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Circular Business Models and Management Accounting Practices: The Case of Sifa S.p.A.

Modelli di business circolari e pratiche di controllo di gestione: il caso SIFA S.p.A.

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Introduction

Companies are increasingly challenged to make the pursuit of sustainable objectives part of their fundamental logic of 'doing business'. Starting from the consideration that traditional linear economy is no longer sustainable, companies are indeed integrating multiple dimensions of economic, social and environmental value by considering value creation to a broad scope of stakeholders, society and the natural environment.

This new trend has led to the development of new business models and companies are beginning the transition from linear business models to the so-called circular business models.

Circular business models are capable of combining the creation of economic value with the reduction, slowing down or closing of resource cycles. Thus, they represent a new managerial approach that aims at a reduction in the consumption of natural resources in order to preserve the surrounding environment. In practice, their implementation requires top management to take new strategic actions to redesign traditional business models, intervening both in the value network and in the relationships with partners along the supply chain, as well as in the value propositions for customers. Therefore, circular business models has great strategic value for companies in order to pursue social and economic growth in a more sustainable way.

It seems undeniable that the transition from linear to circular business models would involve radical forms of reorganizing the business model on a firm and systems' level, questioning both what and how value is created and captured.

In particular, activities and process performed by companies will be reshaped in order to favour the adoption of circular logics of creating, delivering and capturing value. Following along these lines, it is very much likely that these changes will affect also the way managerial accounting practices will support the planning, controlling and decision-making activities of managers. As a matter of fact, new or changed activities and process will entail new managerial information needs to be met. Despite this, the potential impacts that the transition to circular business models may have on managerial accounting practices is still an area open to research that requires, and deserves, additional analysis.

In view of this considerations, the aim of this thesis is to explore how the transition towards circular business models may influence managerial accounting practices. In order to achieve this aim, a theoretical and an empirical analysis, through a case study, will be carried out.

Hence, the work is composed of four chapters organized as follows.

In chapter one, the analysis starts with an overview regarding Management Accounting. Afterwards, an in-depth analysis of the cost concept is proposed, starting from the definition of this concept and then providing different classifications in relation to the ultimate purpose of the analysis made by the

managerial accountant. In the last part of the first chapter, the incidence of management accounting in support of the management process (planning, controlling, decision making) is explored, concluding with a focus on the role of the management accountant within the firm.

The second chapter addresses the topic of the Circular Economy as a whole and the related impact on the business models of companies. The chapter begins with an analysis of the fact that linear business models are no longer sustainable due to the high consumption of raw materials they entail. Subsequently, the analysis goes into more detail on the circular economy, providing a general overview of the theme. Then, an overview of the Regulatory Framework at the European level is provided, followed by the BS 8001/2017 Standards for organizations. Moving down more into the field of business strategy, all possible initiatives that companies can take to become more circular are explored in depth, via the 9 R Framework. In the last part of the chapter, all possible circular business models are highlighted in relation to the strategies adopted by the company.

The third chapter aims to explore the relationship between management accounting and the Circular Economy, how this new philosophy and the related circular business models have affected its practices. The chapter begins with an explanation of the different strategies most adopted in the Circular Economy: Manufacturing, De-manufacturing, and Resource Recovery and End-of-waste.

The second part of the chapter analyses managerial accounting techniques and approaches to account for Circular Business Models going deeper into the concept of Environmental Management Accounting and the tools related to it for the analysis of costs related to environmental impact. This comparison will end with indicators that measure the progress of the transition to the circular business model.

The chapter four proposes a case study. The company examined is SIFA S.p.A., an expanding company located in the hinterland of Macerata, operating in the sector of cardboard production and packaging solutions.

The company is analyzed by highlighting the activities that led to a circular business model, paper recycling and the clarification of wastewater from printing unit washing. The case study is analysed focusing on each of these activities in order to evaluate the impact they had in relation to the practices of management accounting.

Research methodology

This research is based on a literature analysis finalized to extract the correlation between the management accounting practices and the development of the Circular Business Model. The writing is based on a process that consists of a research based on a selection of academic databases, and types of literature.

In particular, the firsts three chapters involved a search to access published studies related to management accounting, and circular economy. The methodological approach to define and select the sampling framework was performed by searching for existing literature focused on keywords in different academic databases.

For the first chapter keywords related to Managerial Accounting such as “managerial accounting”, “costing”, “cost classification” and so on.

For the second chapter keywords related to Circular Economy such as “circular economy definition”, “circular business models”, “9R framework” and so on.

For the third chapter, the research was based on linking the keywords of the first chapter with the ones of the second chapter. In this case, keywords used were, for example, “environmental cost accounting”, “Life-cycle-assesment”, “Remanufacturing” and so on.

After analysing all the literature in order to find the correlation between the two main topics, the analysis proceeds with a case study.

The case study reported concerns a company operating in the packaging sector and in the production of cardboard, a material that lends itself very well to the development of a circular business model, given the raw material (paper) that is very prone to recycling.

In this case, data collection took place through document analysis, several interviews with subsequent data extraction from company software and guided company tours. The interviews involved both managers, quality control manager and sales manager, and the management accountant, in order to have access to a larger amount of data.

Chapter 1

MANAGEMENT ACCOUNTING: AN OVERVIEW

1.1. An introduction on management accounting

The Institute of Management Accountants defines management accounting as " a profession that involves partnering in management decision making, devising planning and performance management systems, and providing expertise in financial reporting and control to assist management in the formulation and implementation of an organization's strategy" (Institute of Management Accountants, 2008, p.1).

Management Accounting aims to provide to managers information and prevision for the decision making through financial e non-financial data (Garrison R. et al., 2016).

Managerial accounting consists of a set of tools and approaches of which the aims are to identify, measure, analyse, interpret, and communicate financial information to managers. The results of the work of managerial accounting will be used by managers in performing their three key-activities: planning through setting goals and strategies to achieve them, controlling the consistency between what was planned and what was actually achieved and making decisions to achieve the short and long-time goals.

The comparison could be made between intermediate budget objectives and intermediate achieved objectives, or even between final budget objectives and final achieved objectives; in order to provide the possibility to make corrective interventions in relation to long-terms objectives.

Management accountability arises from the responsibility of managers to respond to the stakeholders' need to know the real performance of the company. In order to earn the stakeholders' trust, managers have to provide information about how they operate, their decisions and the results achieved. Thus, two forms of accounting are required: Financial Accounting, focused on external reporting, and Management accounting, focused on internal planning and control (Williams J. et al., 2012).

"Financial accounting provides financial statements that report results of operations, financial position, and cash flows both to managers and to external stakeholders: owners, creditors, suppliers, customers, the government, and society." (Williams J. et al., 2012). This accounting typology satisfies the management responsibility to owners and creditors for their investment decisions, to regulatory agencies about the correct observation of the regular and correct performance of the economic activity, and to customers and society regarding the responsible action of the company.

On the contrary, Managerial Accounting has a more internal character, the aims are to identify, measure, analyse, interpret, and communicate financial information

to managers. The results of the work of managerial accounting will be used by managers to support planning, to control and to help the decision-making processes.

To go deeply in defining the differences between these two accounting typologies we can identify six key points (Williams J. et al., 2012):

- "Primary users". While Financial Accounting focuses on external persons, Managerial Accounting focuses on internal ones.
- "Focus and Time dimension of the information". Financial Accounting has a historical (past oriented) perspective based on relevance and reliability of the information, respect to Managerial Accounting that has a future oriented focus, and it is based on the relevance of the information.
- "Rules and restrictions". Financial Accounting must follow GAAP/IFRS and prescribed formats, instead of Managerial Accounting for which it is not required any prescribed format.
- "Scope of the information". Financial Accounting refers to the company as a whole, on a quarterly or annual basis. On the other hand, Managerial Accounting provides reports about segments of the company (product lines, departments), based on shorter periods of time (weekly, monthly).
- "Behavioral". Managerial Accounting reports affect employee behaviour since it is created through measuring results. In Financial

Accounting behavioural implications are secondary respect to adequacy of disclosures.

When we talk about management control is important to mention the two dimensions of the control: material and immaterial. (Marasca et al., 2013).

Those who work in the field of control pay attention to the centres of responsibility, the control process and management accounting. Such mechanisms and tools form a part of the control system, which is called the "material dimension" (Marasca et al., 2013).

This type of dimension is made up of two components:

- A static component, consisting of the technical support structure and the map of responsibility.
- A dynamic component, that is the process by which the control becomes operational.

This dimension is defined as material as it usually consists of procedures and formal documents, such as manuals, reports, service orders, internal notes, organizational charts, easily found in the company (Marasca et al., 2013).

The intangible attribute is due to the fact that the elements that make up this dimension are not usually illustrated in a formal manner in internal documents or regulations but include less visual and deeper elements.

Specifically, it refers to:

- The role intimately assigned to control by top management. The role intimately assigned to control by top management consists of the function that the top management attributes to control. Control constitutes one of the most effective means of achieving the desired degree of conformation with organizations of the same type. As a result of trying to achieve a sort of structural and procedural alignment with what is considered desirable by the stakeholders and by the actors with whom the company interfaces.
- The way in which a number of issues relating to this operational mechanism are managed. Within the immaterial dimension, the methods followed in the control management, that is, how the control activity of management by top managers, by the answers that the company gives following the results of the control activity. The definition and implementation of this operating mechanism, in fact, require the top management to address multiple issues, organizational and operational (such as the style of control adopted, the organization of control functions, positioning in the company organization chart, the power assigned to the controller etc).

The benefits deriving from an effective management control are mainly two.

The first one is a motivational benefit. Being based on results and merits, the recognition of the individual performances leads to an improving of the individual motivation, stimulating employee engagement. This motivational benefit ends with

the enhancement of the contribution of individuals in carrying out their business (Marasca et al., 2013).

The second one is based on the benefit given by greater communication within the company. An accurate management control leads to communicate the business priority within the company, defining the issues that need to be addressed with greater urgency respect to others, and to communicate changing in strategies and objectives. This leads to a stronger alignment between the strategic objectives and the operational activities (Marasca et al., 2013).

Where there are benefits, there are even limits. If the management control mechanism is not well-managed, it is possible to incur in problems. One of these is the "management myopia". It consists of an excessive focusing on short-term results, neglecting long-term ones (Marasca et al., 2013).

Provided that the most strategic goal of companies is related to maximizing profit, managers tend to be more focused on short term gains in order to offer returns to investors, rather than remaining focused on long term profits.

Causes related to this problem are various. The tendency to offer bonuses linked to short-terms objectives, the duration of the managers' contract that could lead them to invest in projects with higher returns in short terms, the will to respond quickly to stakeholder's wishes.

These causes could lead to the reduction of costs that will present profits in the short term, such as employee training, compared to the increase in costs that would

lead to profits in the short term, aggressive marketing strategies such as excessive discounts to increase sales in the short period.

Here, no distinction is made between operating costs (operating expenditure-opex), management costs that have an impact on the strategic expenses, also called costs for the future or development costs; you risk falling into the “trap of the annual performance”.

Furthermore, if not accurately development, the management control could lead to stress and competition within the company, decreasing the collaboration between the various department.

In this chapter, the management accounting in general will be analysed.

Starting from the cost concepts and the cost classifications, specifics of this type of accounting will provide an insight about how it affects the three most important stages of the business management activities: planning, controlling and decision-making.

At the end on the chapter will be exanimated the role of the controller into supporting the managerial decision process.

1.2. Cost concepts and cost classifications

The cost accounting concept was developed during the age of industrial revolution when companies became more complex and dynamic (Fleischman R. K. and Tyson T. N., 1993).

Before this, the cost structure of the companies foresaw the prevalence of variable costs instead of fixed costs. In fact, the production was prevalently handmade, and costs were related to the direct labour, direct materials and other variable costs strictly based on the quantity produced.

This industry development led to new business models and cost structures. Organizations started to increase the presence in the production processes of machineries (Fleischman R. K. and Tyson T. N., 1993).

For this reason, the businesses cost structure changed. The incidence of fixed costs increased due to the growing presence of machinery depreciations, storage costs, rents, and maintenance costs.

In this context, being able to estimate deeply costs incurred in the production observing different aspects.

In order to go deeply, cost accounting is considered important for (Marasca et al., 2013):

- Developing a cost classification based on different features of them;

- Monitoring costs;
- Determining and setting a coherent selling price;
- Fixing standards and goals according to previsions.

Assuming that managerial accounting goal is to provide information to manager in order to help them in the decision making and planning processes, it is important to understand all about the costs.

For this reason, it is important to develop specific cost classifications about the using costs of the production factors, according to different criteria in relation to what the managers are looking for.

Respect to the general accounting, the cost accounting includes deeply classifications of the costs incurred in order to provide more information.

The most used criteria for cost classifications are the following (Marasca et al., 2013):

- Method of assignment of costs to cost objects (direct costs, indirect costs).
- Cost classification for predicting cost behaviour behaviour (Variable costs, fixed costs, mixed costs, stepped costs).
- Costs in manufacturing companies (Manufacturing costs, Nonmanufacturing costs).
- Decision-making costs (Differential costs, sunk costs, opportunity costs).
- Preparation of financial statements (Product costs, period costs).

It is important to highlight that cost accounting is not subject to legal restrictions. Companies are free to choose whether to adopt accounting or extra-accounting data reporting methods to feed the system and are free to process the information they deem appropriate in order to support decision-making processes.

1.2.1. Assigning costs to cost objects

The classification of costs based on the methods of assignment to cost objects leads to satisfy need of knowledge regarding the cost incurred, or to be incurred, for obtaining or for the operation of various cost objects identifiable within the business system (Garrison R. et al., 2016).

Cost object is the destination of the cost, something to which the cost is assigned. This term is used because the management requires information about specific products, clients, services, departments, projects, or activities, in order to know and monitor the costs.

According to this criterion of classification, it is possible to distinguish between direct costs and indirect costs (Garrison R. et al., 2016).

Direct costs respect to the cost object are represented by:

- Costs for production factors incurred exclusively for the cost object taken into account. For example, the depreciation of a machinery used exclusively in a specific production line.

- Costs for production factors for which it is possible and economically convenient to measure the quantity consumed by the cost object. This group includes costs for direct materials (calculated by multiplying the total quantity consumed by unit cost) and direct labour (calculated by multiplying the total hours of work by the cost of the wage per hour).

On the contrary, indirect costs are represented by:

- Costs for production factors incurred in more than one cost objects. Thus, for this reason it is not possible to measure in an objective way the quantity consumed by each cost objectives. For example, the depreciation of a machinery used for several product lines.
- Cost for production factors for which it can be possible but not economically convenient to measure the quantity consumed by the cost objective. An example of this group can be the cost for the electricity of the plant where the production is made.

For this reason, the difference is substantiated in the method in which these two types of costs are assigned to the cost object under consideration.

Indirect costs can be assigned to the cost object only throughout a process of allocation. This process requires an allocation base able to enhance the contribution of each cost object to the common cost taken into consideration. The allocation bases used in this context are, for example, machine hours or direct labour required by each cost objective (Garrison R. et al., 2016).

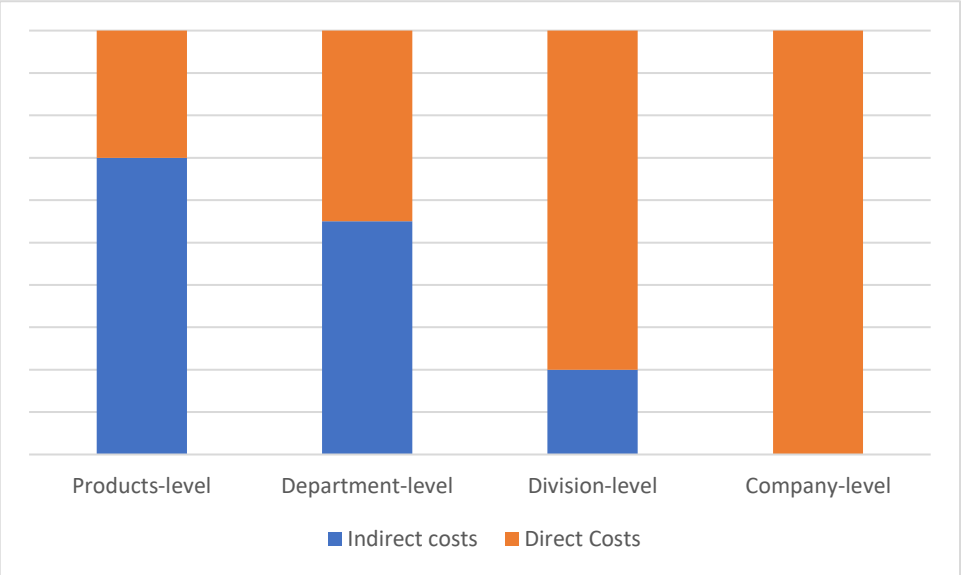
The choice of the allocation base is made following the “functional criterion”. In relation to this criterion, the costs of the production factors must be attributed to the cost object in order to express their contribution to the realization of the cost object; it expresses a cause-effect link between the consumption of resources by the cost object and the incurring of the cost.

An inappropriate allocation base will lead to errors in estimating the profitability of cost object. For example, a mistake in choosing a wrong allocation base may make an unprofitable cost object appear to be profitable, and vice versa.

An important aspect to understand is that the allocation of indirect cost is not objective. It requires a subjective adoption of an allocation base, for this reason, it will be an estimation.

As shown in figure 1, it is also important to highlight the fact that bigger is the cost object, smaller is the incidence of indirect costs.

Figure 1 – Direct and indirect costs in relation to different cost objects



Source: Cinquini, Strumenti per l'analisi dei costi, Vol.1, Fondamenti di Cost Accounting 2003, p.27.

Compared to the product, a small part of costs can be considered direct, but with the expansion of the cost object, the incidence of direct costs also increases, up to reach a totality of direct costs when the cost object is the whole company.

1.2.2. Predicting cost behavior in response to changes in activity

The definition of "cost behaviour" is related to the reaction of the costs upon the occurrence of a change in a certain parameter deemed relevant for their calculation.

In order to understand better the cost behaviour, three are the variables that must be studied: the activity base (cost driver), the relevant range and the time span (Garrison R. et al., 2016).

The activity base consists of the parameter taken into account that should determine the change in costs. These can be several (machine hours, labour hours, number of clients, and so on), but the most used one is the volume of units produced.

The relevant range consists of the interval within which the behaviour of the cost under analysis does not change in relation to a change in the cost driver considered.

Last but not least, is the time span. It is the period of time over which the analysis is conducted. This variable must be taken under control because there are costs that tends to have change in behaviour over the time.

From this point of view, the costs can be distinguished into:

- Variable costs. These are the ones which change as the volume of activity varies. Mathematically talking, the expression used to determine the variable costs is C=c*q, where "C" is the total cost given by "c" the unit cost, and "q" the volume of activity. An example of variable cost is the cost for raw materials, calculated multiplying the unit cost by the quantity used in the production process (Garrison R. et al., 2016).

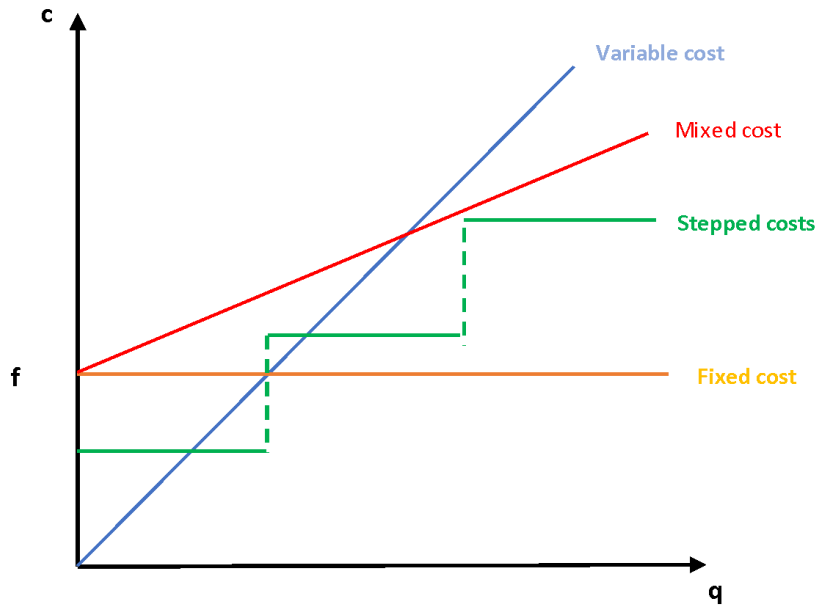
- Fixed costs. These are costs that do not change as the volume of activity varies. Mathematically talking, fixed costs are described by the expression C=f, where "C" is the total cost given "f" the amount of the fixed cost. An example of fixed cost is the rent or depreciation of the plant where the production process is located. Talking about fixed costs it is possible to mention committed costs and discretionary costs. The first group is related to costs given by long-terms decisions

that cannot be changed in the short term, and relate to investments in plants, machinery, insurance premiums. The second group is related to cost given by decisions taken when the annual budget is drawing up, and these are related to funds allocated for advertising campaign, or research and development (Garrison R. et al., 2016).

- Mixed costs. This typology is characterized by containing at the same time both a fixed and variable part. Mathematically talking, fixed costs are described by the expression C=f+c*q, where "C" is the total cost given "f" the amount of the fixed cost added by variable component given by "c*q". An example is given by the costs related to the electricity supply that is given by a fixed part and a variable part related to the electricity consumption (Garrison R. et al., 2016).
- Stepped costs. These costs have the peculiarity that they can increase when levels of activity are reached, and the relevant range is overcame. An example is the cost for commercial employees. Usually, the number change in relation to the number of clients, for this reason an increase in clients will lead to a higher cost given by the recruitment of the new commercial employee (Garrison R. et al., 2016).

The figure describes the graphical representation of the different typologies of cost behaviours.

Figure 2. Typologies of cost behaviours.



Source: Own elaboration.

This cost classification is one of most important, because it is useful for the redaction of the contribution income statement format. This format aims to estimate the contribution margin that is, one of the measures that a company must focused on for the decision-making process.

The contribution margin expresses the portion of the sale price that is absorbed by the variable costs and consequently remains available to cover fixed costs. This indicator can be expressed even as percentage, dividing the contribution margin per unit by the selling price per unit, in this case it won't be express in terms each product sold but in terms of each dollar of sale.

Contribution margin focuses on short run, and it is useful even in decisions involving in temporary use of existing capacity, decisions related to Cost-Volume-Profit analysis (Break Even analysis, what if analysis, and Target Net Operating Income) and related to selling strategies and product mix.

1.2.3. Accounting for costs in manufacturing companies

In manufacturing companies, costs should be divided into two main categories manufacturing costs and non-manufacturing costs (Garrison R. et al., 2016).

Manufacturing costs are costs incurred inside the production department. These are considered direct materials, direct labour, and manufacturing overhead.

Direct materials include the raw material involved in the production process and intended to be part of the finished product.

Direct labour includes the wages of employees who are directly involved into the production process. The employees who are part of this group are those whose production activity consists in the transformation of the raw material or semi-finished product into a finished product.

As explained before, these are costs easily and conveniently traced.

In the manufacturing cost classification also falls costs that are not strictly related to the finished product, but they are part of the production process.

This last category includes all the other costs, that are indirect materials, indirect labour, and other manufacturing overhead (utility costs) (Garrison R. et al., 2016).

Indirect materials cost is composed by raw materials that are not monetary significant, it means that incidence in the total cost is so low and for this reason they can be omitted from the calculation of margins. By the way, these costs could be integrated in the finished product (amid glue in cardboard paper production) or not integrated but used in the production process (machinery lubrification oil).

Indirect labour cost includes all the employees that are involved in the manufacturing process, but their job is not strictly involved into converting raw materials in finished products. For example, supervisors are the responsible of the overall production processes, but their work involve into supervise more than one activity.

Non-manufacturing costs include all the other costs that are not directly involved in the production process. These are selling and administrative costs and can be considered either direct or indirect costs (Garrison R. et al., 2016).

Concerning selling costs, it is possible to include in this class all the costs related to the relationship between company and customers. These are all the costs that incurs when the finished products leave the company to reach the clients, as for example shipping costs, sales commissions, and salesman salaries. In this group is even possible to add the marketing costs, such as advertising.

Administrative costs are all costs related to the general management of the company. These are expenses related, as the name suggests, to the administration of the company. These includes the compensations of the executives, accountant and the depreciation of the related software.

This classification is useful to define cost of goods sold, that is equal to the total amount of costs incurred in the transformation process.

This measure is used to determine the gross margin in the traditional income state format. Thanks to this format it will be possible to focus on the core business of the company, highlighting operating sales and operating costs.

1.2.4. Making decisions

When the cost analysis is made in order to choose between competitive alternatives, another cost classification is needed.

In this case, the typologies of costs to be analysed are differential costs, sunk costs and opportunity costs (Garrison R. et al., 2016).

In fact, in order to take a decision about choosing between two different alternatives, the aim is to define the most suitable and profitable alternative in relation to relevant costs and benefits resulting from it.

The first category concerns the differential costs (or revenues). When the responsible starts the analysis of the different alternatives, it is important to consider

that some costs or revenues will change in terms of incidence or values. This change substantiates in an increase or a decrease, from this concept the name “differential” derives.

The value of these costs/relevance is given by the amount of the increase/decrease.

As it easy to understand, the distinction is made between differential costs and differential revenues, and they must be taken into account in the decision-making process because of their relevance (Garrison R. et al., 2016).

In order to give an example, a differential cost could be an increase in supervisor’s wage after adding a new product line to be supervised.

Sunk costs are expenses already incurred or an investment already made and not recoverable. This is the reason, sunk costs are amounts of money already spent and permanently lost, regardless of what the money is spent on.

These costs or expenses incurred previously and cannot be reversed or recovered in any way should not be used as a basis for making future decisions about a project or investment. However, entrepreneurs very often take sunk costs into consideration when making future decisions (Garrison R. et al., 2016).

An example of sunk cost is given by the cost incurred in employee training into use a new accounting software. After a few years, managers decide to end the adoption of this software. The cost of training in this case is considered sunk cost.

The opportunity cost in economics is the cost deriving from the failure to exploit an opportunity granted to the economic subject. From a quantitative point of view, the opportunity cost is the value of the best missed alternative. In other words, the opportunity cost is the sacrifice that an economic operator must make to make an economic choice.

Opportunity costs are used to evaluate the aspects of choices that do not necessarily involve a monetary outlay on the part of someone but can be useful for choosing between different alternative strategies in the economic field (Garrison R. et al., 2016).

An example of opportunity cost is given by the non-receipt of money deriving from the rent of a building used as a warehouse.

The aim of this classification consists of providing costs and revenues of competitive alternatives, that can be used in order of choosing between them. It is helpful in the decision-making process because it highlights the most profitable and suitable solution for the company.

1.1.5. Preparation of financial statements

In order to draw up the financial statements, costs are classified as product costs and period costs (Garrison R. et al., 2016).

Product costs are the costs related to the resources used for the production of the product in the strict sense, i.e., they include raw materials and conversion.

This type of cost includes costs that are "inventoried". As happens, for example, with the inventory value of the units of semi-finished and finished products, of which, consistently with the principle of competence, the effect on the profit for the year will only occur in the event of future resale (Garrison R. et al., 2016).

A manufacturing company has product costs consisting of materials used in the production process, or direct materials; labour costs directly related to production; and indirect costs such as overhead production.

Any costs not included in the product costs are called period costs. Since these costs are not involved in the production process, they are not treated differently in the income statement following a sale. Rather, they are considered to be actual expenses in the period they arise, and for this reason they are called period costs. These are costs that affect the income for the year in which they arise (Garrison R. et al., 2016).

All sales and administrative costs are treated as period costs. Common examples of period costs include marketing expenses, rent, office depreciation, and indirect business. Although physical inventories are made up of elements that are treated as product costs, the actual inventory management and inventory management expenses are considered period costs.

Product costing methods focus on the attribution of product cost items (those recorded in the production centers) to the activity analysed (full costing); in some cases, it is also appropriate to allocate the costs for the period.

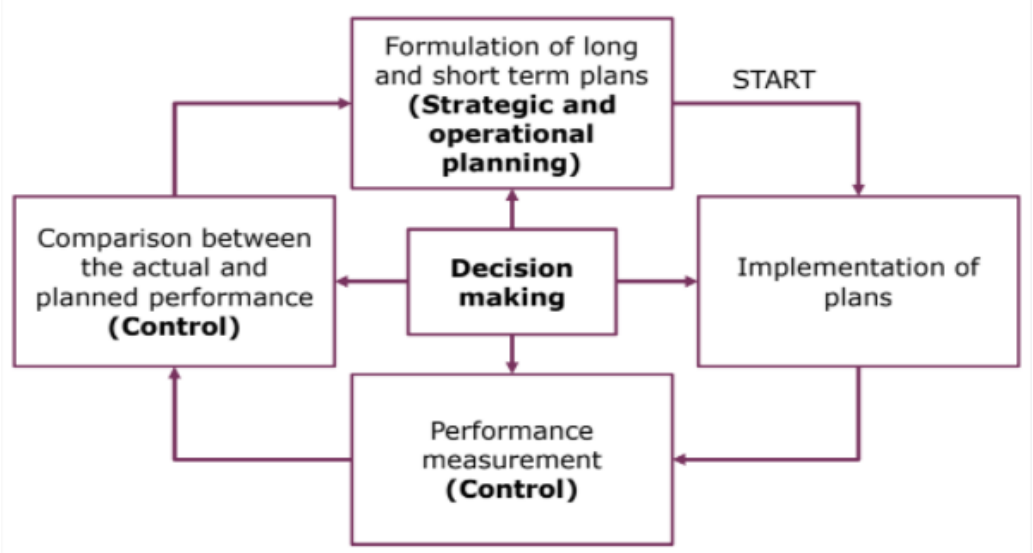
1.3. Supporting the management process through management accounting

In this chapter will be analysed the management process.

This process that aims to move from ideas to actions and it is divided in three steps:

- Planning. It consists of defining the goals to be achieved and the actions to be performed in order to achieve them.
- Controlling. This activity aims to monitor the actions in order to compare the actual results and the planned objectives.
- Decision making. This is the central activity and involves selecting between competitive alternatives in order to achieve company's goals.

Figure 3 – Management process



Source: Own elaboration.

As it is possible to see in the Figure 3, the process starts with the Planning by formulating long and short terms objectives and implementing plans to achieve them.

By planning, the managers find competitive alternatives to tackle the situation outlined the lines of actions.

At this moment they will be able to test and measure their effectiveness. They identify the pros and cons of each alternative.

The decision-making process ends up by defining the course of action from the alternatives. Unless a decision has been made, a plan cannot be implemented.

Once the plans are implemented, the control function is carried out through the use of performance measurement. The use of these measures will be used to compare the actual and the planned performance, in order to monitor the progress of the plans.

1.3.1. Planning

Planning, as the word itself says, is the process by which the company defines the objectives to be achieved and consequently the actions to achieve these goals.

Doing planning means creating a long-term plan to organize the company, organize human resources, business processes, in order to pursue the growth objectives that are established. A business plan examines the internal capabilities

of a company and defines strategies for using these skills to improve the company and achieve objectives of increasing turnover and turnover over time.

Business planning can be defined as a management skill that helps managers plan long-term within a company. The business planning system is also closely related to the industrial planning control system, which directs the management of the company towards compliance with the planned objectives.

The overall process is characterized by two different sub-processes:

- Strategic planning. It evaluates a company's position in the market, its strengths and weaknesses and areas that require growth. It is a complete and analytical guideline for the entire organization, which outlines the high-level objectives, the actions necessary to achieve the desired objectives and results.
- Operational planning. It defines the way in which the various teams and departments of an organization will contribute to the achievement of business objectives. Goals are defined, a plan to achieve them, and the resources necessary to achieve them. All the obstacles and risks that a company might encounter are also outlined.
- Financial planning. It acts on the structure of the financial sources, looking at the planned activities from a financial point of view.

This process is divided into well-structured activities, like any strategic plan, usually contains these elements:

1. A vision statements. This is where the objectives that will guide your internal decision-making process are defined, such as the analysis of the market, competitors, and possible future developments, such as the identification and analysis of the strengths and criticalities of the company.

2. A mission statements. The purpose, and the essence of the company.

3. The resources and reach of your company.

4. A list of business goals, developing programs and strategies for achieving goals.

5. A list of strategies to achieve these objectives and any corrective actions.

With planning, therefore, the company establishes guidelines to follow, it must necessarily be supported by a plan, by a project. The aim is of course to allow the company to be able to make the most of its potential, increase its business with the resources at its disposal.

The budget is the planning tool that is used in companies (public and private) to plan revenues, costs, investments and economic and financial flows.

It is usually set up for the following year and is used to collect the related budget for their area from the business managers of each function (sales, administration, production, etc.). All budget areas will then be grouped to build the company budget, which will be proposed to the management who will be able to approve it or not.

The budget also has a strategic-organizational function in that

- Obliges each area manager to provide a budget and therefore makes them responsible.
- Forces the company to create a schedule.
- Each budgeted economic value is obviously correlated to the priorities given by each area.

1.3.2. Controlling

Management control systems are tools to aid management for steering an organization toward its strategic objectives and competitive advantage. Management controls are only one of the tools which managers use in implementing desired strategies. However, strategies get implemented through management controls, organizational structure, human resources management and culture. (Anthony R. and Govindarajan V., 2007).

The first aim of the management control consists of direct individual and organizational behaviours in order to reach the long terms objectives. In this way, the Management Accountant activity ends up by building a mechanism for guiding and directing the activity of the managers, providing a valid support for decision-making processes. In relation to this fundamental goal, the management control aims to constantly monitor the operating progress, evaluating the manager performances, e coordinating horizontally and vertically the different activities.

Management control system is a tool designed to help managers in the decision-making process and more important the role of the control in this process, larger is the importance given to feedback and feed forward systems (Grafton J. et al., 2010).

Feedback refers to control focused on evaluation of actual outcomes. This aims to test the variance between actual and expected outcome, in order to help managers to identify routine problems, and to pay attention on critical process (Meutia et al., 2017).

When managers try to minimize the variance between predicted and expected outcome, it is possible to talk about Feed forward control system. It aims to facilitate goal setting and develop action plan, getting opportunities and capabilities needed in the future, and it has even the role to communicate strategy that is used by an organization to reach organizational purposes (Meutia, Tubagus Ismail, Ahmad Bukhori. 2017).

For this reason, these two controlling systems are used simultaneously because they complete each other.

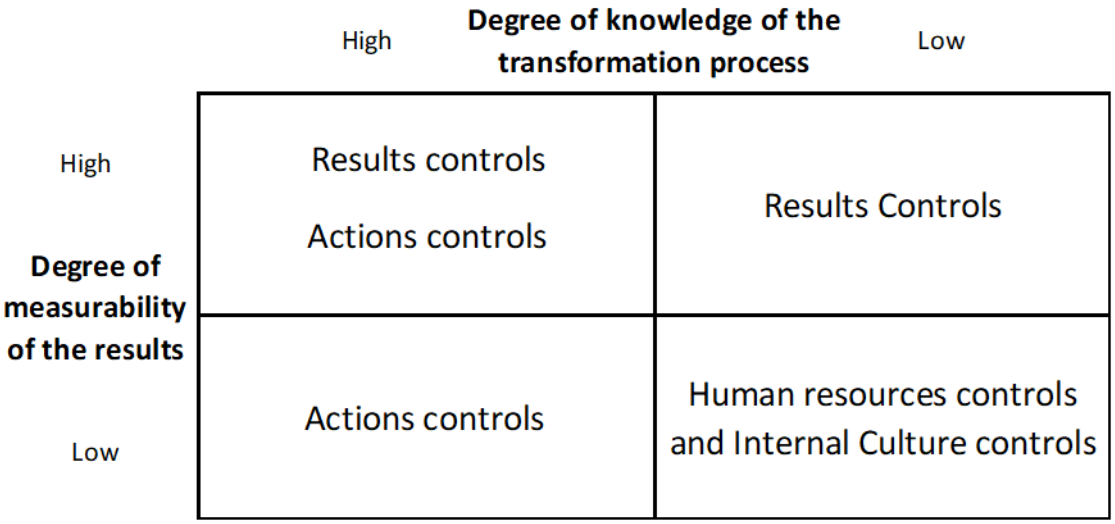
It’s important to highlight a social function of the management control. It assumes a more political value that arises from the assumption of the variety and divergence of interests between the various stakeholders. Keep the organization's activities within a space deemed acceptable by the various stakeholders (Marasca et al., 2013). This social function aims to guarantee the transparency and correctness of the management's work in favour of the stakeholders.

The MCS is not only related to the controls of results, but it could be related to different type of controls:

- Actions controls. These are activities and mechanism that ensures the possibility to verify the actions of the employees in order to avoid the ones deemed harmful to the company. These checks are carried out to align the individual behaviours to the business objectives.
- Human resources controls. These controls lead the human resources to do their job well it is based on the natural tendency to the employees' self-control. These kinds of controls are based on the selection, the training, and the adequate internal allocation of the human resources.
- Internal culture controls. These controls are related to the sharing of the company values in order to make all the employees an important part of the company, this will lead them to monitor each other.

To ensure that these controls are really effective, two key variables are considered on the basis of which to choose the type of control to be implemented: the degree of knowledge of the transformation process and the degree of measurability of the results.

Figure 4 – Management control systems' efficiency conditions



Source: Adaptation from Marasca et al., 2013, p. 41.

The choice of the controls to be adopted is explained in the figure 4. We can say that the human resources controls and internal culture controls are the less accurate one, in fact they require a low degree of knowledge of the transformation process and a low degree of measurability of the results, respect the other two types, that cannot be taken into account when both the knowledge of the production process and the measurability of the results are low.

By the way, the way in case of a low degree of knowledge about the transformation process the results controls can be made in case of the degree of measurability of the results is high. The opposite thing happens for the actions controls that can be developed in case of a low degree of measurability of the results.

1.3.3. Decision making

Decision making arises from the need to solve a problem, or to respond to a threat or opportunity. Decision making can be defined as the process of making choices by identifying a problem, gathering information, and evaluating from alternative solutions.

Decision making is the final act of finding a solution, which first passes through problem solving and finally arrives at action, that is, the actual application.

When you are faced with a problem, the goal you intend to achieve must first be defined, only at a later time all the available possibilities are evaluated and only at this point will it be possible to decide.

Managerial decision, in general, revolve around three main questions:

- "What should we be selling?". This question is related to the core business of the company: products/services in which focusing on, new products/services to be offered in the market, product lines/services to drop off, and the prices to be set up for products/services.
- "Who should we be serving?". This question aims to define the relationship with customers, in relation to the buyer persona defined.
- "How should we execute?". Here, managers have to define the line of action according to what decide in the first two questions.

To implement a decision-making process, however, it is not enough to evaluate the best opportunities, but it is necessary to start with a careful analysis and processing of the information available, up to the evaluation of all the alternatives available.

As in many cases, therefore, there is no single way to tackle the problem, but it is up to the managers to develop an effective method of decision-making strategy.

To simplify the decision-making process, it is useful to follow a decision-making model, which is a step-by-step guide that helps to increase its effectiveness.

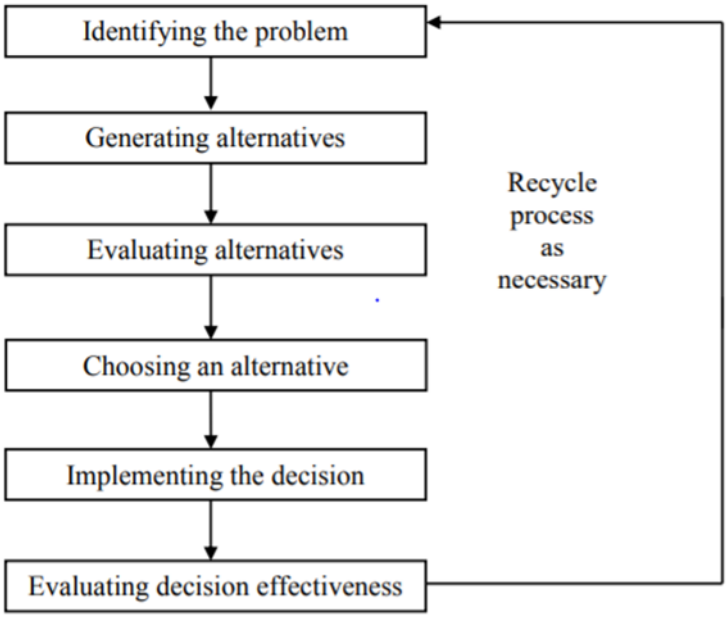
With leaders being exceptionally busy and forced to turn their attention in multiple directions at the same time, the decision model is a powerful tool. Risk scenarios must always be kept in mind. It is not possible to make a decision without taking risks, but by following reliable decision models, leaders can be enabled to assess, and possibly mitigate, the risks associated with each decision.

In order to develop a model of decision making, scientists have emphasized the rational model.

The rational model is related to the assumption that administrative decisions are made rationally. Rationally means that managers make decision under certain conditions. Managers know about their alternatives, the outcomes, the decision criteria, and their ability to implement it (Fred C. Lunenburg, 2010).

After looking at the assumption, we can look at the six steps of the rational decision-making process, as it is possible to see in the figure 5.

Figure 5. The decision-making process



Source: The decision-making process, Fred C. Lunenburg (2010, p. 3).

The process starts by identifying the problem. At this stage it is important to focus on the cause of the matter and focus attention on what is important. It could be that the criticality results from an event that occurs sporadically, but it could also be the symptom of a larger structural problem that needs to be addressed. This process requires a surveillance based on internal and external environment, looking even at competitors progress toward their goals (Fred C. Lunenburg, 2010).

This phase is fundamental to create effective decision models because it ensures that the problem is correctly defined and decreases the probability of misdiagnosis.

The second stage is related to the generation of competitive alternatives to solve the problem. Once the objectives have been defined, it will be possible to define the alternatives to reach them. Information must be collected regarding each of the alternatives and understand how the outcomes of these will contribute to the achievement of the desired result. The number of competitive alternatives is affected by the importance of the decision, because higher the important, higher the time and money spent on finding more and more alternatives (Lunenburg F. C., 2010).

Once generated, competitive alternatives have to be evaluated. In this phase, at the beginning, it is important to understand the feasibility of the alternatives, understand if the alternative is suitable for the company in terms of costs, alignment with the company abilities such as productivity capacity and so on. After that, it will be possible to determine the extent to which the alternative is in line with the objectives to be achieved. While managers evaluate alternatives, they should look even at the human resources in order to understand if the solution is acceptable for them (Lunenburg F. C., 2010).

At this point the decision is chosen and managers can proceed with the implementation. The implementation leads the managers new obligations. Firstly, managers should make sure that the road taken is understandable by all and encourage its acceptance. Manager work will be based also in assigning

responsibilities, a feasible timeline and all the resources required (Lunenburg F. C., 2010).

The final step consists of evaluating the effectiveness of the decision made. The evaluation of the effectiveness of the decision is linked to the achievement of the objectives specified in the first phase of the production process. To make this feasible, decisions are linked to key performance indexes (Lunenburg F. C., 2010).

The decision making is the process of choosing, after the planning, one of the different alternatives generated in order to start the plan implementation.

Two examples of decision-making activities related to the management accounting are the "make or buy" decision and "costs/benefits analysis" (Garrison R. et al., 2016).

"Make or buy" decisions are based on a differential analysis that compares costs relating to the possibility of producing a good internally (make) or outsourcing its production (buy). The make alternative provides for the costs incurred in the case of internal production, which can be avoided with outsourcing. The buy alternative provides for the costs related to the outsourcing of the production process, which can be avoided with internal production (Garrison R. et al., 2016).

There are two possible results of this analysis:

- Make higher than buy. In this case, the company should outsource the product line because it would entail a financial advantage (increase in Net Operating Income).

- Buy higher than make. In this case, the company should maintain the production inside the company because the outsourcing would entail a financial disadvantage (decrease in Net Operating Income).

"Costs/benefits analysis" are based on a differential analysis that compare the costs and the benefits that are either relevant or irrelevant to the decision. An example of this typology of analysis is given by the possibility of adding or dropping a product line (Garrison R. et al., 2016).

Taking as example the dropping of a product line, the costs are given by the lost in terms of less contribution margin from the selling; in the other hand, the company benefits from lower fixed costs related to the production.

At this point, there will be two possible scenarios:

- Benefits higher than costs. In this case, the most profitable solution is to drop the product line because it negatively affects the Net Operating Income.
- Costs higher than benefits. In this case, the company should not drop the product line because it has a positive effect on the Net Operating Income.

1.3.4. The role of the management accountant

The controller or managerial accountant or management accountant is the professional figure inside the company who is responsible for ensuring that the

managerial accounting tools and processes of the company function correctly and effectively, thus allowing the company to achieve the set objectives (Marasca et al., 2013).

The Controller plans and manages a systematic collection of data, monitoring the various activities within the company and recording the information in appropriate management systems.

This work involves close collaboration with the managers of all the areas from which the information comes, so as to be able to periodically draw up reports and reports on the progress of the real company departments.

The managerial accountant verifies that the company management is in line with the set objectives. He/she aims to prepare the budget, verify that costs and revenues correspond with forecasts, and prepare analysis reports, in order to propose corrective solutions to the company management, in case of deviations, or improvement actions (Marasca et al., 2013).

The control that is carried out goes beyond the formal procedures that are applied: it is done with a view on achieving company objectives.

Basically, the controller's work is related to the controlling stage of the management process.

In particular, the main activities carried out by the controller are (Marasca et al., 2013):

- Prepares the company budget. With this tool it is possible to highlight the operational objectives defined by the company management. The responsibility centres are identified, that is the corporate bodies responsible for the achievement of each objective.

- Acquires data to measure performance indicators. Check if the company management aligns with the established objectives. The collection of the data necessary for measuring the indicators is carried out periodically. Depending on the business needs of top managers, it can be on a weekly, monthly, or annual basis.

- Processes the data and communicate the results. Produces management reports that highlight the differences between expected results and actual results. The reports are sent to those who can implement improvement actions to get back in line with the company objectives or to formulate new objectives.

- Formulates corrective actions and improvement proposals. Together with the Company Management / Responsibility Center Managers, areas for improvement are identified in order to reduce the differences found between expected and actual results. In the event of significant deviations, new objectives may be formulated to be achieved in line with the intermediate results achieved.

- Measures the final value of the indicators and communicates it. At the end of the control cycle, the controller will formulate a report explaining the results obtained in relation to company performance in order to support the management's decision-making process.

Chapter 2

CIRCULAR ECONOMY AND CIRCULAR BUSINESS MODELS

2.1. Why classical linear models are no more sustainable

The last decade has been characterized by a global demographic increase which has led to a growth in demand for raw materials.

To understand the seriousness of the excessive use of raw materials, just look at "Earth Overshoot Day". "Earth Overshoot Day marks the date when humanity's demand for ecological resources and services in a given year exceeds what Earth can regenerate in that year.". In 2021, the day chosen is 29 July. This means that from that day on, the consumption of raw materials will be greater than what natural ecosystems are able to regenerate, and we will emit more CO2 than the oceans and forests can absorb.

Looking back, in 2020 it was 22 August, the only year in which an anticipation of the date caused by the COVID-19 pandemic was found for the first time, which led to a reduction in the general consumption of raw materials due to the closure of several businesses. In previous years, however, it is possible to see a constant anticipation of the estimated date: November 4 in 1980, October 11 in 1990, September 23 in 2000, August 7 in 2010.

According to a study by the Global Footprint Network regarding the "Ecological Footprint", an indicator that compares the resource demand of individuals, governments, and businesses against Earth's capacity for biological regeneration, "Humans use as much ecological resources as if we lived on 1.7 Earths"(Global Footprint Network, 2021).

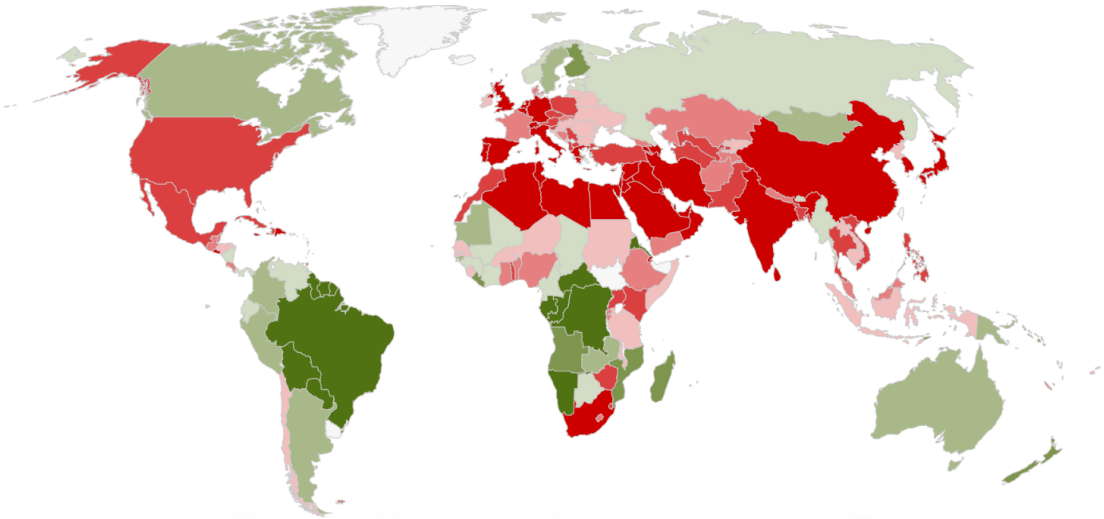
This means that, taking the world average between countries, the current consumption of raw materials would require 1.7 Earths. The value is obtained through the ratio between the value assigned to the “Ecological Footprint”[1] and the value of the “Biocapacity”[2].

However, the trend does not remain the same all over the world. As can be seen in Figure 6, there are some countries in which the Biocapacity exceeds the Ecological Footprint (countries colored green). These countries are referred to as Biocapacity Creditors. On the contrary, the countries in which the Ecological Footprint exceeds the Biocapacity (those colored in red) are defined as Biocapacity Debtors, as they exploit more resources than they have available.

[1] The Ecological Footprint (demand side) “measures the ecological assets that a given population or product requires to produce the natural resources it consumes (including plant-based food and fiber products, livestock and fish products, timber and other forest products, space for urban infrastructure) and to absorb its waste, especially carbon emissions” (https://www.footprintnetwork.org/our-work/ecological-footprint/).

[2] The biocapacity (supply side) “represents the productivity of its ecological assets (including cropland, grazing land, forest land, fishing grounds, and built-up land)” of a certain country(https://www.footprintnetwork.org/our-work/ecological-footprint/).

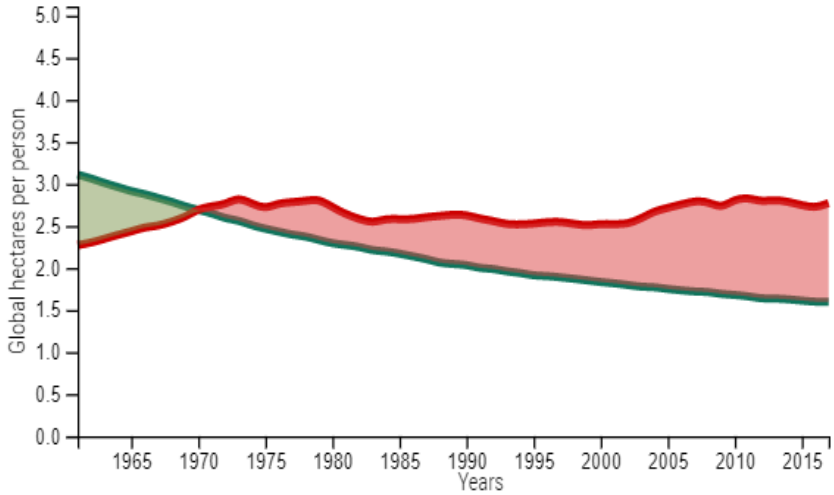
Figure 6. Ecological deficit/reserve



Source: Global Footprint Network (https://data.footprintnetwork.org/?_ga=2.212697426.738997368.1630504342-117049947.1628159807#/)

The problem is summarized globally in the graph in Figure 7. An ecological deficit occurs when the Ecological Footprint of a population exceeds the biocapacity of the area available to that population. A national ecological deficit means that the nation is importing biocapacity through trade, liquidating national ecological assets or emitting carbon dioxide waste into the atmosphere. An ecological reserve exists when the biocapacity of a region exceeds its population's Ecological Footprint.

Figure 7. Ecological Footprint



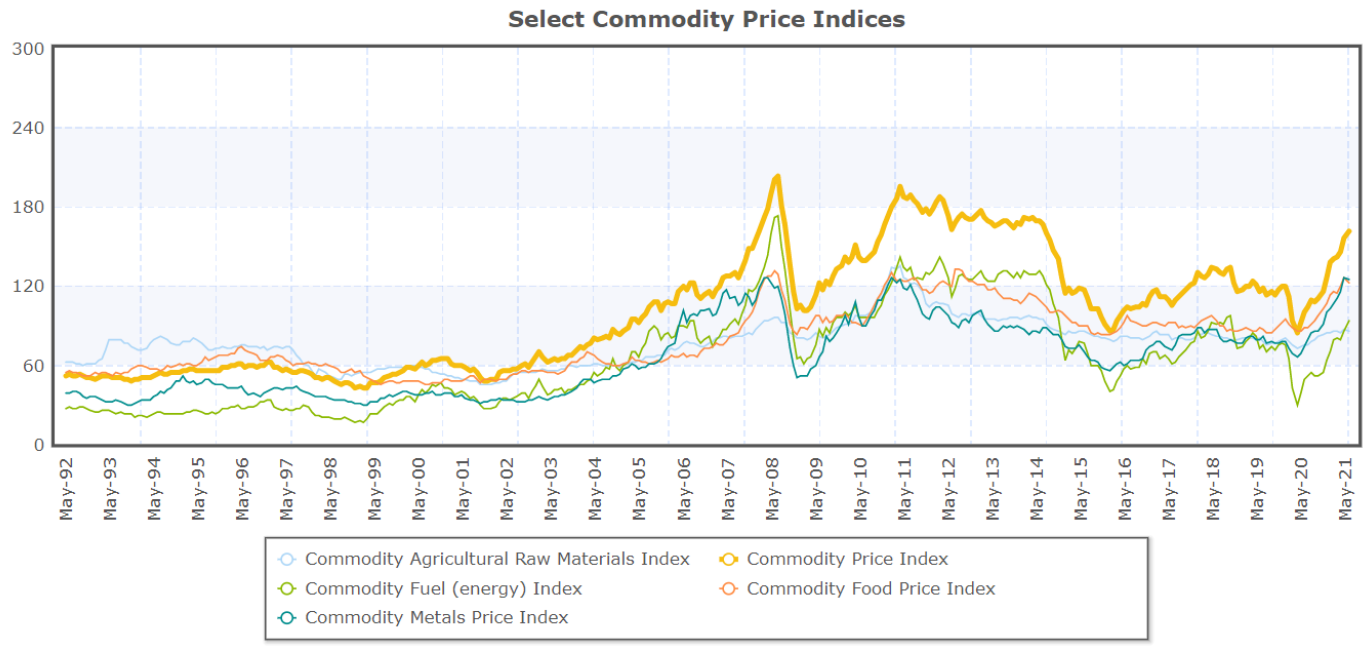
Source: Global Footprint Network. (https://www.footprintnetwork.org/our-work/)

This shortage of raw materials has been perceived by many companies in recent years in terms of the general increase in the prices of the latter. The commodities markets are among the oldest markets in the world, but currently, prices are not determined by supply and demand, as one would expect in the case of "markets", but by the increasing importance of the so-called futures markets. exchanges, in which banks, funds and other investors determine the future prices of commodities in an absolutely speculative way.

The graph in Figure 8 shows the trends in prices relating to commodities grouped into four categories such as Commodity Agricultural Raw Material Index, Commodity Fuel (energy) Index, Commodity Metals Price Index, Commodity

Food Price Index. The graph also includes a fifth category represented by a general price indicator which is the “Commodity Price Index”.

Figure 8. Commodity Price Indices.



Source: Index Mundi (https://www.indexmundi.com/commodities/)

By observing the trend of this indicator, it is possible to note that there has been a constant increase in commodity prices.

There were several slowdowns that slowed the increase. Just think of the 2008 financial crisis which led to a collapse of the global financial market which led to a general reduction in prices. Another slowdown was found in 2020 with the outbreak of the pandemic that brought the entire global economy to its knees and also led to the temporary closure of activities.

In short, reserves of some non-renewable resources, such as fossil fuels, are already highly at risk. We are running out of the most accessible deposits of several metals, for some such as copper we have already exceeded the maximum level of production.

This overconsumption is leading the world to some environmental disasters and the trend is not close to the end.

In this context a change is needed, and the classical linear model is no more sustainable.

2.2. Circular Economy: An overview

Starting from an explanation of the CE there are plenty of definitions for this new economy, but the one taken as a reference is the following. CE is "an economic system that is based on BMs which replace 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to benefit of current and future generations" (Kumar et al., 2019).

In other words, it can be said it is a change in the economy where the aim is to prolong the life of the products and materials in order to dispose just what is necessary and reintroduce in the production cycles the rest, with the final aim of eliminating waste and decouple the consumption of resources from growth. If all this can be accomplished, it will be possible to rebuild the overall system and rely on a completely different SC and interactions among stakeholders.

In order to allow the replacement of the 'end-of-life' concept it is important to understand that the CE is based on two key cycles: one biological and one technical. The former regenerates the ecosystem by reducing excessive extraction of natural resources aiming at affecting the natural balance of the ecosystem as low as possible, while the latter emphasizes the extension of a product's lifespan

through a hierarchy of circular strategies, which include reuse, repair, refurbishment, remanufacturing and recycling to achieve the highest exploitation possible of the resources once they have entered the loop (Jabbour et al., 2018). These are some of the BM, but there can be many declinations or combinations of them.

More in general, to govern the CE cycles there are three main principles to be followed (The Ellen MacArthur Foundation, 2012):

- Preserve and enhance natural capital by controlling finite stocks and balancing renewable resources flows. This concept starts from making resources virtual, whenever optimal. Moreover, when there is the need for resources, the system selects them and chooses the best technologies and processes in terms of renewable or more durable resources. What the CE should also aim to, is to create the conditions inside the systems for the regeneration of the nutrients. Overall, it could be said that it is important to preserve the resources in order to preserve the whole environment, the risk in fact is that the speed of extraction and consumption overcomes the capacity of the planet to create them.
- Optimize resource yields by circulating products, components, and materials at the highest utility always in both technical and biological cycles. What needs to be done in this sense is to design for remanufacturing, refurbishing and recycling to maintain the technical components and materials

inside the production cycles. Choosing tighter inner loops could allow savings in terms of energy and other resources. Another way of increasing the productivity of the resources could be through sharing them. For what concerns the biological cycles the value creation is the opportunity to extract additional value from products and materials by cascading them through other applications.

- Foster system effectiveness by revealing and designing out negative externalities. The aim is to reduce damage to systems and areas such as food, mobility, shelter, education, health and entertainment, and at the same time managing externalities like land use, air, water and noise pollution.

The principles mentioned above are principles for action, while now it will be highlighted what are the actual characteristics of a CE (The Ellen MacArthur Foundation, 2012).

- Waste is designed out: it must be designed out by intention. Biological materials are non-toxic and for this reason can be returned to the soil, while technical materials are designed to be recovered and their value is increased.
- Build resilience through diversity: diversity is a key driver for versatility and resilience, and they are essential for systems to survive
- Renewable energy sources power the economy: the energy used to fuel the economy should be renewable.

- Think in systems: everything, from businesses, people or plants, is a part of complex systems where parts are linked to each other. All those links must be taken into consideration from a company when passing from linear to CE.
- Prices or other feedback mechanisms should reflect real costs: prices in a CE act as messages and therefore need to reflect full costs in order to be effective. A lack of transparency on externalities acts as a barrier to the transition to a CE.

2.3. Regulatory frameworks

2.3.1 Overview of European Frameworks

In Europe there is the European Resource Efficiency Roadmap and the Resource Efficiency Platform, a committee to provide guidelines to the European Commission, the state member and private organization to achieve higher effectiveness in the shift to an economy based on efficient use of resources. The goals of this project are to the boost in the transition to the CE, the elimination of harmful subsidies for the environment, the improvement in terms of efficiency of the resources in B2B relationships using for example a passport for products.

Since the CE model prescribes that waste is not only minimized but also cycled back into production processes, studies of CE policies focus primarily on waste treatment, including production process-based approaches to eliminate waste (Hartley et al., 2020). Current EU legislation on waste reduction can be broken down into general requirements and requirements specific to certain products. For what concerns the general requirements there is the Waste Directive from 1975, which obliges Member States to take measures in order to make sure that waste is disposed without putting in danger human health and the environment. It also introduced the ‘polluter pays' principle, therefore the cost of disposing waste is undertaken by those who dispose the waste.

The current legislation, introduced in 2008, is known as the Waste Framework Directive. It contains the definitions for such activities as prevention, treatment, recycling, re-use, preparing for re-use and recovery. It also defines the waste management hierarchy.

Finally, there is the Landfill Directive, which has the objective of preventing or reducing as much as possible the negative effects on the environment by introducing technical requirements for waste and landfill sites. It seeks to achieve this specifying technical standards at Community level and setting out requirements for the location, management, engineering, closure and monitoring for landfills. The Directive also includes requirements related to the characteristics of the waste to be landfilled (Hughes, 2017).

Regarding the specific waste measures, there are firstly the product-specific waste measures, that are divided between (Hughes, 2017):

The Packaging Directive, which was published in 1994, covers a wide range of packaging. It aims at limiting the production of packaging waste and promoting recycling, re-use and other forms of waste recovery and leave disposal at last, if nothing else could be done on the packaging. The Directive also includes restrictions on the use of certain heavy metals.

The Waste Electrical and Electronic Equipment (WEEE) Directive covers waste coming from the disposal of a wide range of electrical and electronic equipment. It requires that Member States have facilities for separate collection and that those are

collected and transported in a way that allows preparing for re-use, recycling. Moreover, it is required that the confinement of hazardous substances and treatment operators use the best available techniques to meet minimum requirements.

The Batteries Directive defines the rules to follow for the recovery and disposal of used batteries and accumulators, together with the concentration of specific substances in new batteries and accumulators and their use in products so that they can be replaced.

Another specific waste measure is the one about substance restriction. Most requirements on substances apply to all products and are formulated as EU Regulations. Therefore, there is no need for national legislation since those measures apply directly across the EU. Specifically, the Directive on the Reduction of Hazardous Substances (RoHS), applies only to electrical and electronic equipment.

Some legislations have been made on the performances of products. Eco-design requirements for the design of products have been divided in two Directives, the first covering energy-using products (EuP) an the second, which replaced the first, on energy-related products (ErP). The Eco-design Directive aims to ensure that the same technical requirements apply in all Member States, but it doesn't have specific conditions itself, instead these are contained in supporting EU Regulations. Measures that apply to specific products placed on the EU market are described in

EU Regulations, which can be seen as legislative containers for the detailed technical requirements.

Hence, when placing a product on the EU market, manufacturers need to take into account both the technical requirements in the relevant EU Regulations and the administrative provisions set out in the national laws transposing the framework Eco-design Directive.

There are 3 European standard organizations (Hughes, 2017):

- CEN, which produces standards on general and non-electrotechnical matters.
- CENELEC, which produces standards on electrotechnical matters.
- ETSI, which produces standards on telecommunications matters.

Finally, it is important to mention the European Commission's Circular Economy Package of December 2015. Its measurements cover the whole cycle, from production and consumption to waste management and the market for secondary raw materials. Under the Commission's proposals, the Circular Economy Package will aim to reduce waste to a minimum so that, when a product reaches the end of its life, its materials are kept within the economy whenever possible.

Proposals include:

- A common EU target for recycling 65% of municipal waste and 75 of packaging waste by 2030.

- A binding landfill target to reduce landfill to maximum of 10% of municipal waste by 2030.
- A ban on landfilling of separately collected waste
- Promotion of re-use and economic incentives for producers to put "greener" products on the market and support for recovery and recycling schemes.

The Circular Economy Package stresses the important role that design can play and this is reflected in the Action Plan, which states that the European Commission will emphasize CE aspects in future product design requirements under the Eco-design Directive (Hartley et al., 2020).

Legislation of the waste economy in the EU is still improving and accepting concrete measurements to increase the quality of processes in waste management and stocking (Taušová et al., 2019). Identifying the four life-cycle stages of products, it is possible to identify a basis for eight policy recommendations that can be applied in the EU and similar contexts.

2.3.2. BS 8001/2017 Standards for organizations

Organisations had no authoritative guidance on Circular Economy principles, strategies, implementation, and monitoring. In order to overcome this lack, the British Standards Institution has launched a new standard "BS 8001/2017-Framework for implementing the principles of the circular economy in organisations". The standard includes a list of terms and definitions, general principles, a flexible management framework for implementing strategies in organizations, and a detailed description of eco-nomic, environmental, design, marketing, and legal issues, all related to the Circular Economy. (Stefan Pauliuk, 2018).

Research considering companies with different features was developed in 3 different stages from 2013 to 2015. In 2013, "more than 200 standards related to specific areas of waste prevention and resource management but no formal standards that defined or focused entirely on the circular economy" (BSI, 2017). In 2014, the SDS/1/10 an expert and shareholder committee were established to develop a framework standard for implementing the principles of the Circular Economy in organisations.

To define the Circular Economy, the BSI uses the definition "economy that is restorative and regenerative by design, and which aims to keep products, components and materials at their highest utility and value at all times,

distinguishing between technical and biological cycles" (BSI, 2107). In order to explain deeply the definition given, three more expressions have to be analysed: "restorative" which means to spent resources being fed back into new products and services, "regenerative" referring to the capacity of the new system to heal and renew the resources involved in the production process, and the "value" that does not refer to financial but also to non-financial gain (Pauliuk S., 2018).

At this point, two kinds of benefits have to be analysed: macro-level benefits and micro-level benefits (BSI, 2017). Starting from the first category it is possible to mention the improvement in resilience of economic systems given by the less dependence on raw materials, economic and employment growth, and environmental care given by the preservation of the natural capital and the mitigation of climate change. The second category includes benefits related to cost savings, new sources of innovation and revenue, and improved customer relationships given by a greater proximity to the customer.

As summarized in Figure 9, the BS 8001/2017 provides:

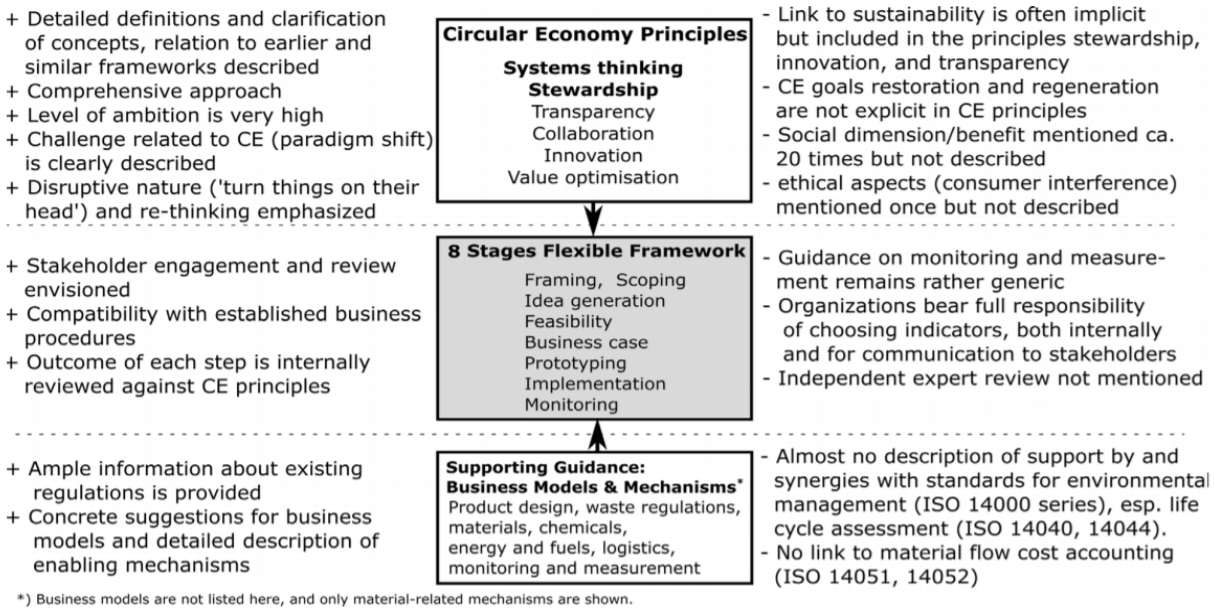
- Circular Economy Principles that all the companies should refer to. Here it is important to highlight the Systems thinking, defined as "holistic approach to understand how individual decisions and activities interact within the wider systems they are part of" (BSI, 2017), and the Stewardship, defined as "an organization is responsible for the

management of all facets of its decisions and activities, from inception through to fulfilment and end-of-life" (BSI, 2017).

- 8 Stages Flexible Framework (core of the standard) that involves a guide for the practical implementation of Circular Economy principles. The flexibility feature of this framework is given by the possibility for the organization to adapt the framework according to the "circularity maturity".
- The Supporting guidance (Business Models and Mechanisms). "When implementing the principles of the circular economy, the overarching goal for an organization is to create long-term business value by design through the sustainable management of resources in its products and services" (BSI, 2017).

According to Stefan Pauliuk's critical appraisal, "It is a guide ... It does not contain requirements that must be met, which means that it is not possible to claim compliance to the standard or undertake some form of certification to it." (Pauliuk S., 2018).

Figure 9. Overview of the Standard BS 8001/2017



Source: Critical appraisal of the circular economy standard BS 8001/2017 and a dashboard of quantitative system indicators for its implementation in organizations. Stefan Pauliuk

2.4. Business actions and strategies

After a general overview of the main concepts of the CE, here the most common strategies are analyzed, these represent the concrete actions behind the business models aforementioned.

The Ellen MacArthur foundation, with the ReSOLVE framework, introduced six business actions in order to implement the theoretical principles (Jabbour et al., 2018):

- Regenerate, which requires shifting to renewable energy and materials in order to regenerate the environment, reclaim, retain and restore the health of the ecosystems and return recovered biological resources to the biosphere
- Share goods and assets between individuals or companies, reuse products and prolong life through maintenance, design for durability, upgradability, etc.
- Optimize, increasing the organization performance through digital manufacturing technologies, removing waste in production and SCs and leveraging on big data, automation, remote sensing, and steering
- Loop, maintaining materials and products in the production cycles through remanufacturing products or components, recycling materials, digest anaerobically and extracting biochemicals from organic waste
- Virtualize, replacing physical with virtual and dematerialized products
- Exchange, replacing old with advanced non-renewable materials, applying new technologies and choosing new products/services

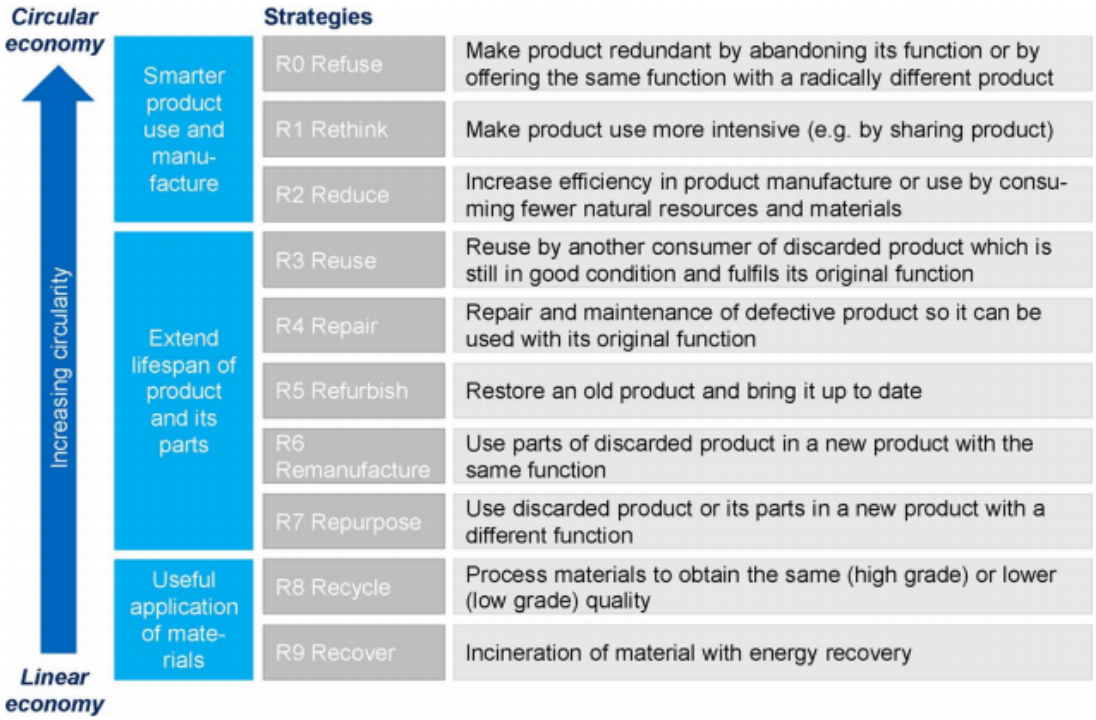
An analysis carried out in 2017 by a group of scholars who took into consideration 114 different definitions concerning the Circular Economy, theorized the existence of at least 9 R strategies and numerous possible combinations of them.

The traditional circular economy models of the doctrine foresee the presence of 4 Rs (Reduce, Reuse, Recycle, Recover), considered as overcoming the previous model of the 3 Rs (Reduce, Reuse, Recycle).

The R paradigm is a fundamental principle of the circular economy since it defines the guidelines of "how to do" circular economy, or the strategies to be implemented to bring the system to circularity (listed in Figure 10). The peculiarity that defines its name is that all strategic activities begin with the letter R.

These 9 Rs represent possible circular strategies that can be implemented by companies. They are ordered according to their degree of "circularity", that is, in relation to their ability to reduce the consumption of virgin resources while reducing waste (Kirchherr J. et al., 2017).

Figure 10. The 9 R Framework



Source: Conceptualizing the Circular Economy: An Analysis of 114 Definitions. Julian Kirchherr et al. (2017).

In turn, these strategies are divided according to the objective for which they are implemented:

- "Smarter product use and manufacture"

- "Extend lifespan of product and its parts"

- "Useful application of materials"

The increase in the number of possible strategies aims to allow a greater focus on the different activities that can be implemented in order to move to different circular business models (Kirchherr J. et al., 2017).

The strategies observed, however, are not universal, but favour the mixing between them in order to adapt in the best way to every single business need. This therefore directs the company to focus not only and exclusively on the use of the resource, but on the design of products characterized by intense use in the short term or by a second life immediately following the previous one.

The European directive on waste (Waste Framework Directive, 2008) is based on the 4R paradigm - reduction, reuse, recycling, and recovery - and is still the most widely used.

Reduce refers to the input of resources usage, which is based on reducing the input materials and energy in the production and consumption processes with the objective of increasing the efficiency in manufacturing processes and use.

Reuse is concerned with processing and promotes a higher utilization of resources through the reuse of raw materials, by-products and used products. Therefore, product lifecycle can be extended, and the waste created in production processes can be minimized without need for other special treatment or changes.

Recycle is concerned with output which it is not wasted but it is turned into secondary resources replacing virgin resources input (Romero and Molina, 2014)

Recover stands for the recovery of energy and water that is possible with waste incineration or thermochemical process, but it also represents the action of collecting products at the end of use, disassembling, sorting and cleaning for utilization in other life cycles.

Among the others two of these practices are the one that will be better investigated since they are the cases of interest for the scope of this thesis.

2.5. Typologies of circular business models

After having analysed the context in the chapter before, it is possible to highlight how important it is to reduce production wastes in terms of commodities involved in it.

An upstream change, where resource management needs to be improved naturally, increasing their production efficiency in production and consumption processes, reducing waste and trying to keep the value of products and materials as high as possible. Not only upstream, downstream it is necessary to avoid having everything disposed of in landfills. It still has any possible usefulness and indeed, try to recover it and reintroduce it into the economic system. These two fundamental aspects represent the essence of the Circular Economy that aims to make economic activities more efficient and less impactful on the environment thanks to technological innovation and better management.

Today's economy is based on the linear approach, "take, make, use, dispose". With “linear” we mean that once consumption is over, the product life cycle ends, and the product becomes a waste. The products are designed to respond to a single need and the diversification seems to be more important than the need itself.

Goods are bought, used, and thrown away instead of being repaired or reused. This at the environmental level and economy is unsustainable because of the shortage of raw materials and limited energy, but also because of the volatility of the price of raw materials and the risks involved. In the natural ecosystem there are

no landfills, the "materials" come and go. Everything which is waste for one species is food for another species. The sun provides energy, things they grow, die and return their nutrients to the earth. The cycle starts all over again every time. This natural model has worked flawlessly for millennia, and it is this type of economy that we are trying to inspire.

The industrial symbiosis concept appeared in literature in 1930, to describe the connection among all industries and sectors and in which inputs and outputs generated are all part of a unique organism.

Later, this idea will become one of the main principles of Circular Economy strategies according to which waste is food. The concept behind this new theory is that what is discarded or disposed of from one sector could be used as input in a different field of production starting again another loop.

This movement for preservation of our planet came alive stronger and stronger in the 70s during which the foundations for Circular Economy were built and industrial ecology became one of the largest sustainable economic movements that gained considerable interest.

Starting from the belief of a chemical engineer, Roland Clift, industrial ecology is the study of all the materials and energy flows within an industrial system to create a closed loop process. It advocates for a stronger exchange of material and information among producers to reverse the widely diffused linear approach and work as a “unique organism”. This attitude adopts a systemic point of view: the

design of production processes is aligned with the local ecological constraints and looks, at the same time, at their global impact trying to shape them to perform as close to the living system as possible (Clift et al., 2015).

Kenneth E. Boulding, in one of his most important writings, “The Economics of the Coming Spaceship Earth”, describes the connection between economic development and biological evolution (Boulding, 1966). Boulding had laid the foundations for what could be called a manual for an eco-sustainable society with finite resource flows. In it, the role of consumption and production is taken by the conservation of goods, be they tangible or intangible. To explain the concept, he used two metaphors, the “cowboys’ economy”, and the “spaceship earth” (Boulding, 1966). The first one is used to explain the linear economy comparing that with the endless inhabited plains, and the tireless, romantic, violent and robbery behaviour that are characteristics of cowboys. The second one explains a pre-concept of the Circular Economy that is like a spaceship in which there is a certain availability of energy, water, and materials. Energy reserves can only be replaced by solar energy while those of water and materials can only be durable if they are reused and recycled (Boulding, 1966).

For this reason, the economy should behave like the heart, able to constantly regenerate raw materials, using only an external supply of energy.

In fact, the circular economy represents a new way of managing the value creation, in line with the needs of sustainability and through the breaking of the

traditional concept of the linear economy characterized by take - make - use - dispose. In fact, it aims to a virtuous and synergistic reuse of all the resources involved in the production process (raw materials, energy, space, moment of consumption, etc.) which re-feed, in a renewable process, the production-consumption cycle, with evident positive impacts from the environmental, social and economic point of view (Geissdoe M. et al. 2018).

The positive impact of this new approach derives from the adoption of actions aimed at recover, recycle, reuse, share, collaborate, in order to limit the use of virgin raw materials in every single sentence of the production process, both for goods and services.

The transition from a linear to a circular model involves a change in the logic of the offer. The finished products must be designed in such a way as to require the use of second-hand materials and to allow easy recycling in order to be able to re-enter the production process more easily and, above all, at a lower cost.

Another business driver of the Circular Business Model "lies in the demand side" (Lacy P. et al., 2016)

According to the authors, in fact, the real power of this business model is given by the greater involvement of the consumer in the production process, their rule during and after the use of the final product/service. The Circular Economy begins from a deeper comprehension of the demand and then it finds the peculiarity a product should have and how to sell it.

For this reason, due to the increase in sensibility to environmental problems, customers' preferences and consumer preferences will be shifted towards companies that will operate more responsibly. This has led companies to focus not merely on the production process but also, at the same, level on the market, on what customers really want from companies.

As a consequence, companies are more attracted to assume an active role in the disposal of resources not only to generate benefits for the environment and the community, but also to increase their profits with an optimization of resources usage.

McKinsey and the Ellen MacArthur Foundation proved this approach could boost resource productivity in Europe by 3% by 2030, saving more than € 600 billion a year and generating around € 1.8 trillion in economic benefits. More than half of the enterprise value of the top 50 consumer companies depends on their growth which is vulnerable and related to issues like drought, governments policies on greenhouse-gas emission and reputational damage due to insufficient attention to pollution and safety. If they want to keep growing, a shift to new models is not an option, but is the only way to survive and it has to be a change that involves every level of the actors along the SC.

Under the label of CE there are many different business practices that can be adopted alone or combined, the models mentioned in the definition and representing the building blocks of CE are (Gusmerotti *et al.*, 2019):

- Circular supplies: provide renewable energy, bio based or fully recyclable input material to replace single-lifecycle inputs. Renewable energies instead of non- renewable to power the production processes, materials that do not harm the environment like bioplastics or natural ones or even input that can be recycled like metals or minerals. A company can decide to produce recyclable materials as input for external actors or for themselves. The biggest barriers for this model are that, at least at the beginning, it requires big investment in terms of money and time. To develop a recyclable material, years of research, collaborations with universities and other actors to share knowledge are necessary. Companies should also make investment to change their linear production system to be suitable with the characteristics of the new input material.

- Resource recovery: recover useful resources/energy out of disposed products or by-products. This model is based on the idea that value is hidden in any flow of the production phases, not only when the final object is delivered to the customer. It avoids loss of materials since every type of output, waste included, is a potential resource. However, two efforts are necessary from the company point of view: organization of reverse logistics to collect products at the end or their life and design

products and processes to be able to reuse any component or material. These materials could come from the company or from external loops, but in both cases, it is easier to recover components if disassembly is not an issue.

Accenture identifies two sub models belonging to this category (Accenture, 2013):

- Recovery of products at their end of life (EoL), with the aim of restoring their value in closed or open loop
- Recovery of scraps from production processes and operations of the company to get back part of the value. (Lacy P. et al., 2016)

The main challenges are the capability to preserve quality of the resources and core components and the organization of the reverse flow.

- Product life-extension: extend the working lifecycle of products and components by repairing and reselling them. Providers of products see the opportunity to make money not in big volumes, but in the long life. Thus, the preferred characteristics are functionalities, quality, and ability to last. This idea goes in the opposite direction with respect to some sectors like electronics or the smartphone one in which the producer is always looking for new functionalities to be added to make the existing version obsolete. On the contrary, in the product-life

extension, longer life means higher profit and there are many ways to extend it. First of all, it's important to create products of high quality that can last more than the ones produced today, and this can be combined for example with a "pay per service" profitability model. Repairing and remanufacturing are other pillars to bring back the initial value of a product, these then could be sold to customers that are sensitive to prices and that are willing to purchase "like new" objects.

Another option could be to update the functionalities whenever there is a new one or restore one of the performances that deteriorates faster than the others.

Usually, not performed by the producer itself, there is also the possibility to resell the object or exchange them (Lacy P. et al., 2016).

To be successful with this model is crucial to focus on customers since the touchpoints will be increased and the customer experience becomes of primary importance. This will also generate more data for the company about its customer base (Lacy P. et al., 2016).

- Sharing platform: enable increased utilization rate of products by making possible shared use/access/ownership. It allows more customers to use the same resources, lowering the demand for new units and at the same time it increases the exploitation of those resources instead of producing others.

The platform per se does not offer any product, but it generates profits thanks to the match between provider and user. The idea behind this model is nothing new: in the past if more than one person would go to the nearest city to work, they would organize the day before talking in the square, now they can do it thanks to the power of digital technologies. Internet, mobile applications, social networks and all the other instruments increase speed, security, real time information and allow to reach a huge number of users (Lacy P. et al., 2016). The advantages for the user are convenience, lower price, and higher quality of the service or even products offered.

Convenience is connected to the fact that they have access to many products that are most of the time closer to their location than brick and mortar options, having also easy payment methods accessible anytime and anywhere.

The second positive aspect is related to the fact that they just pay for access and not ownership, hence is usually less expensive for users.

Lastly, every user is willing to have customized and personalized solutions and usually sharing platforms are strongly focused on the customer experience and the services offered, resulting in higher performance when compared with physical stores (Lacy P. et al., 2016).

The main obstacles are that it is vital to reach the critical mass of users on both sides to be effective and behaviors of users should be monitored to

prevent from ruining the products and insurance systems must be guaranteed.

- Product as a service, also called product service system (PSS): offer product access and retain ownership to internalize benefits of circular resource productivity. Like the sharing platform, the idea on which the model is built is that people prefer to buy a service or a specific performance of a product instead of being the owner. The main difference with the sharing platform is that the ownership of the offered products is retained by the manufacturer that takes care of all the services during the use. This model can be declined in different ways: customers pay with respect to an indicator (e.g., Kms, hours of use etc.) following the "pay-per-use" method. They could rent a product for a limited time horizon with the rights to have exclusive access or agreement based on performance according to which clients buy a service with a predetermined quality level and the company will guarantee that result (Lacy P. et al., 2016). With the increase of interactions, the provider, who sometimes is also the manufacturer, can gather lots of information from close relationships with customers which only pay for the service but have no responsibility on maintenance or operative costs. The original equipment manufacturer could know how customers use their products and consequently improve the performance

and the efficiency of their offer. In this direction manufacturers should think about the quality of the final products but also of all the related services to be profitable. Information is important to know the condition of every product, the use and location and they could represent the biggest threat of their success: if a company is not able to guarantee a certain level of service, a certain control over its offerings, maintenance and assistance in every city in which they operate, they will not be financially sustainable (Peter, Rutquist, & Lamonica, 2016).

Three main types of products as a service have been suggested (Yang et al., 2018) (Lindström et al., 2017):

- Product-oriented, when manufacturers sell products while providing related services, which is a solution that may not have such a big impact on CE since the goal is still for many firms to sell as many units as possible, but manufacturers have the incentive to design their product to last as long as possible to reduce maintenance and related services costs. If the producer wants to maximize the profit, the objective is to cut down costs of services that are included in the price of purchase for the end-user, therefore the producer will start from the design phase to create products that go in this direction.
- Use-oriented ones when manufacturers sell the utility or accessibility of products without transferring the ownership to customers. They have a better potential to reduce environmental impact since business set-ups like leasing,

renting, and sharing basically reduce the number of produced components. In this case, if the manufacturer wants to get higher profit, the strategy is to increase the use-intensification, if paid-per use, or extend the life of product both by making the components possible to be disassembled or reused, and by design for long-lasting objects. Doing so, she will avoid costs of pre-production, production, and distribution of new products and maximize the value extracted from end-of-life products for which the ownership remains by the producer.

- Availability- and result-oriented ones, when manufacturers retain the ownership of products and sell the results of products, which have the best potential to reduce environmental impact, since in addition to the reduced number of components produced, the provider can also optimize the operation and maintenance. This model also creates the incentive to reduce the energy and materials used to provide the service because the customer just pays for it and if the owner who desires to increase the margin must increase the efficiency in terms of inputs used.

The second and the third seem to have a larger potential to be sustainable and support CE initiatives since the product-oriented model is still too linked to the "sell as much as you can" model, even though it pushes the manufacturer to design for long-life products. However, it could be a smart strategy to implement the first model at the beginning and then try to make incremental improvements to achieve the others. When companies adopt a PSS BM to become circular there can be

several challenges. First, the financial risks of the product are transferred from the users to providers since customers can suspend the contract earlier.

Moreover, operational risks are transferred to providers, since users do not own products and they could adopt careless behavior, increasing the need for repair and maintenance activities and therefore costs that the provider has to pay.

Nevertheless, costs for renovating processes might prevent them from offering products at such a lower fee. What happens is that in general companies avoid providing remanufactured products since they fear this could cause a reduction of sales.

- Finally, CE pushes companies to adopt BMs where end-of-life is replaced with renovation. Thus, there could be uncertainties related to the quantity, the mix, the quality, the time and the place of returns of products offered, which would decrease the probability of achieving an economic scale in reverse logistics and renovation activities.

In this situation, with the support of the Internet of Things (IoT) technology it could be possible to supply devices with sensors, make the objects able to communicate and be a part of an information network. Companies would be able to monitor the product remotely, and the correct information would be very useful in order to create the circularity desired (Gianmarco Bressanelli *et al.*, 2018b).

- Industrial symbiosis, to which it will be referred to as IS.

This BM engages separate industries together to reach competitive advantage. This engagement involves physical exchange of materials, energy, and services. Wastes generated by one firm can be used by other firms as inputs or to feed new products. The European Commission recognizes that IS is a useful approach to increase resource use and production efficiency. An industrial symbiosis network (ISN) is a network of firms having IS relationships (Fraccascia and Yazan, 2018).

Through online platforms firms can share their demand and potential supply of wastes with other users. Its use brings several advantages (Fraccascia and Yazan, 2018):

- They support the identification of all the IS relationship feasible for each firm from a technical point of view;
- They make easy and fast finding IS partners because information is shared in real time;
- Each firm can choose, among all the potential ones, the firms allowing to maximize its economic benefits;
- Even firms which are not close to each other communicate among them. In particular, larger areas provide a greater variety of potential waste producers and users.

From the technical perspective, the most important condition for the development of sustainable IS relationships over the long period is the match between supply and demand of wastes.

This represents a barrier against implementing sustainable IS-based business. Information communication technologies are claimed to play a critical role in solving these problems. Through online platforms, firms can easily share information about things such as their geographic location, type and the amount of produced and required resources. What plays a critical role for the initial phase is companies' willingness to share information, since it might be interpreted as revealing sensitive data about the company. Sharing non-sensitive information regarding geographic locations and quantities has less positive impact than sharing sensitive information about costs in both performance measures (Fraccascia and Yazan, 2018).

It is important to mention that circular business models (CBMs) do not operate in isolation, in the sense that in some cases firms adopt a combination of models, since they operate in different parts of the value chain, and therefore can contribute differently to value creation. For example, the adoption of a PSS may serve to incentivize the adoption of repair.

Some of the BM, like recycling, reuse and repair have existed for a long time. Also, the sharing of poorly utilized household possessions and the provision of access to products, which is not far from the traditional product leasing, are not new concepts either. What changes is the fact that they become more sophisticated, structured and more and more sectors are adopting them.

Chapter 3

Management Accounting and Circular economy

3.1. The transition towards circular business models

A sustainable transition to more circular businesses needs to be supported by fundamental innovations, driven by the manufacturing industry, at systemic level, encompassing product design, value-chain integration, business models, ultimately posing new challenges on the way demanufacturing and remanufacturing technologies and systems are conceived and implemented (Tullio Tolio et al., 2017).

In this context, remanufacturing, demanufacturing, and recycling represent three possible paths to take in implementing a circular business model.

De- and remanufacturing includes the set of technologies and systems, tools and knowledge-based methods to systematically recover, reuse, and upgrade functions and materials from industrial waste and post-consumer products, to support a sustainable implementation of manufacturer–centric Circular Economy businesses. While demanufacturing liberates target materials and components, remanufacturing restores or upgrades their functions.

Resource recovery includes all the activities done by companies to ensure a decreasing in waste disposal reintroducing them in the production process.

3.1.1. Demanufacturing

"Demanufacturing can be defined as the breakdown of a product into its individual parts with the goal of reusing and remanufacturing parts or recycling the remainder of the components" (Marcello Colledania, Giacomo Copani, Tullio Tolio, 2014).

A Demanufacturing system includes a set of knowledge-based technologies, tools and methods that allow you to optimize the residual value of industrial waste and high-tech products at the end of their life, with a view to the Circular Economy.

Therefore, a demanufacturing strategy should include the right mix between product remanufacturing and re-use, sub-assemblies and components re-use within manufacturing, material recycling and recovery, incineration and waste disposal in landfills in order to maximize the residual value of end-of-life products and to minimize the environmental impact.

Demanufacturing is a process that allows a large quantity of raw material to be recovered if it is correctly carried out. For this reason, many large companies are already actively working on this issue.

In order to make the Demanufacturing process on end-of-life products as efficient as possible, it is important to consider, in the preliminary design phase, the best solution in terms of environmental impact, costs and quality.

There are several theoretical approaches, which provide multiple insights both as regards the design guidelines and for specific technical solutions.

- Design for disassembly. It consists in considering the disassembly operations to which the product will be subjected in its life cycle and in optimizing them before the production phase begins. The main objective is therefore the design of an efficient and economical disassembly, such as to allow the recyclability and reuse of a product, or such as to increase its maintainability. Considering these aspects in this initial phase of the project means being able to analyze the simplicity of disassembly and improve it to then make this operation concretely feasible. In fact, a disassembly operation occurs not only at the end of the product's life, but also whenever maintenance is required: it is therefore closely linked to the efficiency, reliability, and maintainability of the product. Optimizing the disassembly process leads to numerous advantages, as it offers the possibility of reducing the time required, lowering the cost of operations, reducing the associated energy need and automating the process.
- Design for Recycling. Set of strategies that tend to optimize the recyclability of a given product. The choice and evaluation of materials in the life cycle, their separability, their degree of purity, ease of removal becomes fundamental.
- Design for Remanufacturing. It consists of a series of strategies aimed at the reuse and reintroduction of certain components into the production chain. These affect the assembly and maintenance processes.

These approaches, developed to achieve eco-design, in turn fall under what is called Design for Environment (DfE), “a field of product design methodology that includes tools, methods and principles to help designers reduce environmental impact” (Cassandra Telenko et al., 2008, p. 1).

3.1.2. Remanufacturing

"Remanufacturing is an industrial process whereby products, referred to as cores, are restored to useful life. During this process the core passes through a number of remanufacturing steps, e.g., inspection, disassembly, part replacement/refurbishment, cleaning, reassembly, and testing to ensure it meets the desired product standards" (Sundin E., 2004, p. 2).

The application of large-scale remanufacturing processes began to become important during the Second World War in the United States and the United Kingdom. At that time, the production facilities were mainly used in the production of material. For this reason, the practice of remanufacturing was widely used to extend the life of old machines.

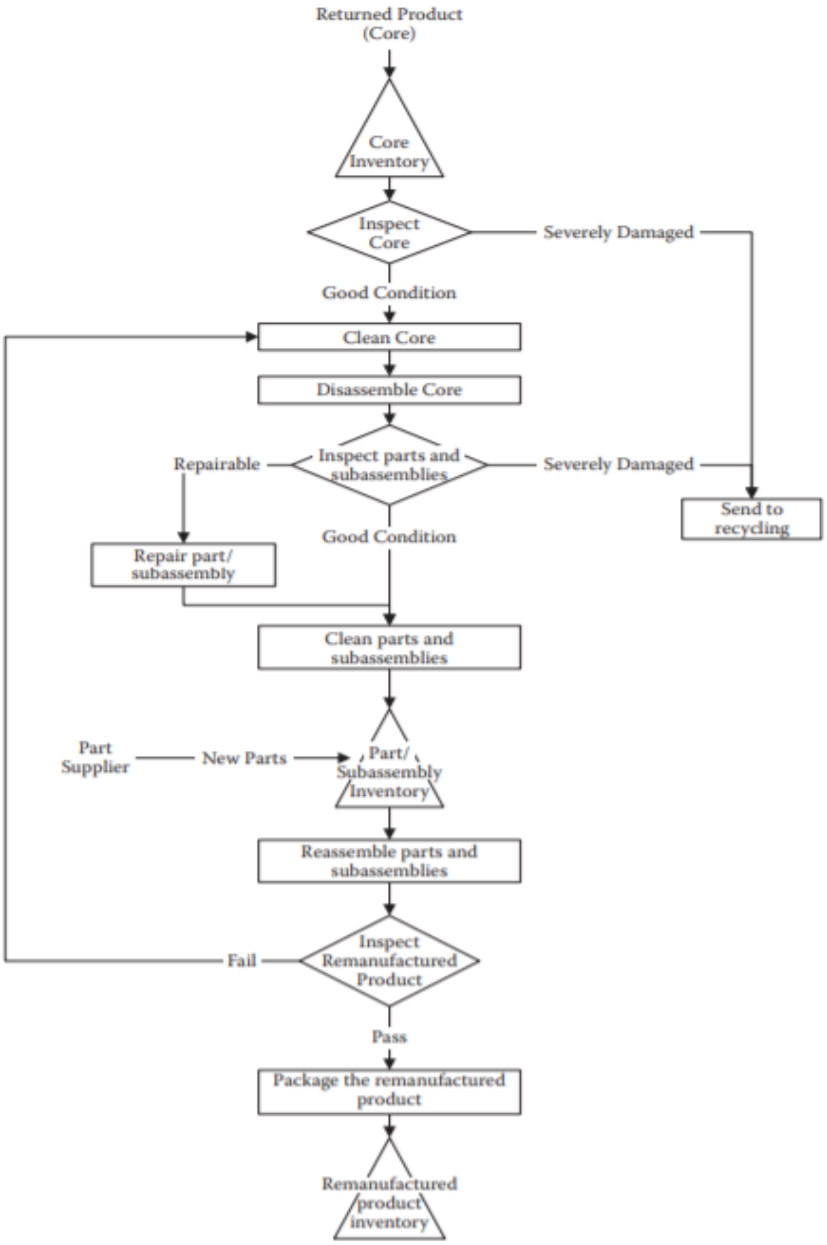
Over the years, the sector that has benefited most from remanufacturing is that of the automotive industry. However, this concept, in recent decades, has also gathered other realities, such as, for example, the sectors of electrical appliances, cartridges and toners, household appliances, industrial machinery, mobile phones.

Remanufacturing is a phenomenon that is also expanding into new sectors of industry and into new countries, as is the growing interest of customers in reused products. Although the processing steps may be different, a typical flowchart has been developed which summarizes the main actions that are carried out in the remanufacturing process.

The following operations are common in most remanufacturing plants (Mehmet Ali Ilgın, Surendra M Gupta, 2012):

- Cleaning, inspection, and sorting. The products collected from consumers are cleaned, inspected, and sorted into two categories: good condition and severely damaged. Severely damaged products are sent to a recycling facility directly. Good condition products are disassembled.
- Disassembly. Products are separated into their components and subassemblies through disassembly. Disassembled parts and subassemblies are inspected. If a part or a subassembly is not in good condition, it is directly sent to a recycler or to a disposal facility. Repairable parts or subassemblies are repaired. Good-condition and repaired parts and subassemblies are sent to the part-subassembly inventory. Depending on the part demand, new parts procured from suppliers can also be added to the part-subassembly inventory.
- Reassembly. A remanufactured product is reassembled using the subassemblies and parts from the part-subassembly inventory. The resulting product is inspected. If it is not functional, it is cleaned and disassembled into its parts and subassemblies again. Functional products are packaged and sent to the remanufactured product inventory.

Figure 11. Remanufacturing process.



Source: Remanufacturing modeling and analysis. MA Ilgin, 2019, p. 9.

Figure 11 illustrates the flowchart developed around the used/non-functioning/broken product that enters the remanufacturing process, which takes the name "core".

In a study by Ostlin (2008), it shows that there are three main "business drivers" for remanufacturing: profit, company policy and the environment. These factors are crucial to successful remanufacturing, but they don't necessarily have to all be present.

The first driving factor for remanufacturing is based on the consideration that the economic resources that were used in the manufacture of the product are reused, so the production costs of the recovered products can potentially be lower than those required for a new production. This makes regeneration profitable. The resources recovered will be materials, energy, machine processing times, labor and all other costs associated with a new production. The price of the remanufactured product is closely related to the price of the new product, but generally the price of the remanufactured product tends to be lower. A push towards remanufacturing may also not be linked to economic problems. These include factors related to company policy such as the protection of a secondary market, the promotion of a specific brand and the protection against particular regulations. From an environmental standpoint, remanufacturing can offer a higher percentage of material recovery than recycling or other forms of recovery. It is very important to take into account how much it would affect prolonging the life of products with obsolete or polluting

technologies. The recovery of products containing technologies incompatible with the environment can have very negative aspects, especially if the strong environmental impact is concentrated in the use phase.

3.1.2.1 Benefits and barriers to remanufacturing

Remanufacturing can improve the competitiveness as well as the eco-friendly image of a manufacturer by providing the following advantages (Kerr and Ryan, 2001; Giuntini and Gaudette, 2003; Ijomah, 2010):

- Remanufacturing requires low-skilled labour, less energy, fewer materials and lower disposal costs, therefore it is more advantageous than traditional production. From a strictly business point of view, the benefits range from less use of expert labor (more expensive), energy and materials, lower disposal costs deriving from the disposal of machinery and related public funding, greater knowledge of product issues, and the recognition of a brand-identity more eco-friendly;
- Remanufacturing provides consumers with the possibility to obtain high quality products at low prices. Because of less production costs, remanufactured products are priced 30% to 40% less than similar ones;
- Remanufacturing processes require less energy and natural resources because most of the raw materials are already present in their final form. As a direct

result of energy savings, remanufacturing can also be an important factor in reducing greenhouse gas emissions. Benefits derive from a lower use of natural resources and energy resources linked to the recovery of materials and the consequent lower emission of gases and pollutants.;

- From a more social point of view, the benefits will be linked to new job opportunities and more sustainable development.
- Producers can reduce penalties related to environmental laws. Thanks to the parts recovered and reused, it is possible to obtain reductions on disposal costs. Furthermore, by extending the life span of the products, it is possible to delay their final disposal.

However, the remanufacturing presents also challenges and barriers (John Mbogo Kafuku et al., 2015):

- Protection of Intellectual property;
- Risk of loosing intellectual property when remanufacturing is carried by third parts;
- Prevention of importation that leads companies to choose a recycling approach ignoring the remanufacturing.
- Negative perceptions of customers about products that contain used parts;
- Because of accounting techniques not accurately developed, managers are not informed about the real financial performance of remanufacturing.

3.1.3. Resources recovery and End-of-waste

The increasing in production and, consequently, in raw material consumption led companies to a higher material and energy import dependency, as it is possible to see at the beginning of the second chapter.

On the other hand, the increase in human consumption has brought with it a vast increase of the quantities of waste generated that has to be managed properly (Ragossnig, Schneider. 2019). For example, looking at the EU, an average of over 1.8 tons of waste was generated per capita on an annual basis in 2016 (excluding mineral wastes), 27% of which was municipal solid waste (Eurostat, 2017).

In 2015, the European Commission introduced the "closing the loop" concept of material/product lifecycle and measures that cover the whole life cycle of materials, from production and usage through waste management and ultimate disposal, to the market for recovered resources and recovery. The benefits of this loop arise in the circulation of the resources and in the possibility to keep them within the company for as long as possible (Ragossnig, Schneider. 2019).

The emphasis is putted on keeping materials inside the loop. George et al. (2015) developed their circular economy model. This model takes into account pollution and recyclable material input, next to economic parameters. The model concludes that economic growth can only be maintained/improved trough an increasing in recycling ratio. Therefore, increasing the rate of recycling is a central objective in

the implementation of effective and environmentally sound, waste management systems throughout the world (Ragossnig, Schneider. 2019).

Recycling of waste involves the production of secondary resources. Materials cease to be considered as waste (End of Waste, EoW) and they enter in the product-sphere. The relevance of this is to which sphere of legislation the certain material belongs (Ragossnig, Schneider. 2019). The transition from waste to product can be considered done whe the secondary material enters in the production process as a waste input. A different option is that the EoW status is achieved prior to a certain process using the respective secondary resource (Ragossnig, Schneider. 2019). In that case the secondary material must not only meet certain EoW (i.e., quality specifications) criteria, but also criteria laid out for the marketing of substances and criteria also applicable to any other primary substance.

The European Commission directive pointed out specific criteria in order to identify when a specific used material can no longer be considered as a waste. In relation to the directive a waste cease to be waste when it has undergone a recovery (including recycling) operation and satisfies specific criteria according with the following conditions (European Commission, 2008):

- The substance or object is commonly used for specific purposes;
- There is an existing market or demand for the substance or object;
- The substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;

- The use of the substance or object will not lead to overall adverse environmental or human health impacts.

In order to be considered EoW, companies need to be able to demonstrate that the waste complies with all the four mentioned criteria.

The scope of defining EoW criteria is to facilitate and promote recycling, ensuring a high level of environmental protection, reducing the consumption of natural resources, the amount of waste sent for disposal, and obtaining “secondary” materials that could be freely traded as materials in the market (Ragossnig, Schneider. 2019).

3.2. Managerial accounting techniques and approaches to account for Circular Business Models

3.2.1. A framework for manufacturing investing analysis

The remanufacturing represents a huge investment for the company. For this reason, it requires a pre-work to estimate the real profitability given by the adoption of this strategy.

For this reason, John Mbogo Kafuku et al. (2015) have proposed a conceptual framework for remanufacturing investment decision making to ensure the completeness of the investment analysis capturing the necessary requirements for investment analysis. It begins from a definition of remanufacturing as follows, "the determination of pre-inputs essential for collection of information and resource inputs, process to upgrade used products to meet original function specifications and deliver services to satisfy customers' requirements as it was originally." (John Mbogo Kafuku et al., 2015, p. 591).

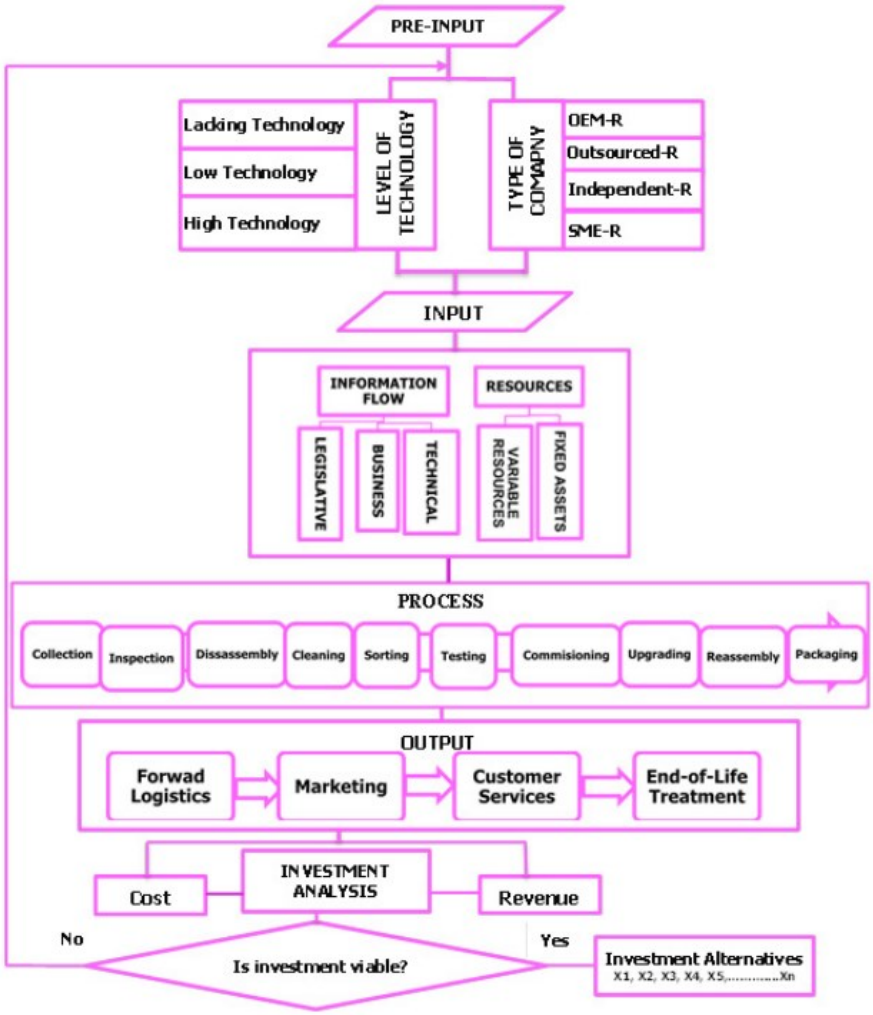
Firstly, the company has established its vision for sustainability in relation to factors such as information and resources, types of company, technology, product logistics, marketing, customer and end-of-life treatment.

Early after that, a remanufacturing investment decision-making occurs. This decision making will be based on a cost-benefit analysis aims to determine (John Mbogo Kafuku et al., 2015):

- Optimal input parameters;
- Internal and external processes;
- Product outputs scenarios;
- Product use and post use treatment.

The analysis starts with the pre-input. In this stage, the level of technology and the type of the company will be studied. The four types of remanufacturing companies are: Original Equipment Manufacturer-Remanufacturing, Outsourced (Third Party) Remanufacturer, Independent Remanufacturer, and Small and Medium Enterprise-Remanufacturer (John Mbogo Kafuku et al., 2015). Also, the level of technology has to be taken into account in order to make investment decisions. Here, technology options are clustered in three main groups (John Mbogo Kafuku et al., 2015): lacking technology (remanufacturing process labour intensive), low technology (high labour involvement), and high technology (low labour involvement).

Figure 12. Conceptual framework for remanufacturing investment analysis



Source: Investment Decision Issues from Remanufacturing System Perspective: Literature Review and Further Research. John Mbogo Kafuku et al., 2015, p. 592.

The framework continues with the processes by which the remanufacturing is composed and, finally, it ends up with the output stage. This stage analyses different scenarios, considered as unique, in logistics, marketing, customer services, and end-of-life treatment. The last part of the framework is investment analysis. In this phase

costs and revenues related to the investment are evaluated. In the moment in which the costs turn out greater of the revenues, the investment is not practicable and therefore the framework returns to the beginning. In the opposite case in which the revenues are greater than the costs, the investment is practicable and therefore can be taken in examination with the other alternatives (John Mbogo Kafuku et al., 2015).

3.2.2. Environmental Management Accounting

Due to the increase in the sensitivity of companies on the issue of environmental sustainability, and to the establishment of business models based on a more sustainable economy (CE), the management accounting activity is also moving towards new models that provide for the integration of environmental costs.

In this context, the concept of Environmental Management Accounting developed. Looking at the literature, this accounting method is approached in two different ways. The first approach takes into account only monetary measures, while the second one considers both monetary and non-monetary measures (RL Burritt et al., 2002).

"The main difference between conventional and environmental accounting systems is that the latter separately identify, measure, analyse and interpret information about environmental aspects of company activities" (RL Burritt et al.,

2002, p.40). In fact, looking at the conventional approach, environmental information is missing, or unclear. Looking at the company activities it is possible to highlights two main groups of environmental impacts which are environmentally related impacts on the economic situation of companies, and company-related impacts on environmental systems (Schaltegger and Burritt, 2000).

The first one is based on monetary environmental information that includes all corporate-related impacts on its past, present or future financial stocks and flows, and is expressed in monetary units (Monetary Environmental Management Accounting, MEMA). The second one is based on material and energy amounts that have an impact on ecological systems and it is expressed in physical units (Physical Environmental Management Accounting, PEMA). For these reasons, the EMA is defined as a generic term that integrates both Monetary Environmental Management Accounting, MEMA and Physical Environmental Management Accounting, PEMA. (RL Burritt et al., 2002).

In this paragraph, it will be analysed two Environmental Accounting groups of tools that are the most commonly used in the CE business models.

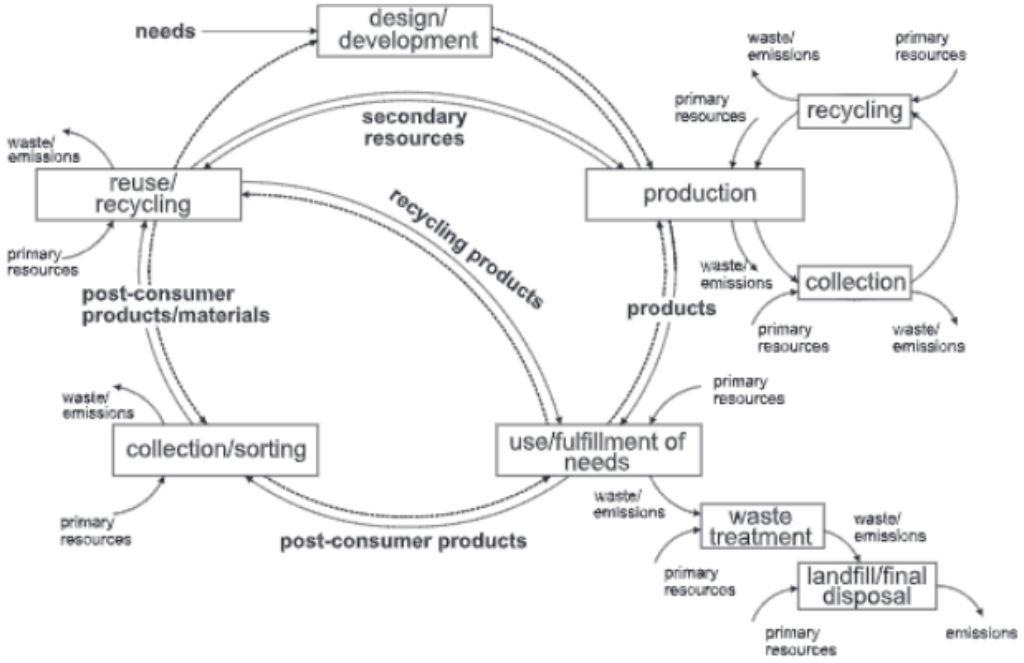
3.2.2.1. Life Cycle Assessment

Figure 13 shows a scheme of the product life concept, which is usually referred to as a “life cycle” because of loops between the several life phases. Examples of

such loops are the reuse and recycling of post-consumer products (originating in the end-of-life phase) or recycling of production scrap.

"Life cycle assessment (LCA) is a methodological framework for estimating and assessing the environmental impacts attributable to the life cycle of a product, such as climate change, stratospheric ozone depletion, tropospheric ozone(smog) creation, eutrophication, acidification, toxicological stress on human health and ecosystems, the depletion of resources, water use, land use, and noise—and others" (G. Rebitzer et al., 2004. p.702.).

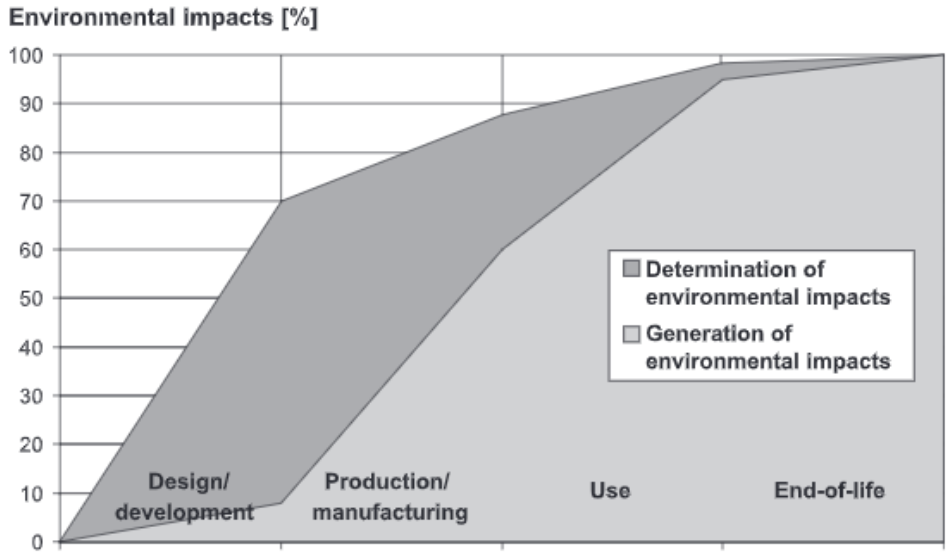
Figure 13. Schematic representation of a generic life cycle of a product



Source: Life cycle assessment. Part 1: Framework, goal and scope definition, inventory analysis, and applications. G. Rebitzer et al., 2004, p.702.

When an LCA is conducting, stages that have to be taken into account are design/development, production/manufacturing, use, and end-of-life. As it is shown in figure 14, these phases present differences according to the percentage of the determination of environmental impacts (higher at the beginning of the product life cycle), and the generation of environmental impacts (full at the end-of-life stage) (G. Rebitzer et al., 2004).

Figure 14. Generalized representation of the (pre)determination and the generation of environmental impacts in a product's life cycle



Source: Life cycle assessment. Part 1: Framework, goal and scope definition, inventory analysis, and applications. G. Rebitzer et al., 2004, p.702.

In 2006, the International Organization for Standardization[3] developed two standards, ISO-14040 (2006) and ISO-14044 (2006), in order to describe the required and recommended elements of E-LCAs. These standards identify the four stages thank to which the LCA is conducted (Evan Stuart Andrews, 2009):

- Goal and Scope. This first phase includes the reasons and the use why the study is being conducted, and the definition of how the study is being approached.
- Life Cycle Inventory (LCI). It involves data collection and calculation to quantify inputs and outputs of materials and energy associated with a product system under examination. In this case, all inputs and outputs of a unit process and of a product system are related to the main output of the unit process and the final product of the product system, respectively.
- Life Cycle Impact Assessment (LCIA). In this stage, the significance of potential environmental impacts of a product system based on the previous stage results (LCI) is evaluated according to several elements. The results of LCI stored (inventory) are firstly classified (classification) in relation to the problem which is connected with (for example, global warming), after that there is the calculation of category indicator results (characterization).

[3] ISO is an independent, non-governmental international organization that brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges. (https://www.iso.org/about-us.html)

- Life Cycle Interpretation. This phase consists of combining the results of LCIA and LCI, and, subsequently, analyse them in relation to the goal and scope in the first stage. Here, the goal is to reach conclusions and to give recommendations defining areas of improvement or key environmental information that could be communicated to attract consumers.

3.2.2.1.1. Life Cycle Costing

Since traditional cost accounting systems are not able to correctly determine environmental costs, such us costs related to recycling activities, the use of life cycle costing (LCC) represents a possible way to overcome this problem (Pernilla Gluch et al., 2004).

Initially it was developed for investment calculus, not for an environmental context. In 1960, the U.S. military developed for the first time a method to assess the costs of long living goods. The reason was related to the fact that for some goods, such as tanks and tractors, the purchase price reflects only a minor part of the costs that will be caused by the product (Evan Stuart Andrews, 2009).

Recently, research projects have been carried out in order to place this method in an environmental context. This research led to the definition of corporate environmental accounting which is "…the process of identification, measurement, accumulation, analysis, preparation, interpretation and communication of financial

(and non-financial) information used by management to plan, evaluate and control the environmental aspects of an organization" (M. Van der Veen, 2000. P.155).

The definition of traditional LCC is given by the standard ISO-15686: "a technique which enables comparative cost assessments to be made over a specified period of time, taking into account all relevant economic factors both in terms of initial costs and future operational costs" (Pernilla Gluch et al., 2004. P. 572).

Figure 15 shows the corporate environmental tools that have been developed during the last decade. According to the word included in the tools' name, it is possible to understand the effort to integrate traditional cost-accounting approaches with an environmental perspective. The aim of this integration is to include environmental impact into the corporate accounting systems, allocating where a resource is used and to measure it (Pernilla Gluch et al., 2004).

Figure 15. Corporate environmental accounting tools.

Concept	Definitions/description	Cost categories
Full cost accounting (FCA)	Identifies and quantifies the full range of costs throughout the life cycle of the product, product line, process, service or activity [28]	Identifies and quantifies (1) direct, (2) indirect and (3) intangible costs
Full cost environmental accounting (FCEA)	Embodies the same concept as FCA but highlights the environmental elements [24]	Varying
Total cost assessment (TCA) (I)	Long-term, comprehensive financial analysis of the full range of internal costs and savings of an investment [28,29]	(1) Internal costs and savings
Total cost accounting (TCA) (II)	Term used as a synonym for either the definition given to FCA or as a synonym for TCA [28]	(1) Conventional costs, (2) hidden costs, (3) liability costs, (4) less tangible costs
Life cycle accounting (LCA)	The assignment or analysis of product-specific costs within a life cycle framework [30]	(1) Usual costs, (2) hidden costs, (3) liability costs, (4) less tangible costs
Life cycle cost assessment (LCCA)	Systematic process for evaluating the life cycle cost of a product or service by identifying environmental consequences and assigning measures of monetary value to those consequences [5,31]. LCCA is a term that highlights the costing aspect of life cycle assessment (LCA)[a] [28]	Add cost information to LCA
Life cycle costing (LCC) (I)	Summing up total costs of a product, process or activity discounted over its lifetime [24,27,28,30]	Varying
Life cycle costing (LCC) (II)	A technique which enables comparative cost assessments to be made over a specified period of time; taking into account all relevant economic factors both in terms of initial costs and future operational costs [ISO15686].[b]	Varying
Full cost pricing (FCP)	Term used as a synonym for FCA or LCC [28]	See FCA and LCC
Whole life costing (WLC)	Synonym to TCA (I) or LCC [7]. More specifically defined by Clift and Bourke [16] as 'The systematic consideration of all relevant costs and revenues associated with the acquisition and ownership of an asset"	(1) Initial costs and (2) operational costs

Source: The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. Pernilla Glucha et al., 2004, p. 573.

The Royal Institute of Chartered Surveyors identified the benefits of the LCC which are four (Flanagan R. et al., 1983):

- to enable investment options to be more effectively evaluated;
- to consider the impact of all costs rather than only initial capital costs;
- to assist in the effective management of completed buildings and projects;
- to facilitate choice between competing alternative.

There are even limits that restricts the use of this accounting tool in an environmental context (Pernilla Gluch et al., 2004):

- It cannot handle decision-making under uncertainty because of the assumption that the decision-maker is rational;
- In environmental context there are irreversible changes that exclude the assumption of the economic theory that alternatives are always available;
- It doesn't take into account items that have no owner, such us natural environment;
- The one-dimensional unit assumption (monetary) over-simplifies the multi-dimensional environmental problems.

3.2.2.2. Material Flow Cost Accounting (MFCA)

Another model of Environmental Management Accounting strictly related to the CE way of thinking is the Managerial Flow Cost Accounting (MFCA) (Jasch C., 2006). The scope of this tool is to help improving firms' both environmental and financial performance identifying the combination of value flows, material flows, and energy usage (M. Schmidt, 2015).

The MFCA is applicable to any organization that uses materials and energy, regardless of its products, services, size, location, and existing management and accounting systems. Initially, the MFCA can be applied as an environmental accounting management tool in the supply chain, both upstream and downstream, and can help develop an integrated approach to improve the efficiency of materials

and energy in the supply chain. To reap the benefits of an MFCA project extended to the supply chain, it is imperative that collaborating organizations commit to sharing information on processes and related material and energy flows, in order to allow a comprehensive understanding of the production system for a consequent effective implementation of the MFCA (ISO, 2011).

According to the ISO-14051, the MFCA identifies potentials for monetary saving by avoiding all non-productive energy and material flows (ISO, 2011). This is even the difference between this method and the LCA. LCA simply focuses on determining the energy and the material flows, while MFCA, quantifies and assesses possible potentials for savings in monetary terms (M. Schmidt, 2015).

ISO 14051 provides three main goals of MFCA (ISO, 2011):

- Increasing the company's transparency in terms of material flows and energy use, including the relative costs and the environmental aspects;
- Supporting the organizational decision-making processes in different areas such as process engineering, production planning, quality control, product design and supply chain management;
- Improving the sensibility of the company regarding the consume of materials and energy within the organization.

For this reason, MFCA is expected to be effective in investment appraisal of plant and equipment, modifications or substitutions of raw materials, improvements

in product design and production planning, and on-site improvement activities (Katsuhiko Kokubu, 2015).

MFCA shows not only the direct costs of wastes (losses), but also the lost added value in the company. It includes costs of material, costs of labour and costs of capital. For this reason, the amount of this lost added value is higher than the pure costs of the wastes and companies are more inclined to invest in avoiding such losses. MFCA is therefore a special way of evaluating the costs incurred by a company and can lead to lean production activities (M. Schmidt, 2015).

According to Schaltegger and Burritt one difficulty of MFCA is that the energy and material flows in a company must be known and, for this reason, an elaborate ecological accounting system is needed (M. Schmidt, 2015, p. 1311).

In traditional cost accounting systems, the costs for waste are often treated as disposal costs in a very general manner. The waste disposal costs are assigned directly to the product highlighting the percentage of raw materials “lost” during the production process.

Material Flow Cost Accounting, on the other hand, considers all costs that were incurred in the process chain before the material input became a material loss. These are hidden costs such as transport, machine use, energy as well as auxiliary and operating materials. Even if the loss of material can be sold later as recyclable material, the loss in value will probably be higher than expected. Hence, MFCA aims to avoid losses in the first place instead of just recycling them.

The ISO-14051 provides an example to explain the difference between the application of traditional accounting system and the application of MFCA system.

The example is based on a case study of a Company A, which is a manufacturing company based in Japan.

Before introducing MFCA, Company A believed that its existing processes had a very high production yield ratio of 99%. It means that 99 out of 100 pieces of raw material input becoming finished products.

However, that result changes after the introduction of MFCA. The calculation indicated that the material loss cost was estimated in 32% in the analysed process. This means that the yield ratio as calculated by MFCA was 68%, much lower than the 99%. Most of the wastes were actually generated by the process of grinding raw material, but Company A did not recognize these wastes as "losses" in its existing yield ratio management. Such losses were not considered in the calculation because the managers of the company were not able to control them due to the design of the product and the processes that were already in place.

In Company A, defective products were considered as losses generated from the production line. Finally, MFCA-based results led Company A to reduce these material losses and integrate a new material, reducing the portion to be grinded by 80%, in cooperation with the supplier. As a result of the introduction of the new material, the amount of sludge and wastes generated by both Company A and the supplier decreased significantly (ISO, 2011).

So, MFCA highlights losses that are not always recognised, and, for this reason, do not take into account in production management. These losses are not separated, and they go to be part of manufacturing costs. The aim of the MFCA application, in fact, is given by the possibility of developing ways of reducing them.

However, if the loss provided by MFCA is not well recognised by existing managers, measures would be required to incorporate the new concept into the operation, before conducting any activities for improvements. For this purpose, it is necessary to examine whether any conflicts can be recognised between MFCA and existing management perspectives (Katsuhiko Kokubu, 2015).

3.3. Circular business models and key performance indicators

The transition toward a circular business models brought benefits with it. These benefits of a more innovative, strong, and advantageous economy have led increasing interest not only by the policymakers but also by scholars in deepening this issue. Meaning of concept of CE, its usefulness, its assessment, are subject of continuing scholarly debate.

In order to evaluate the performance of the transition some indicators have been provided by different scholars. Some of the most commonly used are the following (Angelina De Pascale et al., 2021):

- Circular Economy Index (CEI). This indicator is given by the relationship between the material market value i.e., the value obtained by the recycler, and the material value entering the recycling plant. It measures the circularity of a specific product, including all the end-of-life product used as input in recovering processes.
- Recyclability Benefit Rate (RBR). This indicator is given by the relationship between the hypothesized environmental benefits deriving from the recovering of the product and the environmental externalities linked to product disposal. It is strictly related to the LCA methodology because it considers the potential environmental impact values of resources involved in the production.
- Circular Economy Performance Indicator (CPI). This indicator is obtained from the relationship between the actual obtained environmental benefits and the ideal ones, considering the quality. The environmental benefits are evaluated trough LCA and the most appropriate wate treatment is based on the typology of recycling loop. About the possible results, a CPI higher than 1 indicates that the environmental benefits obtained are greater that the ideal ones, according to the quality, lower otherwise.
- Circularity Calculator. This indicator shows the percentage of a product or part in remanufacturing, refurbishment, and recycling, and calculates resource flows and the financial value of closing loops. Its goal is to evaluate the circularity of a certain product highlighting the main weaknesses of the production process.

Looking at this indicator, designers can compare different design solutions and business models for diverse scenarios.

Chapter 4

The case of SIFA S.p.A.

4.1. An overview and history of the company

SIFA S.p.A. is a family-owned company with headquarter in Francavilla d'Ete (FM), a small village located in the centre of Italy, and another two plants, one in Mogliano (MC) and another in Montecarlo (LU).

Since 1968, the company is specialized in packaging solutions and boxes in corrugated cardboard mixing at the same time tradition and innovation.

In 2019, the company reached a total revenue amount equals to €49.066.911 and a net operating income of €6.768.984. These data assume more importance if compared with the ones of 2018. The total revenues have registered an increase of 6,5% and the net operating income has increased by 37,2%.

The mission of the company is summarized by "Protect and enhance the work of our customers"[4]. According to SIFA definition the packaging goal is, not only to ensure the protection of the good transported, but it is a communication tool that exalts the product.

[4] SIFA S.p.A. https://sifaspa.eu/

The values are related to the solid roots of the family artisan tradition connected with passion for work, environmental protection, ethical responsibility, and social cohesion. The organization looks at the future always remembering the origins.

“Dynamicity, innovation and attention to details are the tools that allow us to respond timely and with competence to the most various needs”.

SIFA S.p.a. was born from the initiative of three brothers, Giuliano Trasarti, Luigi Trasarti, and Vittorio Trasarti. They wanted to start their own business and, in 1968, under the name of FAC (“Fustellatura Automatica Cartone”). The business idea was born to satisfy the demand for boxes and cardboard by local companies, especially shoe factories, mainly present in those areas.

The business started with the purchase of a cardboard cutting machine, in Francavilla d’Ete, where they lived. In 1971, the first employee was hired. The production was about 100 quintals of cardboard, 4000 paper whit a unit value of 3 lire per sheet.

In these years, the first investments began. Even if the VAT came into effect, increasing the prices, they proceeded to purchase a new production machinery.

In 1972, the productivity increased reaching the production of 100 boxes per day.

In 1973, there was the energy crisis. The prices of crude oil and its derivates increased significantly due to the Yom Kippur War, in which Egypt and Syria attacked Israel. The OPEC (Organization of the Petroleum Exporting Countries)

decided to raise drastically the price per barrel and embargo. This led to the Austerity, and for the first-time business faced the problem of containment of energy consumption.

With the oil price, even the cardboard price increased by doubling. The company resorted to loans to pay the procurement of raw materials.

However, the quality and services offered by the company stands out from the competition leading to the quick extinction of the loans.

In 1976, in order to increase the productivity, the company acquired firstly a new establishment of 750 square kilometres, and after one year there was another expansion of 3500 square kilometres.

In 1980, the company started a new production line based on pizza boxes. This investment was slow to bring profits due to the scepticism found in the first 5 years.

The investments went on with the acquisition of a new automatic die-cutter machine, in 1982.

At the beginning of 1990, there was the “boom” of the pizza boxes bringing the company among the leaders in Italy.

In 1992, in order to increase the productivity and satisfy new needs of the customers, the company bought the Casemaker machinery. This new machine ensured the production of industrial packaging with three-colour print.

By consequence of this expansion, in 1994, the company had 27 employees.

The entrepreneurs started to think about producing the cardboard instead of buying it periodically. however, it included the purchase of a new machine: the corrugator.

In order to find a place where put this new machine, the company finalized the purchase of a former consortium in Villa San Filippo (MC) of 4000 square metres.

The investment in this new property did not go well because it was in an inhabited centre and the corrugator was very noisy. For this reason, the building was resold in 2002.

In 1997, there was a new investment opportunity in Mogliano (MC), in a complex of 5000 square meters, of which 2000 square meters free, and 3000 square meters owned by three different artisans.

In 1998, the move to the new building began and, after two years, the became owner of the other 3000 square meters available.

In these years, the number of employees rose to 30, with 7 in the new building in Mogliano.

During these years, the acquisition process of the corrugator went on. The entrepreneurs went to Japan in order to buy the “heart” of the machine from Mitsubishi. The other parts of the machine were bought in Italy.

The investment was financially very important, and it was not easy to find a credit institution willing to finance. The financing came through “Intesa Leasing”, depreciable in 8 years.

After one year and half, the corrugator was turned on for the first time.

In 2000, the company registered 60 employees.

In 2001, the company tried to start a process of delocalization in Romania. The delocalization process started by most of Italian companies, led to an increase in packaging and boxes in the destination countries. The new company of the Group was called Vancarton and it had 15 employees. It was not a real delocalization, because the boxes and packaging solutions were made in Italy with the raw material purchased in Italy. The company was sold in 2016.

These operations brought the company to a consistent turnover increase. From 1999 to 2001, the turnover increased for 11,7 billion of lire (from 9.3 billion to 21 billion).

Over the years, Sifa S.p.A. has always been capable of catching opportunity and gain a strong market position over the competitors.

Thanks to the solid structure of the company and a leader position into the market the company has grown constantly.

Nowadays, the company can count on a turnover of over 46 million of euros, and 158 employees.

4.2. Product lines and production process

It operates in a business-to-business market providing suitable solutions according to customer needs. For this reason, the aim of SIFA S.p.a. is to establish long and solid partnership with the clients.

The production quality is certified by the UNI EN ISO 9001 Ed. 2015. The ISO 9001 standards have been defined by the International Organization for Standardization to outline the requirements for quality management systems within companies. These are general and flexible rules, applicable to different business processes and sectors. Thanks to this certificate, the final customer can have full confidence in the fact that the services and products placed on the market correspond to certain specifications and that all the phases relating to their realization can be retraced and verified. This is one of the most recognized certifications.

A very important tasks is performed by the Customer Service. It aims to support the technical-planning and after-sell processes, deliveries are made with own means of transport.

SIFA S.p.a. can count over 75.000 different type of boxes designed according to clients' needs about different uses, sizes, and other peculiarity of the cardboard.

The main product lines of the company can be grouped by the following categories:

Boxes for e-commerce. In this case SIFA S.p.a. offers the possibility to personalize the product with high-definition prints with a maximum of 6 colours.

American boxes and die-cut boxes. These are designed to be suitable to different industry that require specific features. Wraparound and plateau also fall into this group.

Paper products and exhibitors. Pre-formed or self-assembling packaging, exhibitors, and trays are made every day for all product sectors.

Pizza and take away boxes. In this case products are customizable or standard, but these are subjected to periodic quality controls because in close contact with food.

Corrugated cardboard. The offer is based on different kind of wave (such us micro-wave, micro triple-wave, double-wave, single wave) up to the dimension of 2.800 x 5.000 millimetres.

Over 25 kinds of paper compose the range of raw materials used according to the final destination of the product, allowing to produce over 2.000 different corrugated cardboard compositions.

The production starts with the purchase of the reels of paper, that consists of long rolls of paper stored according to the typology in the first warehouse.

At this point, these reels are brought to the corrugator where the transformation process can start.

This machine is the central point of the entire cardboard corrugated production process.

According to the kind of wave desired, the reels are arranged in different place of the corrugator. This machine is connected to another one which is used to prepare the amid glue in order to paste the pieces of paper to the created wave, below and above.

Figure 16. Corrugated cardboard typologies by wave.

Source: SIFA S.p.A. website, https://sifaspa.eu/.

For example, in producing a double wave, 5 reels will be used; in producing a single wave, 3 reels will be used.

The aim of the waves in the corrugated paper is to ensure a higher strength of the packaging, acting as a pillow that absorbs the blows received from outside, and ensures the stack thanks to a higher compressive strength.

Once these are ready and out of the corrugator, some pieces of corrugator paper move on to cutting and printing, others are moved to the semi-finished products warehouse ready to be sold.

The corrugator ensures the production of over 600.000 of square meters of cardboard and over 110.000.000 per year, data that are constantly increasing over the years thanks to the constantly innovation and strict attention to every stage of the production process.

The transport inside the production department is carried out through automated processes. It involves into the use of a handling system WIP (Work in Process), which directs the corrugated sheets to the machineries according to the next production stage by using carrels able to move the stacked corrugated paper. These processes have led the company to obtain the recognition as industry 4.0.

Semi-finished products are moved to the converting department which is divided into “Die-cutting division”, “Industrial packaging division”, and handmade packaging.

The first one is composed by a rotary die-cutting machine that ensure the possibility to cut and print cardboard at the same time.

The second one involves in the use of the Casemaker machine. It allows to make corrugated cardboard packages of various sizes and with different prints.

The third one consists of the use of a slitter-scorer and consequently closing with the gluing machine with manual or stapler semiautomatic with steel clips.

At this point, all the products arrive to the end-line system that adds mechanically pallets, straps and, in some cases, cellophane. When the products are out of the end-line system, they are transported to the finished products deposit of belonging because in this case the company disposes of two different ones.

Once products are in the warehouse these are ready to be loaded into trucks for shipping.

Over the years, the company has always paid attention to the environmental impact. A lot of actions have been started in order to achieve certain goals related to the reused and recycling of raw materials such as water, paper, electricity.

In fact, paper is a raw material which lends itself a lot to reintegration into the production process and there are many companies that recycle it.

This led to the development of a new business model, a circular business model, based on the reintegration of raw materials in the productive process.

4.3. Towards the adoption of a Circular Business Model

According to Sifa S.p.A. values, the eco-sustainability is one of the key-factors of the overall production process. In fact, how it is possible to read in the website, “Sustainability in Sifa is a real business philosophy”.

This is the reason why they decided to develop a Circular Business Model. The aim of the company is to reduce the environmental impact of the production thanks to the adoption of new technologies.

Every changing in production processes, transportations and industrialization is based on the reduction of waste of raw materials.

According to the Figure 17, the circular business model starts from the design of the product that is strictly related to the business phylosophy. The production mainly favors the remanufacturing, the use of virgin fiber paper and recycled paper.

The distribution, as said before, carried out with company-owned means of transport aimed to be as efficient as possible, making the most of the load capacity of the trucks.

All these actions lead the company to reduce at the lowest level the consumption of all the raw materials involved in the overall business activities. The circularity includes all the raw materials, such as carbon dioxide, fuel, electricity, and water, not only paper.

But considering the high consumption of paper the company has decided to invest in the collection of paper. In order to have a large quantity of paper to to be sold to paper mills that will take care of recycling.

Figure 17. SIFA S.p.A. Circular Business Model

Source: SIFA S.p.A. website, https://sifaspa.eu/

Various are the actions developped in order to be as circular as possible.

Starting from the paper, the objective of the company is to increase the incidence of the recycled paper in the production processes. Of course there are kind of boxes

that do not allow the use of recycled paper, as for example food packagings, which must be made exclusively with virgin fiber

Being the paper one of most easily recyclable raw materials, the company put a lot of effort into the paper collection inside and outside of the company. The collection inside the company is made by a system capable of collecting all the waste deriving from the production activity thanks to ducts that transport it to the outside where there is a machinery suitable for pulping.

The second way that ensure the collection of paper is given by the picking up from the clients. Every time that a camion leaves the firm to reach a customer, these are also charged with loading the paper wasted in order to avoid unladen journeys. This process is made by proprierty means of transport.

By the way, the circular actions are not limited to paper recycling.

The printing of packagings involves in the use of inks. The disposal of this particular kind of waste is very expensive.

In 2020, the administration of the company decided to invest into a system of purification of printing water. This investment involves into the purchasing of a new machinery. Thanks to different chimical reactions and a series of filters able to retain the impurity of the water, at the end of the process the remaining water can be used in certain processes. At the moment, the water is used to make the paper more workable for the macerator and to .

Another objective of the company is to develop a production process entirely powered by photovoltaic panels. At the moment a photovoltaic system has been built in only one of the production plants, but they are thinking about increasing the electricity production capacity of the company in order to reach this goal.

4.4. Paper recycling

Paper is a material very suitable for recycling processes and therefore ideal for a company that is moving towards a circular business model.

In SIFA S.p.A., it represents the core raw material of the overall production process because it is used at the beginning in the corrugator for the production of the corrugated cardboard. At the moment, the recycled paper involved in the production process is more or less 40.000 tons respect to the 20.000 tons of virgin fiber paper, more than 66 per cent of the total paper consumption. By the way, virgin fiber paper cannot be substituted because it is required for the production of packages in contact with food and for other production lines that require the use of the typical greater elasticity of virgin fiber.

SIFA S.p.A. does not recycle for itself, it takes care of more than half of the entire recycling process. As shown in the Figure 18, the company activity in this cycle involves in the collection of the paper. It consists of two main typologies of collection:

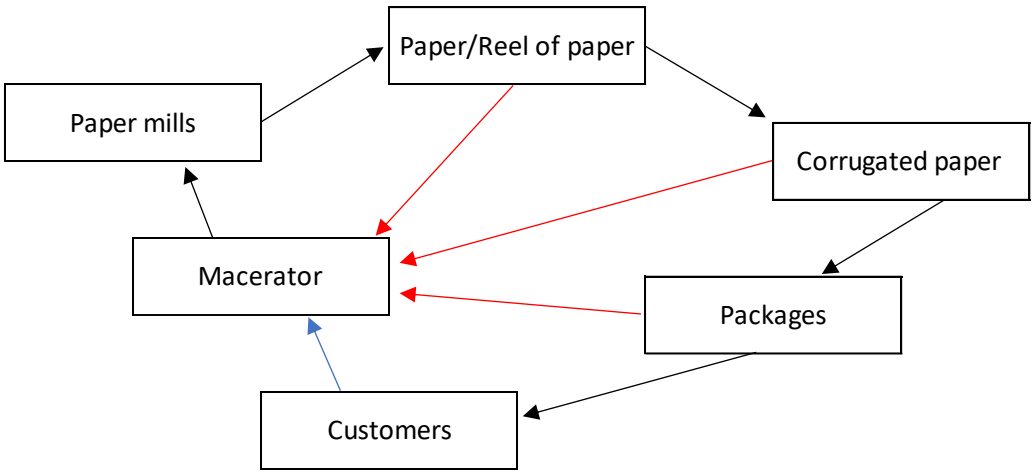
- Internal collection (red arrows in the Figure 18). Every machinery used in the production department produces production waste, whether it is caused by defective material or by the die-cutting activity. The production waste is conveyed into channels that connect each machinery to the macerator

located outside the building. At this point, the paper is pressed into blocks to then be loaded into the truck headed to the paper mills for recycling.

- External collection (blue arrow in the Figure 18). This activity is carried out by the trucks that collect paper from the clients. Here, when the carriers go to deliver an order to customers, in order to avoid trips with an empty load, they collect, against payment, the customers' wastes of paper and cardboard. Even in this case, the paper collected ends up in the macerator to be pressed.

The remaining part of the process is carried out by the paper mill. Once they have received the paper, they will take care of the pure transformation of waste into reusable paper in the production process.

Figure 18. Paper recycling process



Source: Own elaboration.

4.5. Clarification of wastewater from printing unit washing

The second circular activity that the company is implementing consists of the purification of wastewater from printing unit washing.

This activity is carried out through the use of a machine purchased in 2020. The activity generally consists of separating the liquid component from the ink waste used by the box printing machinery. Ink waste from printing machines is directed to this machine. At this point, the waste is collected in a first container where it is accumulated and homogenized. Subsequently, these liquids are passed to the second section where a series of chemical-physical treatments take place that start the process of separation of the muddy part from the liquid part. The result of this first process reaches the last section. In this section, the liquid initially ends up in the sludge thickener. The last process that the liquids undergo consists of passing through a sludge filter press. Here, the separation takes place.

The sludge ends up in the appropriate containers while the purified water will be channelled into special pipes for reintegration into the production process. The purified water is used in two different ways:

- As a cooling liquid for the machinery;
- Directed to the macerator and is used to wet the paper in order to facilitate its maceration.

Excess sludge, however, is not returned to production but is placed in bags that will later be disposed of by third parties.

4.6. The effects on managerial accounting

The paper recycling involves a cost for the collection of this material. Since one of the controller's tasks is to monitor costs, he is required to monitor the trend in the purchase prices of reels from paper mills and the cost of the collection activity. This activity helps managers to set the prices adequately, taking into consideration the paper current price.

Figure 19. Paper waste selling price

Paper waste selling price		
	Cardella paper mill	Polesine paper mill
Jun-20	0.070	0.040
Jul-20	0.070	0.040
Aug-20	0.070	0.040
Sep-20	0.070	0.040
Oct-20	0.070	0.045
Nov-20	0.080	0.045
Dec-20	0.090	0.055
Jan-21	0.110	0.070
Feb-21	0.125	0.080
Mar-21	0.145	0.100
Apr-21	0.195	0.140
May-21	0.195	0.140
Jun-21	0.200	0.140

Source: Own elaboration.

The Figure 19 shows the trend over one year of the unit selling price of the wastepaper, the price at which SIFA S.p.A. sells the waste paper. The difference in prices between the two paper factories is given by the different typologies of the wastepaper sold. It is possible to notice how the prices has constantly increased as consequence of the overall raw materials trend, previously analysed.

These two paper mills are even the most important suppliers from which the company buys reels of recycled paper.

During the interview, the controller underlines the benefits of this circular activity. According to the interview the benefits are in terms of:

- Relationship with the paper mills. Due to this activity, paper factories become at the same time supplier and client. Supplier because it provides the reels of paper that the company needs for the production process. Client because it buys the paper that the company collects. This two-ways relationship intensifies the relationship between them. This activity is encouraged by the fact that paper mills prefer companies' waste respect to the ones collected by public-owned companies because of the higher quality of the paper (the garbage collected through the bins is not very well controlled).

- Logistic. The collection of paper gives to the company the possibility to avoid zero-cargo trips. It is possible thanks to the fact that trucks deliver products to the clients collecting up paper wastes of them.
- Social responsibility and brand imagine. This activity increases the social responsibility of the company that is at the strictly related to an important process such as recycling, considering the environmental impact of the paper production. So, due to the increasing sensibility to the environment, this activity improves the brand imagine. Some clients are more inclined to choose as partners companies that keep an eye on the surrounding environment.

The second circular activity carried out by the company is the clarification of wastewater from printing unit washing. Regarding this particular activity, the controller highlighted the benefits of lower cost due to ink disposal.

Thanks to the use of this machine, it is possible to reduce the cost of waste disposal, as shown in figure 20.

Without this clarification process, in 2019, the disposal company would be called monthly as the amount of material to be disposed of was greater.

Figure 20. Cost of waste disposal before and after the purchase of purification machinery.

Without purification		With purification	
Data	Cost of waste disposal	Data	Cost of waste disposal
Jan-19	€ 3,766.29	Jan-21	€ -
Feb-19	€ 3,766.29	Feb-21	€ 5,470.99
Mar-19	€ 3,766.29	Mar-21	€ -
Apr-19	€ 3,766.29	Apr-21	€ 5,470.99
Totale	€ 15,065.16	Totale	€ 10,941.98

Source: Own elaboration.

With the purchase of the purifier, disposal now occurs once every two months. As you can see, the cost of disposal is higher. This happens because the material being completely muddy is more difficult to dispose of and therefore more expensive.

Figure 21. Difference in cost of waste disposal

Cost of waste disposal 2021	€ 10,941.98
Cost of waste disposal 2019	€ 15,065.16
Difference in cost of waste disposal	-€ 4,123.18

Source: Own elaboration.

However, when compared the costs for the same amount of time present a substantial difference. Considering the first four months of the two years taken into consideration, in fact, it is possible to note a decrease in disposal costs of € 4,123.18. In fact, this differential makes it possible to cover further costs relating to the

investment, including depreciation of the machinery, and therefore to bring an advantage also in economic terms to the company.

Conclusions

The main objective of this thesis was to analyse and explore how the transition towards circular business models may influence managerial accounting practices. In order to achieve this aim, a theoretical and an empirical analysis, through a case study, have been carried out.

From a theoretical point of view, the analysis has led to the identification and the examination of some potential cost accounting methods that allow to take into consideration the costs related to environmental impact, also in relation to the extension of the product life cycle. In particular, the literature analysis has shown a number of managerial accounting practices that are classified under the name of Environmental Cost Accounting.

The Life Cycle Assessment (LCA) is a method of calculating the environmental impact of a given product based on its life cycle taking into account all relevant economic factors both in terms of initial costs and future operational costs. Due to Life Cycle Costing method, it is possible to correctly determine environmental impacts costs used by management to plan, evaluate and control the environmental aspects of an organization.

Moreover, the literature has also proposed the Material Flow Cost Accounting (MFCA), whose aim is to help improving firms' both environmental and financial performance by identifying the combination of value flows, material flows, and

energy usage. This approach is more related to the flow of raw materials in order to make them as efficient as possible.

In this context, some indicators have been developed in order to evaluate the degree of circularity of a business model. These indicators are Circular Economy Index, that measures the circularity of a specific product, Recyclability Benefit Rate, that measures the potential environmental impact values of resources involved in the production, Circular Economy Performance Indicator, that compares the environmental benefits reached with the ideal ones, and Circularity Calculator, that evaluates the circularity of a certain product.

Besides these cost accounting methodologies and indicators, the thesis also highlights a possible framework in terms of cost-benefit analysis deriving from demanufacturing/remanufacturing activities. Since the investments in these cases are very expensive, the framework provided aims to evaluate the best investment alternative providing a decision-making model containing the necessary requirements for investment analysis. The best alternative is defined through a cost benefit analysis.

Concerning the empirical analysis, the thesis has explored the case of SIFA S.p.A, an Italian company that works in the field of packaging and that has started a transition from a linear to a circular business model. The case analysis has shown that the case company has undertaken a number of new activities to accomplish this transition and, as a consequence, some managerial accounting practices have been

changed or reshaped in order to follow these new activities and provide the management with relevant information.

First, the possibility of recycling paper led the company to undertake an activity of internal and external collection of waste and the subsequent sale of this recyclable waste to paper mills used for this activity. The internal collection is carried out through a system for conveying production waste through pipes to the macerator located outside the plant. While the external one is carried out collecting wastepaper from clients.

From a management accounting point of view, this activity has led the management accountant to look more closely at the costs related to the raw material. For this reason, the aim of the management accountant is to help the other offices to set the purchase prices of reels from paper mills and the cost of the collection activity adequately. In order to this, he has to constantly monitor the trend of the paper price.

Another activity undertaken by the company regards cleaning the water used to wash the printing inks. This activity is carried out by a machinery that separates the liquid component from the muddy one of water used to wash the printing inks.

The role of the management accountant was key in determining all the costs related to this activity. In particular, the management accountant performed a differential analysis in terms of disposal costs and the analysis was based on two

different alternatives: buying a machinery able to do this particular activity or maintaining the current situation.

Despite the transition to a circular business model is in its infancy, the case company has already put in place some actions to carry out this transition and has already reshaped some managerial accounting practices to follow this transition.

In conclusion, it is worth underlining that the potential impacts that the transition to circular business models may have on managerial accounting practices is still an area open to research that requires, and deserves, additional attention. Thus, more qualitative and quantitative studies are needed in the future in order to further analyze how such a transition may impact the management accounting activities and the techniques, the relationship between the management accounting function and the other functions, and the role and the identity of the management accountant.

References

Accenture United Nations Global Compact (2013). The UN Global Compact-Accenture CEO Study on Sustainability 2013, Architects of a Better World. Accenture.

Andrews E. S. (2009). Guidelines for Social Life Cycle Assessment of Products. United Nations Environmental Programme.

Anthony R., Govindarajan V. (2007). Management Control Systems, Chicago, Mc-Graw-Hill IRWIN

Boulding K. E. (1966). The Economics of the Coming Spaceship Earth.

Bressanelli G., Adrodegari F., Perona M, Saccani N. (2018). The role of digital technologies to overcome Circular Economy challenges in PSS Business Models: An exploratory case study. Procedia CIRP, Volume 73, 216-221.

Burritt R. L., Hahn T., Schaltegger S. (2008). Towards a Comprehensive Framework for Environmental Management Accounting — Links Between Business Actors and Environmental Management Accounting Tools. Australian Accounting Review Volume 12, Issue 27 p. 39-50.

British Standards Institution (BSI) (2017). BS 8001/2017- Framework for implementing the principles of the circular economy in organisations.

Cinquini L. (2013). Strumenti per l'analisi dei costi, Vol.1. Fondamenti di Cost Accounting. Giappichelli Editore.

Clift M., Druckman A. (2015). Taking Stock of Industrial Ecology. Springer Open.

Colledania M., Copani G., Tolio T., (2014). De-Manufacturing Systems. Procedia CIRP, Volume 17, 14-19.

De Pascale A., Arbolino R., Szopik-Depczynska K., Limosani M., Ioppolo G., (2021). A systematic review for measuring circular economy: The 61 indicators. Journal of Cleaner Production, Volume 281.

European Commission (2008). Directive 2008/98/EC of the European Parliament and of the Council. Official Journal of the European Union.

European Commission, Eurostat. (2017). Waste statistics - Waste generation, 2016.

Flanagan R., Norman G., (1983). Life Cycle Costing for Construction. Quantity Surveyors Division of the Royal Institution of Chartered Surveyors, London.

Fleischman R. K., Tyson T. N. (1993). Cost Accounting during the Industrial Revolution: The Present State of Historical Knowledge. Economic History Review, vol. 46, issue 3, 503-517.

Fraccascia L., Yazan D. M., (2018). The role of online information-sharing platforms on the performance of industrial symbiosis networks. Resources, Conservation and Recycling. Volume 136, 473-485.

Garrison R., Noreen E., Brewer P. C. (2016). Managerial accounting. Mc-Graw-Hill IRWIN.

Geissdoerfer M., Morioka S. N., Carvalho M. M., Evans S. (2018) Business models and supply chains for the circular economy. Journal of Cleaner Production, Volume 190, 712-721.

George D. A. R., Lin B. C., and Chen Y. (2015). A circular economy model of economic growth. Environmental Modelling & Software. Volume 73, 60-63.

Glucha P., Baumann H., (2004). The life cycle costing (LCC) approach: a conceptual discussion of its usefulness for environmental decision-making. Building and Environment. Volume 39 issue 5, 571-580.

Grafton J., Lillis A.M., Widener S.K. (2010). The role of performance measurement and evaluation in building organizational capabilities and performance. Accounting, Organizations and Society. Volume 35, Issue 7, 689-706.

Ilgin M., Gupta S. (2019). Remanufacturing modelling and analysis. CRC Press.

Institute of Management Accountants (2008). Definition of Management Accounting.

International Organization for Standardization (ISO), (2011). International Standard 14051.

Hartley K., Santen R., Kirchherr J., (2020). Policies for transitioning towards a circular economy: Expectations from the European Union (EU). Resources, Conservation and Recycling. Volume 155, 104634.

Jasch C., (2006). How to perform an environmental management cost assessment in one day. Journal of Cleaner Production. Volume 14 issue 14, 1194-1213.

Kafuku J. M., Saman M. Z. M., Yusof S. M., Sharif S., Zakuan N., (2015). Investment Decision Issues from Remanufacturing System Perspective: Literature Review and Further Research. Procedia CIRP, Volume 26, 589-594.

Kirchherr J., Reike D., Hekkert M. (2017). Conceptualizing the Circular Economy: An Analysis of 114 Definitions. Resources, Conservation and Recycling, Volume 127, 221-232.

Kokubu K., Kitada H. (2015). Material flow cost accounting and existing management perspectives. Journal of Cleaner Production, Volume 108 part B, 1279-1288.

Lacy P., Rutqvist J., Lamonica B. (2016). Circular Economy: dallo spreco al valore. Egea.

Lindström J., Hermanson A., Hellisb M., Kyöstia P. (2017). Optimizing Recycling Management Using Industrial Internet Supporting Circular Economy: A Case Study of an Emerging IPS2. Procedia CIRP., Volume 64, 55-60.

Lunenburg F.C. (2010). The decision-making process. National forum of educational administration and supervision journal, Volume 27, Number 4.

Marasca S., Marchi L., Riccaboni A. (2013). Controllo di gestione. Metodologie e strumenti.

Meutia, T. I., & Bukhori, A. (2017). The role of feedback and feed forward control system to improve competitive advantage of SMEs in Indonesia. European Research Studies Journal, 20(2A), 496-506.

National Footprint (2021). GDP, World Development Indicators, The World Bank 2020; Population, U.N. Food and Agriculture Organization. National Footprint and Biocapacity Accounts 2021 edition (Data Year 2017).

OECD (2018). Business Models for the Circular Economy, Opportunities and Challenges from a Policy Perspective. RE-CIRCLE.

Pauliuk S. (2018). Critical appraisal of the circular economy standard BS 8001:2017 and a dashboard of quantitative system indicators for its implementation inorganizations. Resources, Conservation and Recycling. Volume 129, 81-92.

Ragossnig A. M., Schneider D. R. (2019). Circular economy, recycling and end-of-waste. Waste Management and Research. Volume 37 issue 2, 109-111.

Rebitzer G., Evkall T., Frischknecht R., Hunkeler D., Norris G., Rydberg T., Schmidt W. P., Suh S., Weidema B. P., Pennington D.W. (2004). Life cycle

assessment. Part 1: Framework, goal and scope definition, inventory analysis, and applications. Environment International. Volume 30 issue 5, 701-720.

Romero D., Molina A., (2014). Forward - Green Virtual Enterprises and Their Breeding Environments: Sustainable Manufacturing, Logistics and Consumption. Collaborative Systems for Smart Networked Environments. Volume 434.

Schaltegger, S., Burritt R.L., (2001). Contemporary Environmental Accounting - Issues, Concepts and Practice. International Journal of Sustainability in Higher Education. Volume 2 issue 3, 288-289.

Schmidt M., (2015). The interpretation and extension of Material Flow Cost Accounting (MFCA) in the context of environmental material flow analysis. Journal of Cleaner Production, Volume 108 part B, 1310-1319.

Sundin E., (2004). Product and process Design for Successful Remanufacturing in production systems. Dissertation no. 906, Department of Mechanical Engineering. Linköping University, Linköping.

Taušová M., Mihalikova E., Čulková K., Stehlíková B., Tauš P., Kudelas D., Štrba L., (2019). Recycling of communal waste: Current state and future potential for sustainable development in the EU. MDPI Journal Sustainability. Volume 11 issue 10.

Telenko C., Seepersad C. C., Webber M. E., (2008). A Compilation of Design for Environment Principles and Guidelines. Journal of Mechanical Design. Volume 5, 289-301.

Van der Veen M., (2000). Environmental management accounting.

Yang M., P. Smart, M. Kumar, M. Jolly, S. Evans (2018). Product-service systems business models for circular supply chains. Production Planning and Control, 29:6, 498-508.

Williams J., Haka S., Bettner M. S., Carcello J. V., (2012). Financial & Managerial Accounting. Mc-Graw-Hill IRWIN.