configuration that is associated with the outcome of interest does not imply that the absence of the same configuration explains the lack of the outcome. The use of set-subset connections in fsQCA qualifies for a more nuanced understanding of the links between attributes and expected outcomes than conventional methods that use correlation analysis (Galeazzo & Furlan, 2018).

3.3.1 THE METHOD

To execute the fsQCA method, the researcher has to follow various steps in a rigorous order.

The first one is data calibration.

This passage is the most crucial among all, because it puts the basis and the conditions of the subsequent practical analysis, transforming the data collected into fuzzy score data in a range from 0 (full non-membership) to 1 (full membership).

The cases of each variables have been clustered per condition (Schneider, C.Q. and Wagemann, C., 2012, in Apa & Sedita, 2017): the theoretic and knowledge assumptions, initially assumed by the researcher, are followed and respected when selecting the three thresholds: the one of full non-membership, the crossover point of full ambiguity and the one of full membership.

The second step is the analysis of the necessary conditions.

After having been calibrated, the variables are subjected to a process that determines if they are sufficient, or necessary to the presence of the requested outcome. If they are necessary, they must be dropped from the model and taken for granted in the explanation of the results.

The criteria of selection of the necessary and sufficient conditions is the check of the variables if they exceed a minimum standard level of two values: Consistency and Coverage. Consistency refers to the degree to which cases correspond to the set-theoretic relationship expressed in a solution (Fiss, 2011, in Apa & Sedita, 2017).

A consistency of 1.0 means that a specific configuration has no contradictions, while lower values imply an imperfect relationship between the configuration and the outcome.

Coverage assesses the degree to which a cause or a causal combination accounts for instances of an outcome. This notion can be thought of as a measure similar to the R-squared value in the Regression analysis (Apa & Sedita, 2017).

The two concepts are calculated by the software as follows:

$$Consistency\ (X \subseteq Y) = \sum \min(x_i, y_i) \,/ \sum x_i$$

$$Coverage\ (X \subseteq Y) = \sum \min(x_i, y_i) \,/ \sum y_i$$

where x_i is the degree of membership of individual *i* in the configuration *X,* and y_i is individual *i*'s degree of membership in the outcome *Y*.

The third step is the analysis of the "truth table". This matrix of data has 2^k rows, where k is the number of causal conditions in the analysis; each row expresses a specific combination of the causal condition, the full table shows all the possible combinations of them.

The fourth step is the minimization process of the truth table, in order to find the configurations of variables that best fit in the model to achieve the requested outcome.
The lines of the truth table are reduced by taking into consideration all the combinations that can be associated with at least one or two firms if the reference sample is relatively small (less than 100 observation), but when the total N is large a more substantial threshold should be selected (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008); it should follow a minimum consistency-level criteria of at least 0.80, in general values below 0.75 indicate substantial inconsistency (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

The fifth and final step of the fsQCA analysis leads to a logical reduction of the truth table rows using an algorithm based on Boolean algebra in order to identify a set of simplified combinations (Apa & Sedita, 2017). This process generates three types of solutions: complex, parsimonious and intermediate.

The parsimonious solution includes all remainder combinations, truth table rows that lack enough empirical evidence to be subjected to a test of sufficiency (Schneider, C.Q. and Wagemann, C., 2012, in Apa & Sedita, 2017), that are, for example, those without strong instances or with very few strong ones.
The complex one, on the other hand, defines all remainder combinations as false and do not include them in the result.
The intermediate solution is the one that better clarifies the outcome, in respect to the other two, and the interpretation of it is clearer and simpler. This solution is optimal because it incorporates only easy counterfactuals, eschewing the difficult ones that have been incorporated into the most parsimonious solution. It strikes a balance between complexity and parsimony, using procedures that mimic the practice of conventional case-oriented comparative research (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

3.4 THE VARIABLES

The variables included in the model are the four types of circular business models adopted by the reference sample, the measures of depth and breadth in open innovation relationships, the total years of adoption of a circular business model and the size of the company (measured by the total number of employees).

The Return of Investment (ROI), the market share, and the employment of the company are respectively the three different outcomes for each of the three different models analysed.

Tables 4 and 5 contain the descriptive statistics and correlation matrix for all the variables.
As it can be deduced from *Table 4*, the first four variables (the ones that correspond to the circular business models adopted) are Dummy variables that assume values equal to 0 if they are assent and 1 if they are present.
Furthermore, focusing the attention on ADOP and SIZE, the fact that the values of Standard Deviation are greater than the ones of the Mean witnesses the high variability of the observations of these variables in the reference sample.

Variable	Mean	Std. Dev.	Min.	Max.
RECY	0,65	0,48	0	1
USE	0,09	0,28	0	1
GIVE	0,20	0,40	0	1
CYCLE	0,07	0,25	0	1
BREADTH	5,26	2,21	0	8
DEPTH	2,72	0,88	1	4
ADOP	8,72	10,14	0	44
SIZE	54,46	94,32	1	407

Table 4 Descriptive statistics of the Variables of the Model (own creation)

In addition to that, an interesting result presents in *Table 5* is the positive and significative index of correlation (near to 1) between the variables BREADTH and DEPTH; it shows a high and positive correlation of the aspects of breadth and depth in a business relation enhancing a sustainable innovation.

It can be deducible that the companies in the sample, when approaching a wide number of partners for innovation purposes, at the same time it exploits in depth the relation with them.

	RECY	USE	GIVE	CYCLE	BREADTH	DEPTH	ADOP	SIZE
RECY	1							
USE	-0,4226	1						
GIVE	-0,6753	-0,1522	1					
CYCLE	-0,3617	-0,0815	-0,1303	1				
BREADTH	0,1083	0,1399	-0,1595	-0,1123	1			
DEPTH	0,1123	0,2205	-0,2500	-0,0666	0,8620	1		
ADOP	0,1888	-0,0990	-0,1063	-0,0803	0,1653	0,0291	1	
SIZE	0,3099	-0,1388	-0,1833	-0,1448	0,1682	0,1302	0,5144	1

Table 5 Correlation Matrix of the variables of the Model (own creation)

3.4.1 OUTCOME VARIABLES (ROI) - (SHARE) – (EMPLOY)

The outcome variables that have been chosen in the fsQCA analysis are the Return of Investment (ROI), the market share (SHARE), and the value of employment of the company (EMPLOY).

Being three different measures of a successful performance, three different fsQCA models have been processed. Subsequently, it has been analysed the common points and configurations that better improve all of them at the same time.

The companies in the reference sample have been asked if, in the three-year period before 2017, these indicators have been “decreased/worsened”, “remained stable” or “increased/improved”. For calibration purposes, these three answers have been converted in quantitative values.

In the model, “decreased/worsened” is equal to 1, “remained stable” is equal to 2, “increased/improved” is equal to 3. For all of these outcome variables, the full non-membership threshold has been set to 1, the crossover point to 2 and the full membership threshold to 3.

The model outlined in the thesis is the one with ROI as the outcome; the other models expressing the other two outcomes are reported in the *Appendix section* at the end of the thesis.

3.4.2 CONDITIONAL VARIABLES – INDIPENDENT MEASURES

3.4.2.1 Circular Business Models (RECY) – (USE) – (GIVE) – (CYCLE)

To qualify the sustainability involvement of the companies interviewed, it has been asked which type of circular business model they have adopted.
The answers were: recovery, recycling and reuse of resources/energy (RECY), use of circular input made by specialised suppliers (USE), provide 'circular' input to other companies or institutions (GIVE), extension of the life cycle of the products manufactured (CYCLE).

As it is showed in *Figure 16,* the most adopted business model is the one that recover, recycle and reuse the resources and/or the energy (65% of the companies), followed by the one that provide circular input to other companies or institutions (20%); the least used is the one that extend the life cycle of the product manufactured (7%).

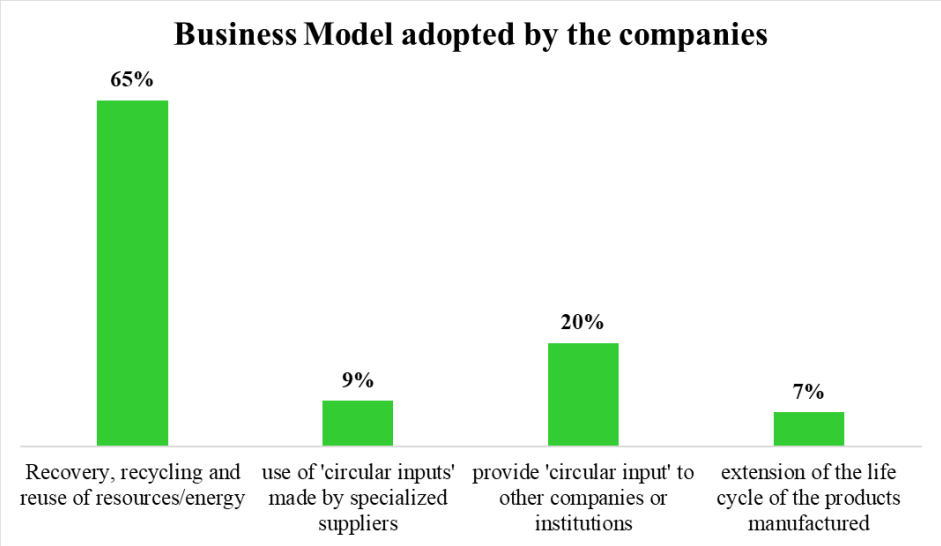


Figure 16 Business Model adopted by the companies (own creation)

In the questionnaire, the companies were asked to answer “yes” if they adopted the circular business model under consideration, and “no” if not. For calibration reasons, the variables were treated as dummy variables were 0 was the value when the answer was “no” and 1 if the answer was “yes”.

Afterwards, in the fsQCA analysis, these variables were considered as crispy set variables (and not fuzzy set ones as all the other variables in the model) because they assumed only two values: 1 if the case was “fully in” and 0 if “fully out”.
As stated by Ragin in “Redesigning Social Inquiry Fuzzy Sets and Beyond” (2008), in Chapter 2, page 34, crisp-set causal conditions can be included along with fuzzy-set causal conditions in a fuzzy-set analysis.

3.4.2.2 External Search Breadth (BREADTH) and Depth (DEPTH)

As described in the paper made by Laursen and Salter entitled “Open for Innovation: the role of openness in explaining innovation performance among U.K. manufacturing firms”, the exploitation of external knowledge, using a wide range of external actors and sources, is a critical activity to help the companies to achieve and sustain innovation.

The Schumpeterian model of the individual entrepreneur that brings innovations to the markets only with his/her own competences and resources has been overcome by a new vision, where innovators rely heavily on their interaction with lead users, suppliers, consultants, and with a range of institutions, in a system that Chesbrough calls “open innovation” model (Laursen & Salter, 2006).
Open innovators are those that integrate these external sources into their innovation processes and competitive strategy (Chesbrough, 2003).
That is why, together with the type of circular business model adopted, it has been chosen to combine the set of variables related to the relationships that a company establishes to realize sustainable activities.

In this thesis work, the focus is not solely based on the type and the number of relationships involved, but especially on the themes of external search breadth and external search depth.

External search breadth is defined as the number of external sources, or search channels, that firms rely upon in their innovative activities.

External search depth is defined in terms of the extent to which firms draw deeply from the different external sources (Laursen & Salter, 2006).

Regarding this two concepts, in the questionnaire it has been asked, in a Likert scale where 1 was equal to "not at all" and 5 to "extremely", which was the intensity of collaborations with a series of external actors.

The answers are summarized in *Figure 17* and, as it can be seen, the most intense collaborations to help reaching a circular business model involve the company and consultants, universities, suppliers of materials, and public entities.

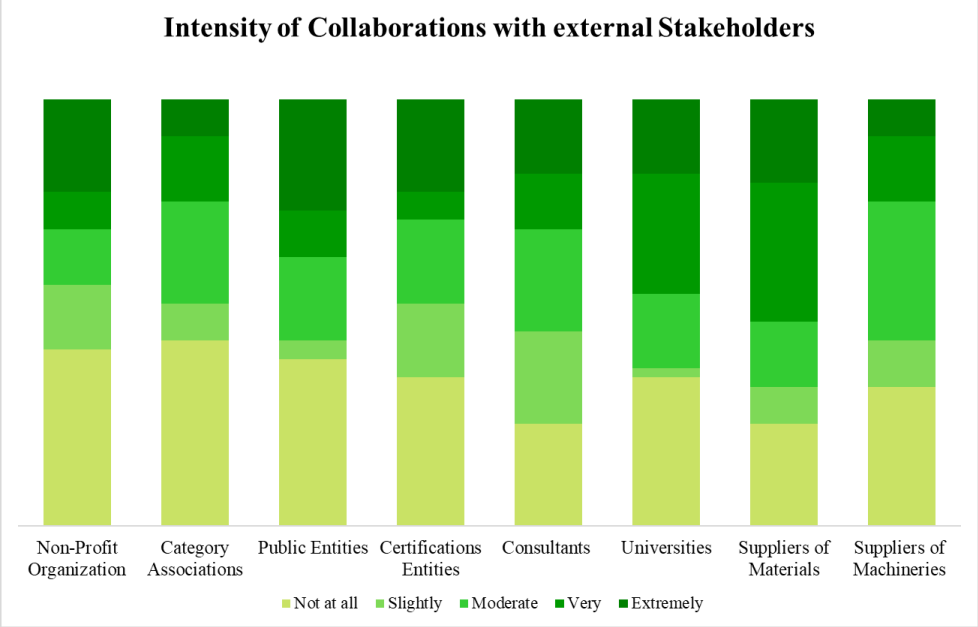


Figure 17 Intensity of Collaborations with external Stakeholders (own creation)

In order to convert the degree of relation with all these stakeholders to the concept of external search breadth and depth, various steps have been followed.

External search breadth was calculated, for every company, with the counting of all the relations that have not a value equal to 1 ("not at all"). Hence, it has been taken into account the number of actors with whom the company had a significative relationship, with values of a degree of collaboration that vary from 2 ("slightly") to 5 ("extremely").

External search depth is equal to the mean of the values, ranging from 1 to 5, corresponding to the degree of intensity of the relationship with every external stakeholder; the method to extract this variable was deducted from Laursen & Stalter's work mentioned above.

After this conversion, to execute the calibration activity in fsQCA, for both the two variables it has been chosen to establish the mean as the crossover point, the value of the mean plus the Standard Deviation of the observations to calculate the threshold of full membership, and the value of the mean minus the Standard Deviation of the observation to calculate the threshold of full non-membership.
By doing so, it was possible to split the distribution of both variables in equal and significative parts for low, medium, and high values.

3.4.3 CONDITIONAL VARIABLES – CONTROL MEASURES

3.4.3.1 Total Years of Adoption of a Circular Business Model – (ADOP)

The variable that expresses the total years of adoption of a circular business model by the companies has been used as a proxy that outlines the reliability in pursuing sustainable activities and the degree of contribution for the establishment of a wider circular economy system in Italy.
Figure 18 shows the year of adoption of all the 47 companies in the sample and, as it can be deductible, the main part of them is located in the right part of the distribution, witnessing a major endorsement to the environmental cause in the latest years, from 2009 to 2017.

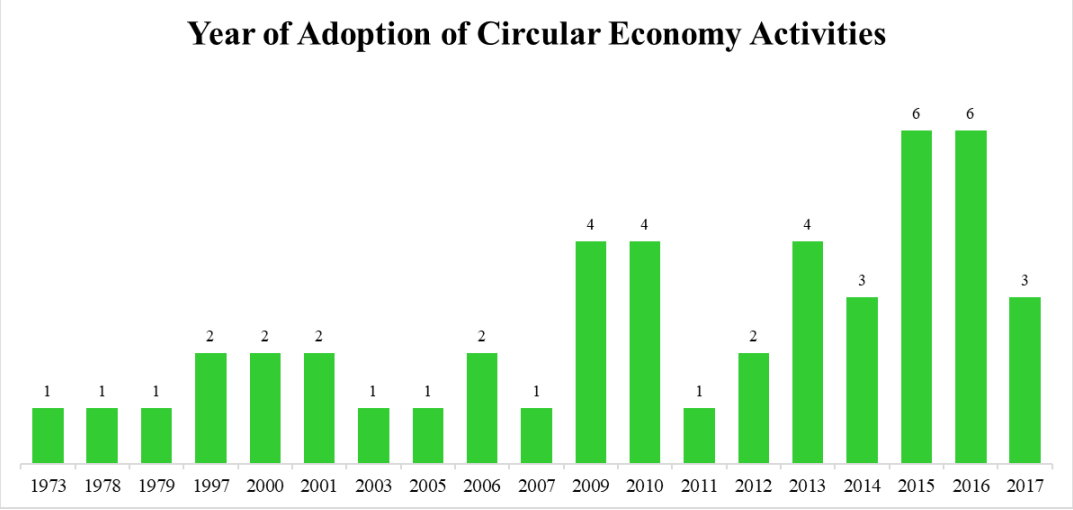


Figure 18 Year of Adoption of a Circular Business Model for each company in the reference sample (own creation)

In fsQCA, the variable ADOP represents the total years of integration of a circular business model, from its first to the 2017, year of execution of the questionnaire of reference for this thesis.

Since the data are skewed to the right side of the distribution, the calibration activity has been done using percentiles (Pappas, Mikalef, Giannakos, & Pavlou, Value Co-Creation and Trust in Social commerce. an fsQCA approach, 2017). In particular, the threshold for full membership is equal to the 90^{th} percentile, the crossover point to the 50^{th}, and the threshold of full non-membership to the 10^{th} one.

3.4.3.2 Size of the Company - (SIZE)

As it can be seen from the descriptive statistics of the model in *Table 6,* the companies in the sample have different and various sizes in terms of employees, from a minimum of 1 to a maximum of 409 workers.

The control variable SIZE expresses the dimension of each company of the sample, taking into consideration the general definition of small and medium enterprises made by the European Commission in 2003.

In the EU recommendation 2003/361, as described in *Table 6,* a company is defined as micro, if it employs less than 10 employees, as small if it has less than 50 employees and as medium if it employs less than 250 workers (European Commission, 2003).

Company Category	Staff headcount	Turnover	Balance Sheet Total
Micro	< 10	≤ € 2 Million	≤ € 2 Million
Small	< 50	≤ € 10 Million	≤ € 10 Million
Medium	< 250	≤ € 50 Million	≤ € 43 Million

Table 6 Definition of SMEs made by the European Commission (own creation)

Figure 19 shows more in detail the composition of the sample in terms of sizes.

It is visible that the majority of the companies is classified as micro (48% of the reference sample), having less than 10 employees, followed by a significative part of them that is small-sized (28%), with less than 50 employees. This data are coherent with the overall scenario of enterprises in Italy: the permanent census of enterprises of 2019 made by Istat explains that 79.5% of the companies in Italy are micro-sized and 18.2% of them are small-sized, while only 2.3% are medium or large (Istat, 2020).

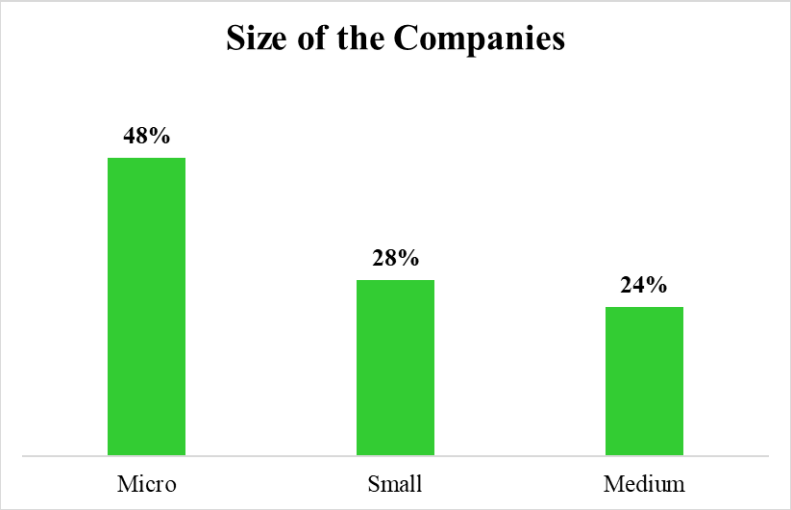


Figure 19 Sizes of the companies in the reference sample (own creation)

According to the aforementioned definition of SMEs made by the European Commission, these thresholds were selected: 250 for full membership, 50 for the crossover point, and 10 for the full non-membership.

3.5 VARIABLE CALIBRATION

Calibration is the process of transforming variables into fuzzy set scales of degrees of membership (Apa & Sedita, 2017).

In the model analysed in this thesis, for each variable (outcome and conditional ones) it was used the *direct method* of calibration. The latter allows the researcher to specify the values of an interval scale that correspond to the three qualitative breakpoints that structure a fuzzy set: full membership, full non-membership, and the crossover point (the value of maximum ambiguity); these three benchmarks are then used to transform the original interval-scale values, to fuzzy membership scores.

Ideally, the calibration of the degrees of membership, in a set, should be based entirely on the researcher's substantive and theoretical knowledge (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

It is important to highlight, as noted by Ragin in his work "Redesigning Social Inquiry, Fuzzy sets and beyond" (2008), that the set membership scores obtained from the calibration activity are not probabilities, but degrees of membership in the target set; they attach a truth value, not a probability, to a statement (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

The calibration process of the three fsQCA models analysed in this thesis, is described in *Table 7*.

	THRESHOLDS		
VARIABLES	**Full Membership**	**Crossover Point**	**Full Non-Membership**
RECY	1	-	0
USE	1	-	0
GIVE	1	-	0
CYCLE	1	-	0
BREADTH	7	5	3
DEPTH	4	3	2
ADOP	20	5	1
SIZE	250	50	10
ROI	3	2	1
SHARE	3	2	1
EMPLOY	3	2	1

Table 7 Variable Calibration Thresholds (own creation)

3.6 ANALYSIS OF NECESSARY CONDITIONS

The starting point to build the Truth Table, and to determine the best variables' configurations of our model, is the analysis of the necessary conditions.

A necessary condition is a condition that must be present for the outcome to occur, but its presence does not guarantee that occurrence (Ragin, Qualitative comparative analysis using fuzzy sets (fsqca), 2009). Sufficient conditions are relevant conditions that exhibit the same outcome and are shared by several cases of variables. Any condition that passes the test, and that belongs to the definition of necessary condition, has to be dropped from the Truth Table procedure, which is essentially an analysis of sufficiency (this is true for all varieties of QCA-crisp set, multi-value, and fuzzy set). The condition identified in this way, would be retained for discussion as a necessary condition and should be considered relevant to any sufficient combination of conditions identified through the truth table analysis (Ragin, Qualitative comparative analysis using fuzzy sets (fsqca), 2009). Conventionally, a condition, or a combination of conditions, is called "necessary" if its Consistency score exceeds the threshold of 0.9 and its Coverage is higher than 0.5 (Apa & Sedita, 2017). In each of the three models discussed in this thesis, it has been executed the analysis of necessary conditions, analysing the causal conditions of each variables and their negations (indicated with the tilde symbol before the denomination).

In *Table 8* it is presented in detail the analysis of necessary conditions for the model with ROI as the outcome, the tables for the other two models analysed (with SHARE and EMPLOY as outcomes), are presented in the *Appendix section* of the thesis.

As it can be visible, the negation of the variables USE and CYCLE (written in bold in the table) could be considered necessary conditions, given that they exceed the standard thresholds of Consistency and Coverage mentioned above.

The same result is visible also for the models with SHARE and EMPLOY as the outcomes.

Configurations of conditions characterized by the absence of circular business models that use circular input made by specialised suppliers, and that extend the life cycle of the products manufactured, determine an increase of performances in respect to indicators as Return of Investment, market share and employment. In addition to that, it is important to state that this result, as standalone, is not sufficient; it is thus necessary to investigate its combination with the other variables, proceeding with the analysis of the Truth Table.

VARIABLES	Consistency	Coverage
RECY	0.633739	0.695000
~ RECY	0.366261	0.753125
USE	0.088146	0.725000
~ USE	**0.911854**	**0.714286**
GIVE	0.218845	0.800000
~ GIVE	0.781155	0.694595
CYCLE	0.059271	0.650000
~ CYCLE	**0.940729**	**0.719768**
BREADTH	0.648024	0.819370
~ BREADTH	0.478115	0.787287
DEPTH	0.518237	0.904509
~ DEPTH	0.685410	0.830571
ADOP	0.554103	0.843201
~ ADOP	0.606079	0.817883
SIZE	0.289666	0.835965
~ SIZE	0.799088	0.759827

Table 8 Analysis of Necessary Conditions with ROI as outcome (own creation)

3.7 TRUTH TABLE ANALYSIS AND MINIMIZATION

The Truth Table is the main tool for systematic analysis of causal complexity.

The goal of this process is to identify explicit connections between combinations of causal conditions and outcomes.
Using it, it is possible to assess the sufficiency of all logically possible combinations of presence and absence conditions that can be constructed from a given set of *k* causal conditions (Ragin, Redesigning Social Inquiry : Fuzzy Sets and Beyond, 2008).

After having executed the necessary condition analysis, the variables USE and CYCLE have been dropped from the model because their absence is a necessary condition. The resulting model has 6 causal condition and, as a consequence of that, the Truth Table has 2^6 rows.

The key determination that must be made at this moment is the check of the Consistency score, that has to be used as a cut-off value for determining which causal combinations to accept in the model and which do not.
Causal combinations with Consistency scores at or above the cut-off value of 0.80 are designated fuzzy subsets of the outcome and are coded 1, those below the cut-off value of 0.80 are not fuzzy subsets and are coded 0 (Ragin, Qualitative comparative analysis using fuzzy sets (fsqca), 2009).
In the Truth Table's construction of the three fsQCA models analysed, it has been selected a frequency threshold of 2 and a Consistency cut-off of 0.80.

In order to minimize the possible configurations and optimize the results, processing the "Standard Analysis" command in the fsQCA software, it has been automatically calculated the Complex, Parsimonious and Intermediate solutions.
In general, Intermediate solutions are superior to both the Complex and Parsimonious solutions and should be a routine part of any application of any version of QCA (Ragin, Qualitative comparative analysis using fuzzy sets (fsqca), 2009).

3.8 THE RESULTS

After the construction and minimization of the Truth Table, the analysis of the three types of solutions has brought to the creation of a table that summarizes the results (*Table 9)*.

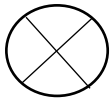
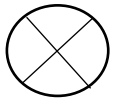
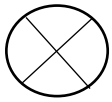
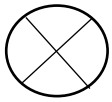
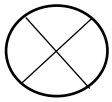
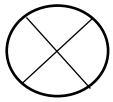
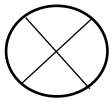
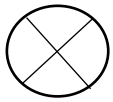
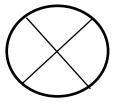
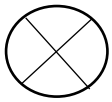
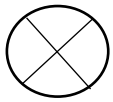
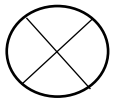
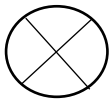
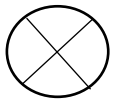
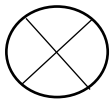
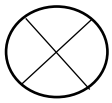
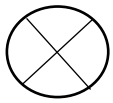
	CONFIGURATIONS				
	1	**2**	3	4	**5**
RECY					
GIVE					
BREADTH					
DEPTH					
ADOP					
SIZE					
Consistency	0.879357	0.982916	0.86383	0.895833	1
Raw Coverage	0.099696	0.26231	0.185106	0.117629	0.107903
Unique Coverage	0.099696	0.193617	0.125836	0.117629	0.0337386
Overall solution Consistency	0.914939				
Overall solution Coverage	0.657143				

Table 9 fsQCA solutions for the model with ROI as the outcome (own creation)

Table 9 represents the results of the fsQCA analysis of the model with ROI as the outcome. The other tables that show the results of the other two models, respectively with SHARE and EMPLOY as the outcomes, are present in the *Appendix section* of the thesis.

Following (Apa & Sedita, 2017) for the design of the table, the black circles indicate the presence of a condition, the white ones with a cross upon indicate the absence of it, and blank spaces indicate a "don't care" situation, in which the causal condition may be either present or absent. According to Fiss (2011) about the distinction among core and peripheral conditions, larger circles indicate core conditions (those with strong causal relation with the outcome), and smaller ones indicate peripheral conditions (those with weak causal relation with the outcome). In practical terms, core conditions are those that are part of both the Parsimonious and Intermediate solutions, while peripheral conditions are those that are eliminated in the Parsimonious solution and thus are only present in the Intermediate solution.

All solutions cover more than a half of the total cases in exam (the overall solution Coverage is 65%) and the overall Consistency (the goodness of fit of the model) is 91%, almost equal to the maximum value of 1.

All configurations show only core condition variables, present in both Parsimonious and Intermediate solutions, and not in the peripheral ones.

The results delineate five different types of configurations that figure an increase of ROI.

Solution 1 has the lowest raw coverage (0.1), representing a configuration that covers less cases in the dataset. 10% of the cases can be explained exclusively by that configuration (the value of unique coverage is 0.1). The value of Consistency is 0.88, indicating that the solution covers one or more cases that do not result in the outcome (Apa & Sedita, 2017).

This configuration is characterised by the presence of the variables BREADTH and DEPTH, the absence of the variables RECY, GIVE and SIZE, and a "don't care" situation for the variable ADOP.

This solution, therefore, shows that a company that does not adopt any of the four circular business models described before, hires a small number of employees and no matter in which year has adopted activities of circular economy, can achieve an increase in ROI if it has a strong, deep and wide network of stakeholders that collaborate for the development of sustainable innovations.

Solution 2 has the highest values of raw and unique coverage (respectively 0.26 and 0.19), meaning that is the configuration that covers most cases in the dataset and that 19% of them are explained exclusively by that solution. The Consistency is 0.98, demonstrating that only a few number of cases covered by the configuration are not present in the outcome.

The solution is described by the presence of the variables RECY, BREADTH, DEPTH, the absence of the variable GIVE, and a "don't care" condition for the variable SIZE.

It can be stated that a company that adopts a circular business model which involves the recovery, recycle and reuse of resources/energy, that relies on a solid and broad network of collaborators for open innovations and that has introduced circular activities for a large number of years, no matter the number of employees that it has, may experience a successful performance in the increment of the index of Return of Investment.

Solution 3 and 4 are mutually exclusive. The first, illustrates the presence of the variable RECY, the latter, the presence of the variable GIVE; for both, all the other variables are absent.

They express that, adopting a circular business model based on the recovery, recycle and reuse of resources/energy, or on the provision of "circular" input to other companies or institutions, a company can obtain an increase of ROI. The other sufficient conditions for achieving this result are that it has recently embraced circular economy activities, it has employed a low number of people and has not developed a strong and wide connection with external actors to reach environmental innovations.

In general, these two configurations refer to micro and small newcomer firms, with a low network of stakeholders, that approach a circular business model since their creation.

Solution 5, in conclusion, covers the 11% of cases in the dataset and only the 3% of the overall cases can be explained by this configuration. The solution has a value of Consistency of 1, therefore all the cases of the configuration are presented in the outcome.

In this setting of variables, RECY, ADOP and SIZE are present, while GIVE, BREADTH and DEPTH are absent.

The scenario states that a company that enacts a circular business model which involves the recovery, recycle and reuse of resources/energy can increase its index of ROI if it has a high number of employees and has been sustainable oriented for a long time; this performance is reached also if the firm has not built a solid relation with a large number of external shareholders to achieve innovations.

3.9 DISCUSSION

After having processed the same methodology to the other two models, with respectively SHARE and EMPLOY as the outcomes, the significative result is the presence of three configurations in common among all the three models. These configurations are the number 1, 2 and 5 of the model with ROI as the outcome (highlighted in bold in *Table 9*), presented in Chapter 3.8.

This result is of extremely importance because it states, with the necessary limitations of the research, that each of the solutions displays a configuration of conditions that is sufficient to predict an increase, at the same time, of the index of Return of Investment, of the market shares and of the employment.

The first solution refers to a company with a low number of employees, that purses sustainable activities (no matter for how long time) but does not adopt a specific and determined circular business model. This type of company experiences an increase in ROI, market share and employment rate, thanks to a high and significative level of external search breadth and depth in the reaching of open innovations.

In this configuration, the firms are theoretically treated like micro and small enterprises that tries to gain a competitive advantage in the market adopting sustainable and circular activities. In this case, the relevant factor to achieve successful performances is not about the size and the turnover of the company, but the network of external collaborators on which the company relies on. In fact, synergies between firms can generate benefits that could not be gained if the partners would have acted independently. It could be created an environment where costs would be shared, investment's risk reduced, and the quantity and quality of innovations increased.

In the Italian economic scenario, this situation can be compared to the industrial districts' phenomena. A cluster is a geographic agglomeration of companies (mainly of small and medium sized), suppliers, service providers, and associated institutions in a particular field, linked by externalities and complementarities of various type; they are the natural manifestation of the role of specialized knowledge, skills, and supporting industries in enhancing productivity (Porter, 2009). Location within a cluster enables companies to become more specialized, more productive, and more innovative (Porter, 2009).

The second solution outlines a type of company, no matter the size (micro, small or medium), that has adopted sustainable approaches for a long period of time and that has made significative efforts in external search breadth and depth for open innovations. In addition to that, enacting a circular business model based on recovery, recycle, reuse of resources and/or energy, the firm may achieve successful performances in terms of ROI, market share and employment rate.

In this case, the key factor of the configuration is the circular business model adopted. A high experience in the circular economy environment, together with an openness attitude in reaching innovations, set the basis for a sustainability setting for the company; but it is the choice of adopting a business model based on recovery, recycle, and reuse of resources that makes the difference in improving the performances of the firm.

The third and last solution reports a configuration where there is a specification of the circular business model to embrace (recover, recycle and reuse of resources/energy), circular activities have been adopted for a relevant number of years, and the number of people employed is relatively high (medium sized firms of the sample).

The significative aspect of this solution is the negative contribution of external search depth and breadth, revealing a firm that innovate mainly internally, rather than collaborating with external actors.

Focusing on the analysis of the complexity of solutions, two main conclusions can be stated.

Firstly, among the four circular business models present in the reference sample, the one that is based on recovery, recycle, and reuse of resources is the only one that has to be adopted, along with the presence of other conditions, in order to achieve, at the same time, improved performances for index like ROI, market share, and employment rate. In addition to that, when enacting this type of circular business model, it is crucial to have a relevant experience and know-how in circular activities; in practical terms, the company has to spend a significative number of years embracing a sustainable attitude and behaviour.

Secondly, in the case when no specific circular business model is adopted, a company of small dimension can still grow and improve its performances of ROI, market share, and employment rate. The strategy, in this case, is to rely heavily on the quantity and quality of relationships that the firm develops with external stakeholders for open innovation purposes.

CONCLUSIONS

The research has the objective of investigating the relationship between the adoption of business models based on circular economy and firm's performance. This work contributes to the previous literature by eliciting how the combination of circular economy and open innovation practices relate to high economic performances.

The empirical analysis is based on data collected through a survey conducted within a collaborative research developed by Legambiente and Laboratorio Manifattura Digitale of University of Padua, in 2017. The results come from a group of 47 Small-Medium Enterprises in the Italian territory, that had adopted one or more circular economy practices in form of a positive relationship between sustainable business models and economic performances, measured in terms of ROI, market share, and employment rate.

The findings derive from a configurational analysis performed through fsQCA, which allows to find different configurations of an initial set of aspects that figure the presence of the researched outcome. By doing so, it was possible to perform a comprehensive examination of the data, making a step forward in respect to the use of classical statistical tools, that normally analyse each single aspect in isolation.

In conclusion, this work detected three configurations leading to high economic performances, which can be summarized as follows:

1) a micro or small sized firm that has not adopted a specific circular business model but has established relevant and deep relationships with a high number of external stakeholders; 2) a firm that has adopted a circular business model based on recovery, recycle, and reuse of resources, that has integrated the circular economy approach for a long period of time, and that has established relevant and deep relationships with a high number of external stakeholders; 3) a medium sized firm that has adopted a circular business model based on recovery, recycle, and reuse of resources, that has integrated the circular economy approach for a long period of time, and that has superficial and contract-based relationships with a limited number of external stakeholders.

The managerial implications that derive from the first configuration differ in respect to the evolution of the level of technology of the market, according to Laursen and Salter (2006).

If the level of technology is in its early stages, managers should focus on investments in external search depth, in order to collaborate heavily with a small number of key sources of innovation, such as consultants, suppliers of materials, or universities. The company, in this case, could improve and entrench the relationship with them and keep the know-how inside the organization or among a low number of partners.

If the level of technology in the market is mature and the network supporting innovation is expanding, managers should focus on investments in external search breadth, with the objective of gaining access to the variety of knowledge sources of this network. Working with a wide number of search channels would it make possible to find new combinations of existing technologies and enable companies to make significant improvements in their existing products (Laursen & Salter, 2006).

Focusing on the third configuration, it can be noted that, as the firm increases in dimensions and complexity, for a manager is critical to maintain control over proprietary knowledge and technology, rather than sharing the know-how and resources with external partners.

Internal development, in this case, is preferred to external collaborations.

Furthermore, analysing the overall configurations, it appears that, in a managerial point of view, the circular business model to adopt if interested in improving ROI, market shares, and employment rate, is the one based on recovery, recycle, and reuse of resources.

It is useful to highlight that this research of thesis provides a theoretical contribution to the circular economy literature, because it investigates the relationship between the themes of circular business model and openness for innovation in a configurational way.

The most relevant result is the finding that the three outcomes under examination (ROI, market share, employment rate) are explained, at the same time, by three different configurations of conditions that represent different scenarios.

Despite the originality and robustness of the results, this research has a number of limitations to be pointed out.

First, the reference sample of companies interviewed is not geographically bounded. The questionnaire is addressed to firms all over Italy and not in a specific region; the result is thus generalized and does not explain strategic choices in a selected and restricted geographic area.

Second, the study is not conducted in a determined sector of market. The solutions found are not derived from business practices of a particular industry, but from enterprises that have in common the adoption of circular activities; therefore, it is not analysed an industry of reference, but a sustainable business environment as a whole.

Last, but not least, the methodology utilised brings with itself a series of restrictions that have to be taken into consideration. The majority of fsQCA procedures are based on subjective choices made by the researchers, following their expertise and knowledge. One case among the others is the crucial step of variable calibration, in which the researchers select the three key thresholds according to the condition they want to stress. Hence, some interpretational biases must be acknowledged (Apa & Sedita, 2017).

It should be noted that fsQCA does not identify the unique contribution of every variable for every solution, but instead it identifies complex combinations of variables and the amount of the outcome that is explained by these combinations (Pappas, Mikalef, Giannakos, & Kourouthanassis, 2019).

Future studies may combine fsQCA methodology with regression-based techniques to gain a deeper insight on the data and explore the effect of each variable on the outcomes, based on the configurations identified from fsQCA (Pappas, Mikalef, Giannakos, & Pavlou, Value Co-Creation and Trust in Social commerce. an fsQCA approach, 2017).

APPENDIX

VARIABLES	Consistency	Coverage
RECY	0.629679	0.785000
~ RECY	0.370321	0.865625
USE	0.077540	0.725000
~ USE	0.922460	0.821429
GIVE	0.216577	0.900000
~ GIVE	0.783422	0.791892
CYCLE	0.076203	0.950000
~ CYCLE	0.923797	0.803489
BREADTH	0.590641	0.848962
~ BREADTH	0.501337	0.938439
DEPTH	0.443850	0.880637
~ DEPTH	0.663101	0.913444
ADOP	0.529946	0.916744
~ ADOP	0.567914	0.871206
SIZE	0.272995	0.895614
~ SIZE	0.798930	0.863584

Table 10 Analysis of Necessary Conditions with SHARE as the outcome (own creation)

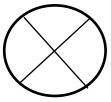
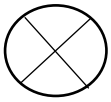
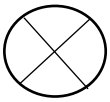
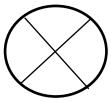
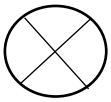
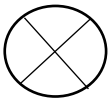
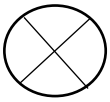
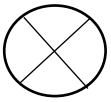
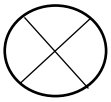
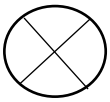
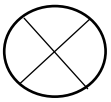
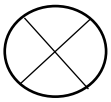
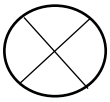
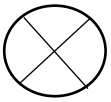
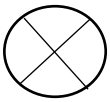
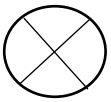
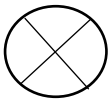
	CONFIGURATIONS				
	1	2	**3**	**4**	**5**
RECY					
GIVE					
BREADTH					
DEPTH					
ADOP					
SIZE					
Consistency	0.929748	1	0.806971	0.982916	0.909859
Raw Coverage	0.226471	0.170588	0.0804813	0.230749	0.0863636
Unique Coverage	0.119251	0.115508	0.0754009	0.170321	0.0211229
Overall solution Consistency	0.928235				
Overall solution Coverage	0.632887				

Table 11 fsQCA solutions for the model with SHARE as the outcome (own creation)

VARIABLES	Consistency	Coverage
RECY	0.631579	0.740000
~ RECY	0.368421	0.809375
USE	0.095306	0.837500
~ USE	0.904694	0.757143
GIVE	0.230441	0.900000
~ GIVE	0.769559	0.731081
CYCLE	0.042674	0.500000
~ CYCLE	0.957326	0.782558
BREADTH	0.633855	0.856264
~ BREADTH	0.456614	0.803303
DEPTH	0.497866	0.928382
~ DEPTH	0.641536	0.830571
ADOP	0.567568	0.922757
~ ADOP	0.563585	0.812551
SIZE	0.298435	0.920175
~ SIZE	0.759033	0.771098

Table 12 Analysis of Necessary Conditions with EMPLOY as the outcome (own creation)

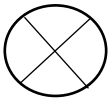
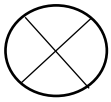
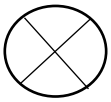
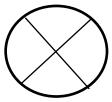
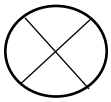
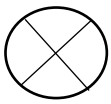
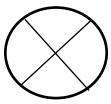
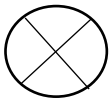
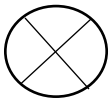
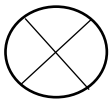
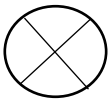
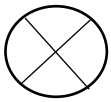
	CONFIGURATIONS			
	1	**2**	3	**4**
RECY				
GIVE				
BREADTH				
DEPTH				
ADOP				
SIZE				
Consistency	0.879357	1	1	1
Raw Coverage	0.093314	0.249787	0.122902	0.100996
Unique Coverage	0.093314	0.197155	0.122902	0.048364
Overall solution Consistency	0.975715			
Overall solution Coverage	0.514367			

Table 11 fsQCA solutions for the model with EMPLOY as the outcome (own creation)

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