Cost-Benefit Analysis of Implementing Circular Economy in a Portuguese Company: From a Case Study to a Model

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ABSTRACT

Purpose: This work was carried out in a company of the upholstery sector in northern Portugal to demonstrate that Investment in Preventive Measures, within the scope of Environmental Management and supported by a Circular Economy approach, is a significant investment decision, with transversal benefits to the entire organization.

Methodology/Approach: This study focuses on an interview, a financial cost-benefit analysis and a sensitivity analysis. The company is in line with concerns about the Circular Economy.

Findings: The findings support that the cost-benefit analysis is a valuable tool for decision-making and for identifying the potential benefits that can arise from implementing measures from the Circular Economy perspective. An action plan was structured with several recommendations in a logic of action priorities. A case study was carried out in the company and a model was designed.

Research Limitation/Implication: The studied company is still at an embryonic stage. Nevertheless, it was possible to identify all environmental aspects, namely, impacts, consumption. The study in question was carried out only in one company. It can be extended to many more companies.

Originality/Value of paper: The measures to be implemented, in addition to bringing economic and financial benefits to the Company, will contribute to a better and greater environmental sustainability and a better intervention at a social level.

Category: Case study

Keywords: circular economy; environmental management; cost-benefit analysis; sensitivity analysis

1 INTRODUCTION

Circular Economy (CE) can be defined as a regenerative industrial system. It replaces the "end of life" concept of products by regenerating them, in part or in whole. For this purpose, the use of renewable energy is recommended, as well as the elimination of the use of toxic chemical products, which impair the reuse of referred products. This concept aims to eliminate waste through superior design of materials, products and systems, appealing to the use of sustainable materials. It calls for new business models towards sustainability. Hence, the CE economic model aims to conciliate economic and environmental goals and performance. The transition from the traditional economic model "take-make-consume-disposal" to the CE model needs an urgent societal response to tackle environmental problems and promote sustainable (D'Amato, 2021).

Masi, Day and Godsell (2017) performed a systematic review of supply chain configurations regarding CE. Merli, Preziosi and Acampora (2018) identified the following main areas for CE research: social and economic dynamics, firm circular process implementation and related consumption, product design and industrial symbiosis. De Jesus et al. (2018) addressed the role of eco-innovations and their contribution to CE transition. Camacho-Otero, Boks and Pettersen (2018) reviewed consumption related CE research. Sassanelli et al. (2019) focused on the methods for assessing CE. Camón and Celma (2020) under carried a CE review and bibliometric analysis. performed a systematic literature review covering different catalysts, obstacles and ambivalent factors influencing CE implementation in business. Concerning the CE benefits, these authors identified the expected economic and other benefits, the threat for business-as-usual, and the managerial support and existing management systems. To sum up, the transition to CE is a priority theme within the European Union. There is public support for its adoption, and academic research supports the view that it contributes to sustainable development and enduring business performance. Nevertheless, companies consider the economic attractiveness and improvement of profitability and value creation majorly important when addressing CE adoption. Therefore, companies need a support methodology to assess CE cost versus benefit.

This research contributes to CE adoption by performing a cost-benefit analysis of CE implementation in a typical Portuguese Small and Medium Company. The cost-benefit analysis (CBA) compares project implementation's real costs and benefits and updates them to the current moment to make the most beneficial decision (Fonseca et al., 2018; Marques, Guedes and Ferreira, 2017; Ramos, Afonso and Costa, 2020; Ramos, Arezes, P.M. and Afonso, 2017). Thus, CBA is a relevant tool for evaluating, selecting, and analysing CE projects encompassing the financial, economic, social, and environmental dimensions, with the purpose of good management (Bravi et al., 2020; Fonseca, Amaral and Oliveira, 2021; Santos, Rebelo and Santos, 2017; Santos et al., 2021; Rebelo, Santos and Silva, 2015; Carvalho, Santos and Gonçalves, 2020), protecting the environment

(Santos et al., 2014; Teixeira et al., 2021b; Talapatra et al., 2019) and creating value for customers (Santos et al., 2019a; 2019b; Rodrigues et al., 2019).

2 MATERIALS AND METHODS

2.1 Case Study – Interview

In the present study, the interview technique to collect information was used, particularly the semi-structured interview. Regarding the conduct of the interview, an individual and open semi-structured interview was used, based on a previously elaborated script. The interviewee was the managing partner of the organization. The main questions are presented in Table 1.

Table 1 – Interview Script – Main Questions

Main Topics	**Questions**
1. Interviewee Data	Gender: male female; age, Years of experience in the sector;
2. Company Practices in Environmental Issues	• Do you have any specific environmental concerns in your company? What kind of actions do you take to preserve the environment? • What is your waste? What is the destination for your waste? • Is any of the waste likely to re-enter the production of any of your products? • Are you currently using any of the waste that comes from your activity to re-enter the production process? • Does your company recycle any waste?
3.Company Strategy for a CE	• What steps can your company take to achieve a CE and thus reduce or even eliminate waste? • Do you consider the transition to a CE beneficial from an economic and social point of view? Why?

The objective of the interview was to collect qualitative information from the entrepreneur about the Company and the respective sector, with particular emphasis on assessing what potential actions can be implemented to achieve the strategy for the implementation of CE.

2.2 Model Cost-Benefit Analysis

This study was based on and adapted from the model developed by the authors Ramos, Arezes and Afonso (2017) concerning the calculation of the financial cost-benefit ratio in the context of Environmental Management. These authors (Ramos, Arezes and Afonso, 2017) developed a CBA in Occupational Safety and Health (ACBSSO) model, that includes not only financial aspects related to the Company's perspective but also economic aspects (from the perspective of all stakeholders, with particular emphasis on workers and in society).

The B/C ratio is equal to the present value of the project's benefits, divided by the current value of its costs. If the calculated B/C ratio is greater than one, the

project is considered efficient. This equates to the requirement that a Net Present Value (NPV) be positive. A B/C ratio of 1.2, for example, means that the benefits of estimating a project are 20% greater than the costs (Ramos, Arezes and Afonso, 2017). Figure 1 shows the financial B/C ratio in the context of Environmental Management. In this model, the B/C ratio compares avoided costs, measured in terms of reduction of environmental aspects and impacts, and the cost of preventive measures designed and implemented according to the risk analysis.

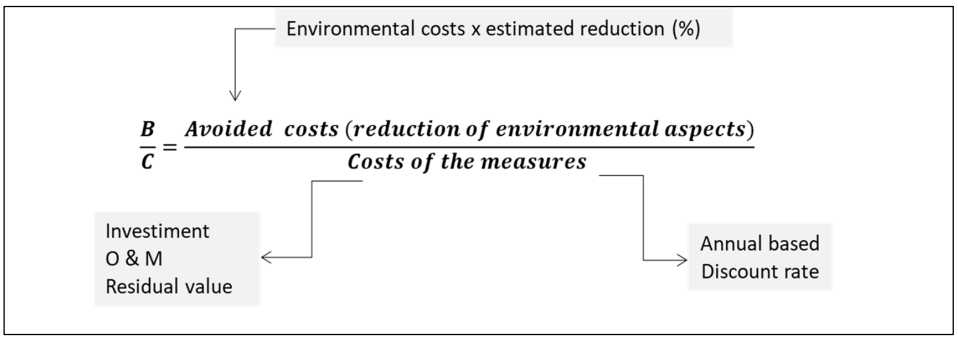

Figure 1 – Schematic representation of the financial Cost-Benefit ratio in the context of Environmental Management, adapted from (Ramos et al., 2017)

CBA is an effective and flexible model for project evaluation based on quantifying inputs and outputs in monetary units. For example, if the result of the ratio is B/C ≥ 1, it means that the benefits are greater than the costs. Therefore, the project should be considered for investment; if B/C < 1, the costs are greater than the benefits. However, the project can be considered if there are unquantified benefits (such as the Company's reputation, employee satisfaction and motivation, among others) and/or positive externalities, such as benefits to society, which arise from quality of products (Costa et al., 2019; Araújo et al., 2019; Sá et al., 2020), new production development methods (Zgodavova et al., 2020; Zgodavova and Slimak, 2008) as well CE (Ramos, Arezes and Afonso, 2017). According to Guide to CBA of Investment Projects 2014-2020 (European Commission, 2014) the standard CBA is structured in seven steps:

1. Description of the context
2. Definition of objectives
3. Identification of the project
4. Technical feasibility & Environmental sustainability (e.g., technical design, cost estimates and implementation schedule)
5. Financial analysis
6. Economic analysis
7. Risk assessment (e.g., sensitivity analysis)

2.3 Sensitivity Analysis of the B/C Ratio

The B/C ratio proposed allows quantifying the benefits of preventive measures on environmental management and as such, environmental aspects for all the stakeholders. It can be an essential support tool to validate, understand and analyse the implementation of preventive measures. The analysis of the B/C ratio will permit to show which preventive measures defined in the risk assessment process are cost-effective and should be implemented. Nevertheless, the quality and availability of environmental aspects data is still a significant limitation to link environmental aspects and business performance (Ramos, Arezes and Afonso, 2017). The B/C ratio is a valuable tool for decision-making related to environmental management. However, it must be emphasized that the manager must understand that the behaviour of the B/C ratio depends on the assumptions made and the contribution of several variables to the result obtained by Silva (2020). The object of the sensitivity analysis is the selection of the critical variables and parameters of the CBA model, that is, those whose variations, positive or negative concerning the value used as the best estimate in the reference case, have a more pronounced effect on the financial parameters and determining economics. Thus, parameters whose variation of, for example, 1% translates into a variation of 5% of the base value of the NPV should be considered.

Assessing a project is not without risks or uncertainties as it is a forecasting exercise. In a sensitivity analysis, the model's impact parameters are determined and subjected to elasticity tests, analysing the reflection in the VAL values. Although the values of this indicator are defined based on forecasts, it may happen that they don't match to the values detected throughout the project. It is essential to carry out tests on the response of forecasts, to possible changes in various parameters (Teixeira et al., 2021a; Carvalho, 2015).

2.4 Company Presentation

The study Company is a Portuguese family micro-enterprise in the upholstery sector, founded in 1984, headquartered in the north of Portugal, and has 9 employees. Its market segment is medium-high quality, operating in 3 different market niches: Upholstery for Decoration, Orthopaedic Chairs for Geriatrics/Health and Articulated Chairs for Private Movie Theatres. Its distribution network in the decoration segment is divided into resale and direct sales to the public; in the remaining segments, distribution is made only through the retail channel.

The Company uses solid wood structure as raw materials, all types of coatings (cotton, PU synthetics, PVC, fabrics with various compositions, natural skins, etc.), foams, threads, fasteners, Velcros, folders, conforel, screws, nuts, metallic mechanisms, motors, among others. As an accessory material, it uses chemical products such as glues, thinners, paints, among others. The Company is not ISO 14001:2015 certified.

3 RESULTS AND DISCUSSION

At this point, the results, and the respective discussion of the interview with the Company's managing partner, financial CBA and sensitivity analysis are presented.

3.1 Interview

The CEO said that its Company has always been concerned with environmental issues about the Company's actions to preserve the environment. They forward all waste to licensed operators, and they internally separate common (urban) garbage. About any of the raw materials they use harmful to the environment, which one(s)? and what do they do to minimize its impact(s)? the CEO reported that both skins and synthetic materials in PVC and foams are harmful to the environment, as they are not biodegradable. The glues are also toxic and are harmful to the environment. However, the Company has a glue cabin with a filter that retains most toxic particles and is not polluting. One possibility would be the replacement with water glues. However, there are still not many options on the market, and the one that exists turns out to be more expensive. When asked if the Company recycles any waste, the CEO said that it is not in its Company. About if there is any concern on the part of the Company in the acquisition of cleaner technology, the CEO related that whenever they purchase new equipment, they are concerned about its energy consumption. The CEO reported that all their products use raw materials of high quality and durability. As a quality product, customers end up having the products for more years, and when they want to change it because they get tired of the model, they try to resell it or give it to family members because the product is still sufficient quality to be used.

In the second group of questions the four questions had the following answers:

1. If they think the transition to a CE is important for the future of companies and the planet, the CEO agrees. However, he thinks that at the level of the Portuguese business fabric, namely micro and small companies, there is still little information on what companies can do to achieve a CE that is economically and environmentally sustainable. Many measures are not economically viable for micro and small businesses. In their case, as an example, they have the replacement of the usual raw material for another that is not harmful to the environment since its cost is much higher, and the consumer is not yet sensitive to this price variation.
2. When asked about what steps their Company can take to achieve a CE and to reduce or even eliminate waste, the CEO related that they never thought about that situation very much. They will have to see what possible measures they can take to minimize the impacts of their activity on the environment and thus achieve a CE.

3. When asked if the transition to a CE is beneficial from an economic and social point of view, the CEO said that it might not be advantageous from an economic point of view and in their activity due to the costs it entails. In addition, the population is still not very open to buying more expensive products just because they are environmentally friendly. In general, the CE will bring economic and social benefits in the long run and producing environmentally friendly articles can bring significant positive impacts to the society. Nevertheless, currently, they work more in specific sectors of activity, such as clothing and food, among others. They will consider possible measures that could benefit their sector, the environment and society.
4. When asked if there are many barriers to implementing a CE, the CEO related that the barriers, in a way, are in line with what he mentioned earlier, raw materials that are less harmful to the environment still have a high cost that is not valued by the population. They believe that incentives should also come from governing bodies at the national and European level, promoting incentives for companies that adopt policies that promote a CE. They are not aware of government incentives to produce environmentally friendly items and even apply for eco-certification. They have been betting on producing high-quality items that will have a longer lifespan, that is, a longer shelf life, extending the period for deposition. In addition, they have a restoration section, and since the product is of good quality, they encourage customers to reuse it, replacing only the covering.

3.2 Analyse of Financial Cost-Benefit

CBA is an analytical tool for judging the economic ad-vantages or disadvantages of an investment decision by assessing its costs and benefits in order to assess the welfare change attributable to it. Environmental impacts can result in significant costs for companies. However, it is not always easy to demonstrate the advantages of investing in prevention. The best way to do this will be through financial assessments and analysis (Ramos, 2013).

This study aims to demonstrate that Investment in Preventive Measures within the scope of Environmental Management is an essential investment for the Company with benefits that are transversal to the entire organization. The most significant costs were selected and realized a financial CBA for Energy Consumption.

Table 2 – Financial Cost-Benefit Ratio of the Acquisition of Photovoltaic Panels

Years	Annual energy consumption (kWh)	Energy cost (EUR)	Benefit (EUR)	Depreciation cost (EUR)	Net benefit (EUR)
1	9,767.00	2,350.83	1,207.15	1,777.50	-570.35
2	10,255.35	2,468.37	1,267.51	1,777.50	-509.99
3	10,768.12	2,591.79	1,330.88	1,777.50	-446.62
4	11,306.52	2,721.38	1,397.43	1,777.50	-380.07
5	11,871.85	2,857.45	1,467.30	0.00	1,467.30
6	12,465.44	3,000.32	1,540.66	0.00	1,540.66
7	13,088.71	3,150.34	1,617.70	0.00	1,617.70
8	13,743.15	3,307.85	1,698.58	0.00	1,698.58
9	14,430.31	3,473.25	1,783.51	0.00	1,783.51
10	15,151.82	3,646.91	1,872.69	0.00	1,872.69

The year 2018 was considered as a reference for presented data related to actual costs and consumption used as a basis for calculation. Table 2 shows the calculations of the annual net financial cost and main benefits obtained by implementing this measure, that was calculated according to the methodology indicated above.

The analysis was carried out on an annual basis and a forecast for 10 years (data presented in columns 2 to 10). The first line presents the annual energy consumption in kWh, with year 1 being the reference year 2018, whose consumption value was 9,767.00 EUR, considering an annual consumption/production growth of 5% for calculation of consumption for subsequent years. Line 2 shows the energy cost using the same logic as consumption, with year 1 being the reference year 2018 and the others, what was calculated based on the same annual growth. Finally, line 3 calculates the benefit obtained by reducing the target of 65% to the energy cost, deducted from the tax 21%. For example, in year 1, the 2,350.83 EUR energy cost was multiplied by 65%, which was also multiplied by (1-21%) to deduct taxes. In the following years the calculation followed the same reasoning.

The acquisition of photovoltaic panels including a 6 kW UPAC central with 6.555 Wp installed, 23 modules of 285 W, 46 fiscol structures, a three-phase suntrio, an inverter, 250 6 MM cables, a circuit breaker, and the installation will have an initial cost of 9,000 EUR. Line 4 shows the cost of equipment depreciation. According to the regulatory decree 25/2009 of 14 September 2009, alternative energy equipment is depreciated at a rate of 25%, having a useful fiscal life of 4 years. Therefore, 25% of the value of the investment, about 9,767.00 EUR, was calculated, and the taxes were deducted (ex: year 1; 9,767.00

EUR x 0.25 x (1-0.21). Therefore. this amount was depreciated from years 1 to 4 only. In line 5 the annual net benefit was calculated by reducing the cost of depreciation (line 4), to the benefit obtained (line 3). As a result, the sum of the net benefit obtained in year 1 to year 10 is 8,073.42 EUR, equal to the value of cash flows without applying the update factor.

The calculation of NPV is presented below, considering the data obtained in the previous table. The calculation of NPV is shown in Table 3 about acquisition of photovoltaic panels.

As stated before, the initial investment is 9,000.00 EUR presented in year zero, the year of acquisition. In line 2, the benefit before tax is calculated (e.g. year 1; 1,528.04 EUR obtained by multiplying the energy cost. 2,350.83 EUR by 65%, which is the desired reduction with the acquisition of the panels). This calculation formula was applied for all years. In line 3, the calculation of the additional taxes is presented in which the benefit (e.g. year 1; 1,528.04 EUR) is deducted from the depreciation amount (9,000.00 EUR x 0.25) multiplied by the tax rate (21%). From the 5th year onwards given that there is no longer any value to depreciate. The tax is calculated directly on the benefit.

Table 3 – NPV of the Acquisition of Photovoltaic Panels

Years	Initial Investment (EUR)	Benefit (EUR)	Additional IRC (EUR)	Cash-flows (EUR)	Actualization factor	Updated CF (EUR)	VAL	Time Years
0	9,000.00			-9,000.00	1.00	9,000.00	5,189.63	6.00
1		1,528.04	-151.61	1,679.65	0.97	1,622.85		-7,377.15
2		1,604.44	-135.57	1,740.01	0.93	1,624.32		-5,752.83
3		1,684.66	-118.72	1,803.38	0.90	1,626.55		-4,126.28
4		1,768.90	-101.03	1,869.93	0.87	1,629.53		-2,496.75
5		1,857.34	390.04	1,467.30	0.84	1,235.43		-1,261.32
6		1,950.21	409.54	1,540.66	0.81	1,253.33		-7.99
7		2,047.72	430.02	1,617.70	0.79	1,271.50		1,263.51
8		2,150.11	451.52	1,698.58	0.76	1,289.91		2,553.43
9		2,257.61	474.10	1,783.51	0.73	1,308.62		3,862.05
10		2,370.49	497.80	1,872.69	0.71	1,327.58		5,189.63

In line 4, cash flows are obtained by reducing the additional tax to the benefit. Thus, the sum of these cash flows will be equal to the sum of the annual net benefit calculated previously. To be able to calculate the NPV according to the methodology specified above, it is necessary to update the value of cash flows annually during the 10 years. In line 5, the update factor was calculated considering the respective year. The discount rate considered was 3.5%. For

example, for year 1. 1/ (1+3.5%) ^ 1 was calculated, where 3.5% is the discount rate and ^1 is the year to which it relates.

In line 6, the updated cash flows are presented considering the updating factor calculated in line 5. By the sum of all cash flows considering year zero, we obtained an NPV of 5,189.63 EUR. In line 8, it was calculated the period when the NPV assumes a value of zero. as a measure of moving to the investment recovery situation. According to this calculation, after 6 years more precisely in the passage from the 6th to the 7th year the NPV changes from negative to positive. The implementation of this measure is evident since the sum of the net benefit from years 1 to 10 is positive, and the NPV is also positive.

Concerning this measure, in addition to the financial benefit, the Company will produce cleaner and more renewable energy and at the same time will contribute to reducing the ecological footprint.

It is important to mention a recent study in this area using the same methodology. The authors Bošnjakovic, Cikic and Zlatunic (2021) highlight in their research "Cost-Benefit Analysis of Small-Scale Rooftop PV Systems: The Case of Dragotin. Croatia" the total investment equipment costs vary significantly depending on the type of installation, the capacity of the PV (photovoltaic) system, and the country in which the system is installed. These prices in 2020 range from 555 EUR/kWh in India up to 2,125 EUR/kWh in Switzerland. The investment costs of large PV systems are significantly lower. In Europe. the cost ranges from 600 EUR/kWh in the Czech Republic to 1,040 EUR/kWh in Ireland.

To determine the payback period, it is necessary to determine the profile of the average daily load for the analysed facility and the profile of the average daily production of electricity for the selected PV system. For the analysed facility, with the existing electricity prices in Croatia, which are among the lowest in the EU and with the existing legislation related to net metering, the roof PV system can be paid for in 10.5 years without government incentives. In addition to reducing electricity bills, installing PV roofing systems provides benefits, such as energy autonomy, reduced carbon emissions, and the creation of new local jobs.

According to the analysis above, it should be stated that financial (NPV methodology) and economic (CBA methodology) analyses have similar characteristics. Both estimate the net benefits of a project investment based on the difference between the situation with and without the project. However, financial analysis is largely confined to organizations or their units. It involves a detailed approach that compares the expenses and revenues of an enterprise to determine its profitability and thus its sustainability. For example, the financial analysis based on the NPV methodology measures cash flows and considers an opportunity cost of capital. In turn, economic analysis takes a broader view and assesses the analysis of the project's impact on society (e.g. Bošnjakovic, Cikic and Zlatunic, 2021). To do this. it should consider the viewpoints of all stakeholders and how the results of a project align with economic and social policies. Typically, costs in an economy are a measure of the resources that society collectively invests in

the realization of the project. The benefits, however, need not only be limited and often intangible benefits. Hence, the economic analysis based on the benefit cost analysis goes beyond cash flows and analyses externalities as well.

3.3 Sensitivity Analysis of the B/C Ratio

This study focused on the financial CBA, having analysed the possible investment from the perspective of its profitability, and calculated the NPV.

According to Guide to CBA of Investment Projects 2014-2020 (European Comission, 2014) the Sensitivity Analysis enables the identification of the 'critical' variables of the project. Such variables are those whose variations, be they positive or negative, have the largest impact on the project's financial and/or economic performance. The analysis is carried out by varying one variable at a time and determining the effect of that change on the NPV. As a guiding criterion, the recommendation is to consider 'critical' those variables for which a variation of ±1 % of the value adopted in the base case gives rise to a variation of more than 1 % in the value of the NPV.

The result of the B/C ratio and the NPV depends on the assumptions made and the variables identified. Considering that a change in a variable could cause the result to vary, a sensitivity analysis was carried out to study the acquisition of photovoltaic panels. The manager should not limit himself to the calculation of the B/C ratio but should also carry out a sensitivity analysis, considering the impact of the variation of the variables involved in the indicator. A sensitivity analysis will allow it to compare different scenarios that can better guide the manager in decision-making. For higher production growth rates, scenarios can become more favourable for decision making. Table 4 presents the sensitivity analysis according to the variation of some variables.

Note that the increase of 1% of the production tax rate leads to increase of NPV much higher than 1%, which assures that the production tax rate is a critical variable (European Commission, 2014).

In the beginning stages, to calculate the NPV of the investment in photovoltaic panels, the production growth rate variable was considered. Production was assumed to grow 5% annually over the period under review. If we increase the growth rate, we verify from the data that the NPV also increases, concluding that the greater the production growth, the greater the return on investment.

Decision making is simple because the return is always guaranteed, the manager knowing that the higher the level of sales and production, the greater the return on investments will be. As measures to be implemented. the acquisition of 23 modules of 285 W photo-voltaic panels is recommended. with a view to reducing the annual energy cost by 65%, as well as promoting the use of renewable and clean energy.

The measures must be integrated into a sustainability strategy based on technological innovation models aimed at valorisation, reduction, reuse, and recycling.

Table 4 – Sensitivity Analysis Decimal Points

	Energy	Photovoltaic panels
Critical variables		Production tax rate
Initial Value		5%
NPV		5,189.63 €
Variation 1		6%
NPV 1		5,751.79 €
Variation 2		7%
NPV 2		6,343.59 €
Variation 3		8%
NPV 3		6,966.57 €
Variation 4		9%
NPV 4		7,622.31 €
Variation 5		-
NPV5		-

3.4 The model - from Linear Economy to Circular Economy

Bennett, Pearce and Turner (1991) explain that the economic paradigm must change from a traditional economic system to one characterized by the CE. It is based on three economic functions: supply of resources, life support and source of absorption of waste and emissions.

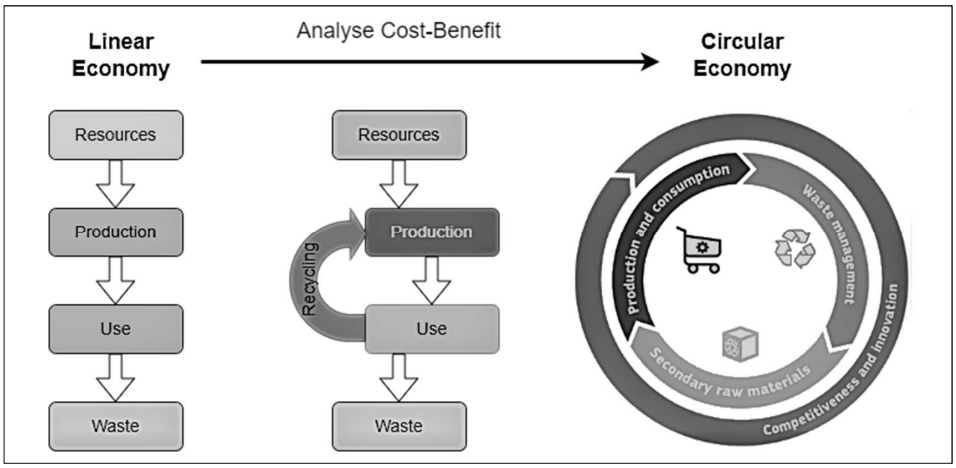

Figure 2 – Transition from Linear Economy to Circular Economy (Adapted from Bennett, Pearce and Turner, 1991; Portugal, 2019)

The CE is not only characterized by product recycling, but it is a new paradigm in which each material is reused as much as possible, reducing waste. It requires a new way of thinking, as well as how to live and consume sustainably. According to Figure 2, the model elaborated according to Eurostat (Portugal, 2019; European Commission, 2015; 2019a; 2019b; 2020). it is necessary to make a CBA and understand that the CE pays off from a financial point of view, and it is good for environment. Hence, it is necessary to adjust the productive system of companies. in the choice of raw materials, in the development of products, use of waste as by-products and recycling, among others.

4 CONCLUSIONS

The studied Company is still at an embryonic stage concerning CE. Nevertheless, it was possible to identify all environmental aspects and impacts and consumption and associated costs, perspectives, and strategies to be implemented. A survey of possible improvement measures to implement in this sector was carried. A relevant CBA was carried out in financial terms and in terms of costs and returns. It was verified the possibility of the Company reaching a more advanced state and approaching that of a CE. From the interview directed at the Company's CEO, from the documentary and empirical survey carried out, and from the application of the financial CBA method, it can be concluded that the implementation of a series of measures already identified will be advantageous.

It was also concluded that the Company should invest in the installation of photovoltaic panels to reduce the cost of energy produced and replace electricity with alternative energy. The Company intends to increase its production in the medium to long term. Hence, the electricity consumption also will increase, making it even more economically advantageous to be a producer of alternative energies. The conclusion supports that the CBA is a valuable tool for decision-making and for identifying the potential benefits that can arise from implementing measures from the CE perspective.

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CONFLICTS OF INTEREST

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