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A strategy to reconcile environmental and economic performances in the process of greening packaging

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ABSTRACT

Packaging is considered to be an essential component of our daily life since it embraces all phases of activities involved in the transfer of goods and services right from manufacturers to consumers. However, once considered as waste, it can become a hazard for both humans and the environment. Therefore, in this context of international climate crises, and with the necessity to comply with European directives, there is an increasingly strong push for packaging to become more sustainable in its production, use, and disposal, as these are linked to direct environmental impacts. Hence, more and more packaging companies and packaging waste management firms are realizing that there is scope for growth if they can carefully orchestrate themselves towards capturing the innovation opportunities in sustainability even though, it has always been challenging to comply with environmental standards while making profits at the same time.

For this study, the link between corporate environmental performance and corporate financial performance from 5 case studies was investigated. Both the qualitative and quantitative analysis method was chosen to gain a comprehensive and thorough understanding of environmental performances in the target companies while a variety of tools was used to measure corporate financial performance, corporate environmental performance, and the link between both performances.

The conclusions were that most of the environmental effects of packaging and packaging waste are related to production, waste management, and distribution. It has also been shown that none of the developed tools works towards an agreement on a conceptual framework to assess the environmental and economic performance of packaging processing and packaging waste management system. Besides, practices such as resource and energy saving, recycled packages, reducing packaging materials, and technology investments help package processing and package waste management firms to improve their environmental performances which can be directly correlated to their financial performances.

Keywords : environmental performance, economic performance, sustainable packaging

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ABBREVIATIONS

BOD- Biological oxygen demand

COD- chemical oxygen demand

VSS- volatile suspended solids

TSS- suspended solids

FOP- Front-of-package

SIGRE- Portuguese packaging waste management system

SPV- Sociedade Ponto Verde (Green Dot Society in english)

EP- Environmental performance

EMS- Environmental Management System

LCA- Life Cycle Analysis

EPI- Environmental Performance Indicators

ERPAM- Environmentally Responsible Product Assessment Matrix

SLCA- Simplified Life Cycle Assessment

MET- Materials, Energy, Toxicity

EIM- Ecological Index Matrix

ISO- International Organisation for Standardisation

LCI- Life Cycle Inventory

ARD- Abiotic Resource Depletion

GWP- Global Warming Potential

ODP- Ozone Depletion Potential

AP- Acidification Potential

POCP- Photochemical Oxidants Creation Potentia

Introduction

Packaging is ubiquitous in our daily lives as it helps to protect the product inside and its transportation from one place to another. However, once used, packaging becomes waste and it is perceived as an environmental problem. Therefore, sustainable packaging and sustainable packaging waste management are becoming a higher priority for both brands and consumers whose perceptions and behaviors around food and food decisions have not ceased to increase.

In the face of climate change, a good product is no longer enough to win consumer's favor who nowadays often look for products and brands that align with their values including social and environmental values. In response to this growing consumer awareness, European authorities through European policies including at the national and local level, have decided to encourage companies towards package processing and packaging waste management system that is more respectful of social and environmental values even though it has always been challenging to improve environmental performance whilst not deteriorating economic performance. This, leading to one of the most sophisticated sustainability studies nowadays, which is to demonstrate the need and the possibility to reconcile economic, social, and environmental objectives.

Indeed, it has been shown that the relationship between economy and ecology has always been conflictual. However, with the advent of the concept of sustainability many attempts have been made to reconcile environmental achievement and financial growth both in the packaging industry and in the packaging waste management systems. Hence, González Boubeta et al. (2018) **[1]** succeeded to obtain a win-win relationship between environmental performance and economic performance while analyzing the sustainability of the packaging strategy of an important Spanish agro-food company, García-Arca, Gonzalez-Portela-Garrido (2017) **[2]** developed a new concept of "Sustainable Packaging Logistics" that leads to conceiving packaging as a strategic element related to the organization's economic and environmental performances whereas according to Van den Elzen (2016) **[3],** using green packaging is a requirement for companies to have a positive brand image and reputation, cost savings, and better environmental footprints amongst other benefits. In the same perspective, Zailani et al. (2015) **[4]** mentioned that green or sustainable packaging can bring benefits to the firm's operational, as well as economic, social, and environmental advantages while, Maziriri (2018) **[5]** view that, green packaging can assist companies to achieve the three pillars of sustainability which are economic, social, and environmental.

Furthermore, studies on packaging waste management system from Carlsson Reich (2005) **[6]** revealed that landfilling was the least preferred option from an economic and environmental perspective while Schmidt et al. (2005) **[7]** proved that combined life cycle assessment (LCA) and life cycle costing (LCC) was a useful tool for environmental and economic analysis in the management of plastic and metal single-use beverage containers. Moreover, Goudenege et al. (2013) **[8]** conclude that the use of reusable packaging is not always cheaper because transport emissions corresponding to packaging return are too substantial to represent environmental benefits compared to the disposable packaging model whereas Levi et al. (2011) **[9],** and Singh et al. (2006) **[10],** demonstrated that adoptions of reusable plastic container systems can provide significant economic and environmental benefits for all stakeholders.

For this thesis, 5 case studies were chosen to investigate the link between environmental and economic performances of packaging industry, and packaging waste management systems. The Sustainable Value approach known as a value-based method for assessing corporate sustainability performance and content analysis method were respectively used to assess the environmental performances of the paper and packaging industry in France and in Finland (Stora-Enso) while LCA was implemented to assess the environmental performances of the fruit and vegetable packaging and distribution systems of an Italian catering supply chain, the Portuguese packaging waste management system (SIGRE), and the ARIADNA Project on packaging waste management systems in Spain. For the assessment of economic performances, dependent variables including the financial ratios return on sales (ROS) and return on equity (ROE) were used respectively for the first and second empirical analysis, LCC was implemented for both the third and the fifth case while Input-Output (IO) analysis was applied for the fourth case study. The link between the corporate environmental performances and the corporate financial performances was assessed using univariate regression analysis with panel data for the first case study and for the second case study, statistical methods including the Pearson's correlation coefficiency was applied. As for case study number three and four, a Multi-criteria analysis was applied to evaluate the link between corporate environmental performance and corporate financial performance whereas for the fifth case study the combination of LCA and LCC was used.

For the implementation of this work, the study first reviews the existing literature on packaging and its environmental impacts, and the sustainable initiatives undertaken by packaging processing firms and packaging waste management. The second module of this work examines the link between environmental performance and financial performance through three research modules including the assessment of environmental performances, assessment of financial performances, and the analysis of the different attempts to detect a systematic

relationship between the environmental and economic performance of firms using mathematical models (regression analysis, statistical analysis, multi-criteria analysis, and combination of LCA and LCC). The third research module consists of 5 empirical analysis, to emphasize their environmental performances and economic performances, to review the mechanisms that explain the relationship between the environmental performance and the economic performance, and finally to propose a strategy to reconcile environmental performances and economic performances.

1 Global trend

The general growth in the global demand for packaging is expected to grow constantly between 2017 and 2022, as shown in figure 1 **[11].** However, packaging whose main role is to prevent the loss of goods, once used, becomes waste that can have a significant impact on the environment.

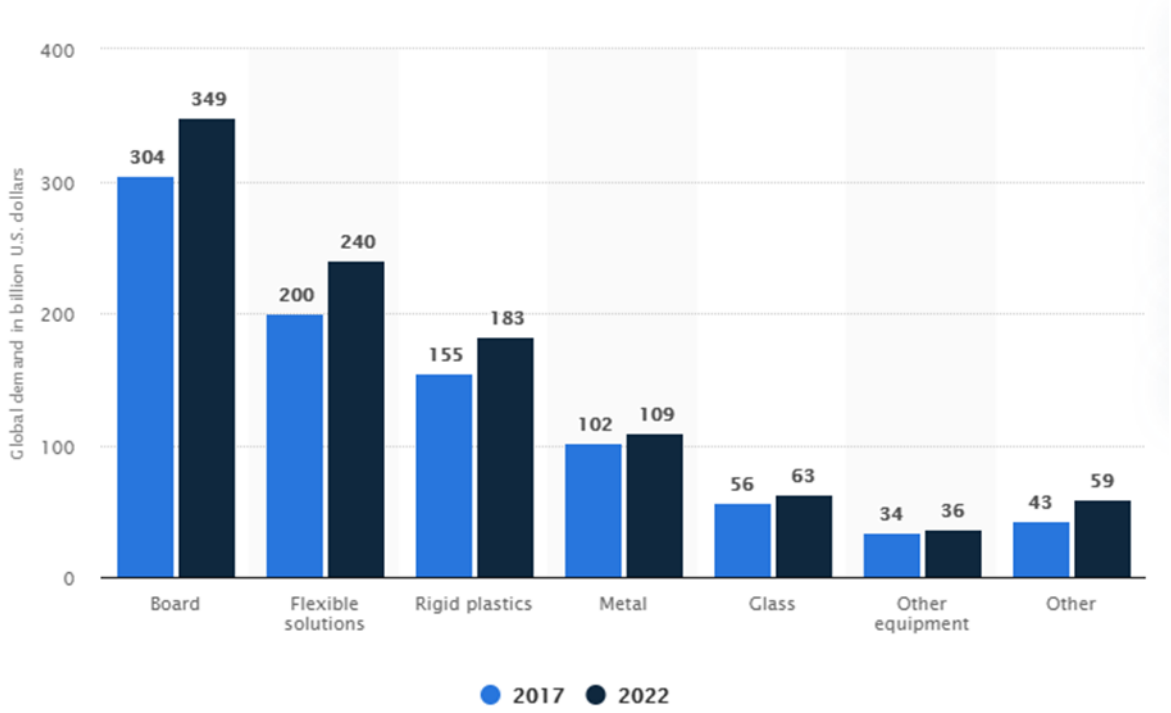

Figure 1 Value of global demand for packaging solutions in 2017 with a forecast for 2022, by material (in billion U.S. dollars)

Indeed, the majority of the global solid waste is packaging products **[12].** Packaging waste generated per inhabitant within the European Union (EU) has not ceased to increase with an increment of around 3.7% between the years 2008 and 2018 **[13].** To achieve environmental suitability, the EU Packaging and Packaging Waste Directive adopted in 1994, with the main objectives to prevent and reduce the impact of packaging and packaging waste on the environment and to ensure the proper functioning of the internal market **[14],** had to lead the 27 members of the EU towards a better environmental management system for packaging and packaging waste. Hence, in 2013, 65% of packaging was recycled in the EU-27, with 85% for paper and cardboard packaging ; 74% for metallic packaging ; 73% for glass packaging ; 36% for wooden packaging, and 37% for plastic packaging.

Furthermore, the Packaging Directive sets new targets to be met by 2025 and 2030 for the share of packaging waste prepared for reuse and recycling (65% and 75%, respectively), with

specific targets for various packaging materials (plastic, wood, ferrous metal, aluminum, glass, paper, and cardboard) **[15].**

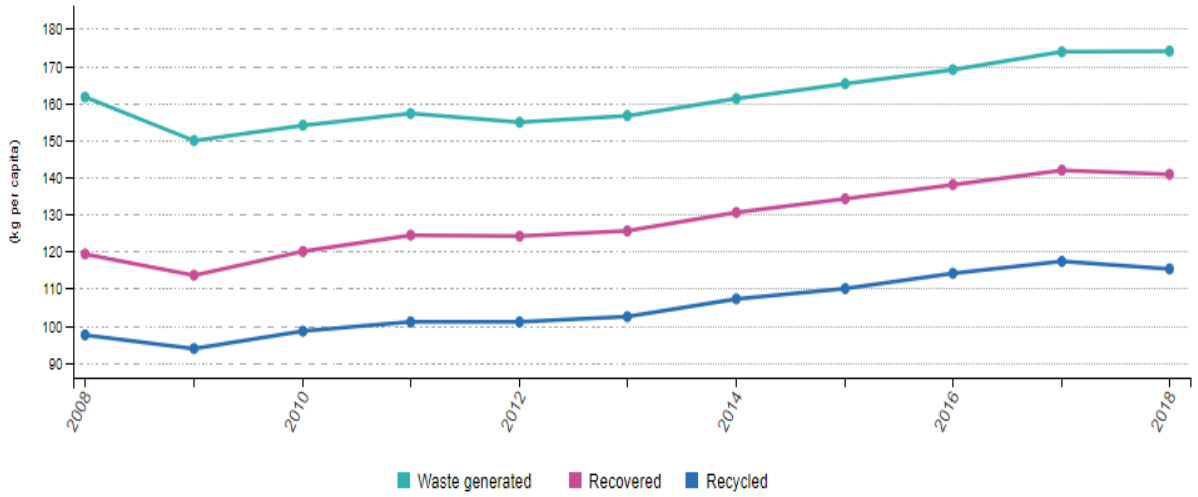

Figure 2 packaging waste generated, recovered, and recycled, E-28, 2008-2018 Source : Eurostat (online data code : env_waspac)

1.1 Introduction to packaging

Packaging can be defined as the science, art, and technology of enclosing or protecting products for distribution, storage, sale, and use. Hence, the packaging does not only perform protection and containing tasks but is also refers to as a marketing product **[16].** The packaging industry is composed of two major components, including, the providers of packaging products and the end-users (Figure 3) **[17].** Each of them is characterized by varying investment status and potentials, contingent upon growth stimuli in each sector. Packaging is also present in various sectors of activity as illustrated in figure 4 **[17].**

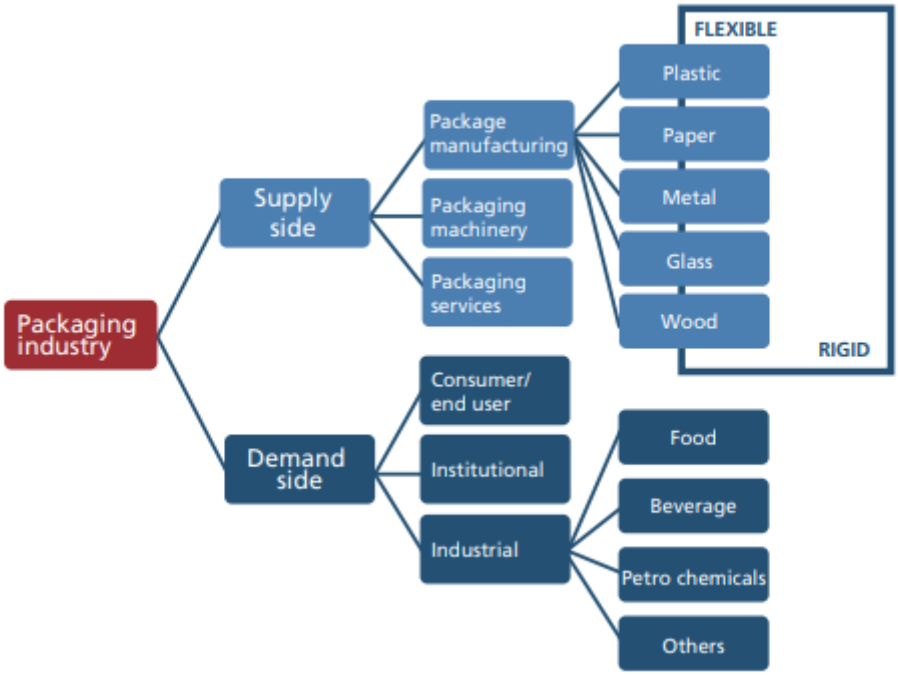

Figure 3 The packaging industry

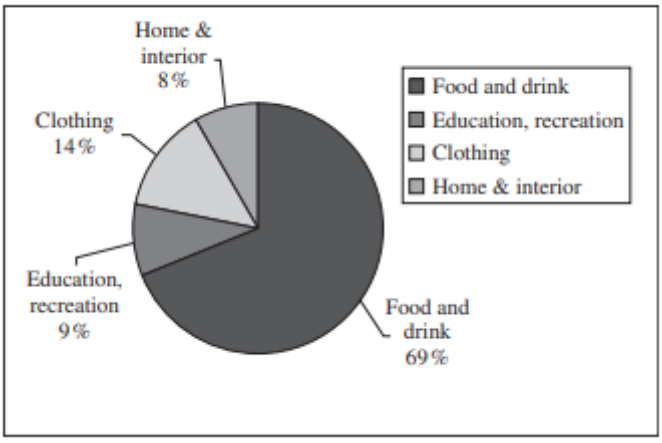

Figure 4 Packaging use by type of goods

1.1.1 Types of Packaging

Commonly, the packaging is divided into three general categories including, primary packaging representing the layer of packaging in immediate contact with the product; secondary packaging presenting the core product, and tertiary packaging, or shipping packaging that helps to store and transport the product (figure 5) **[18].**

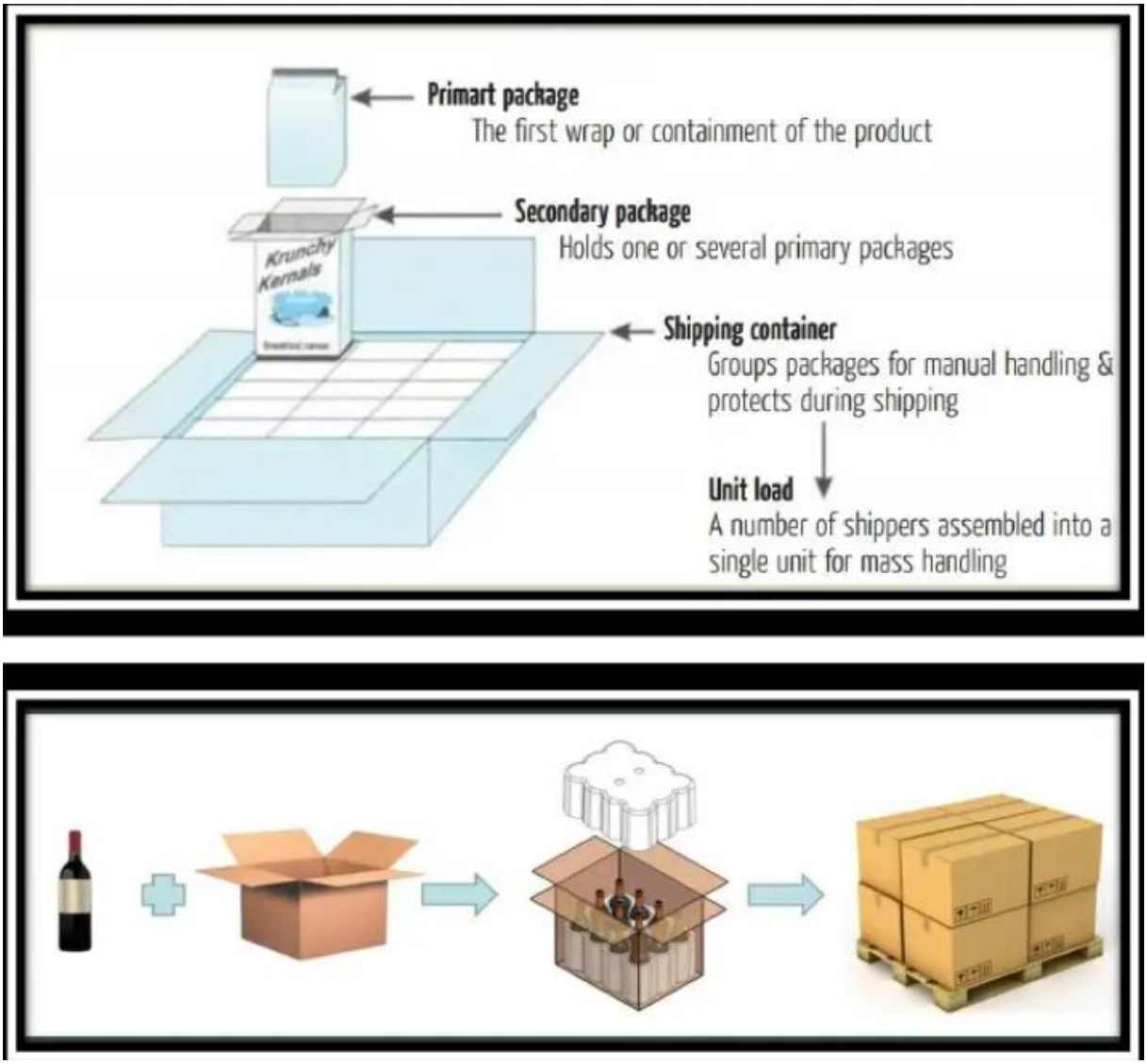

Figure 5 Types of Packaging.

1.1.2 Materials used in Packaging

There are a large variety of materials and containers that are used for packaging including glass, aluminum, steel, paper, cardboard, plastic, wood, and another miscellaneous packaging **[19].** Figure 6, illustrated the share of packaging per material **[20].**

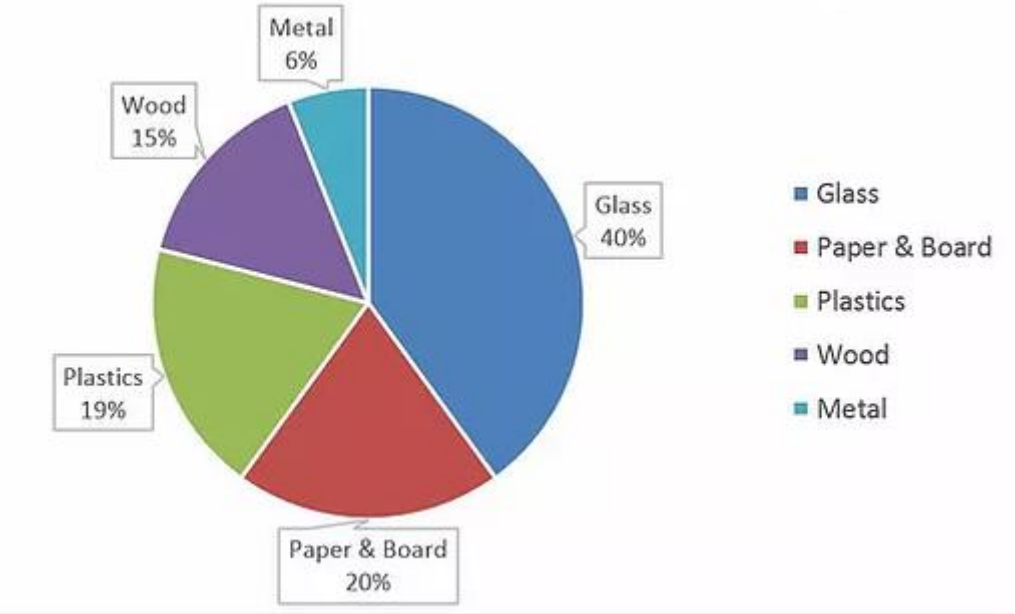

Figure 6 Share of packaging per material (by weight)

1.1.3 Packaging Systems

A packaging system is a set of operations that fulfill the function of creating sales units of the product as illustrated in figure 7. It includes the product's processing and the packaging operation which is considered to be a crucial part of the packaging system because it is through this system that the raw material acquisition reaches over the product's system **[21].** Thus, identifying the boundaries of the packaging system is especially important when considering life-cycle studies.

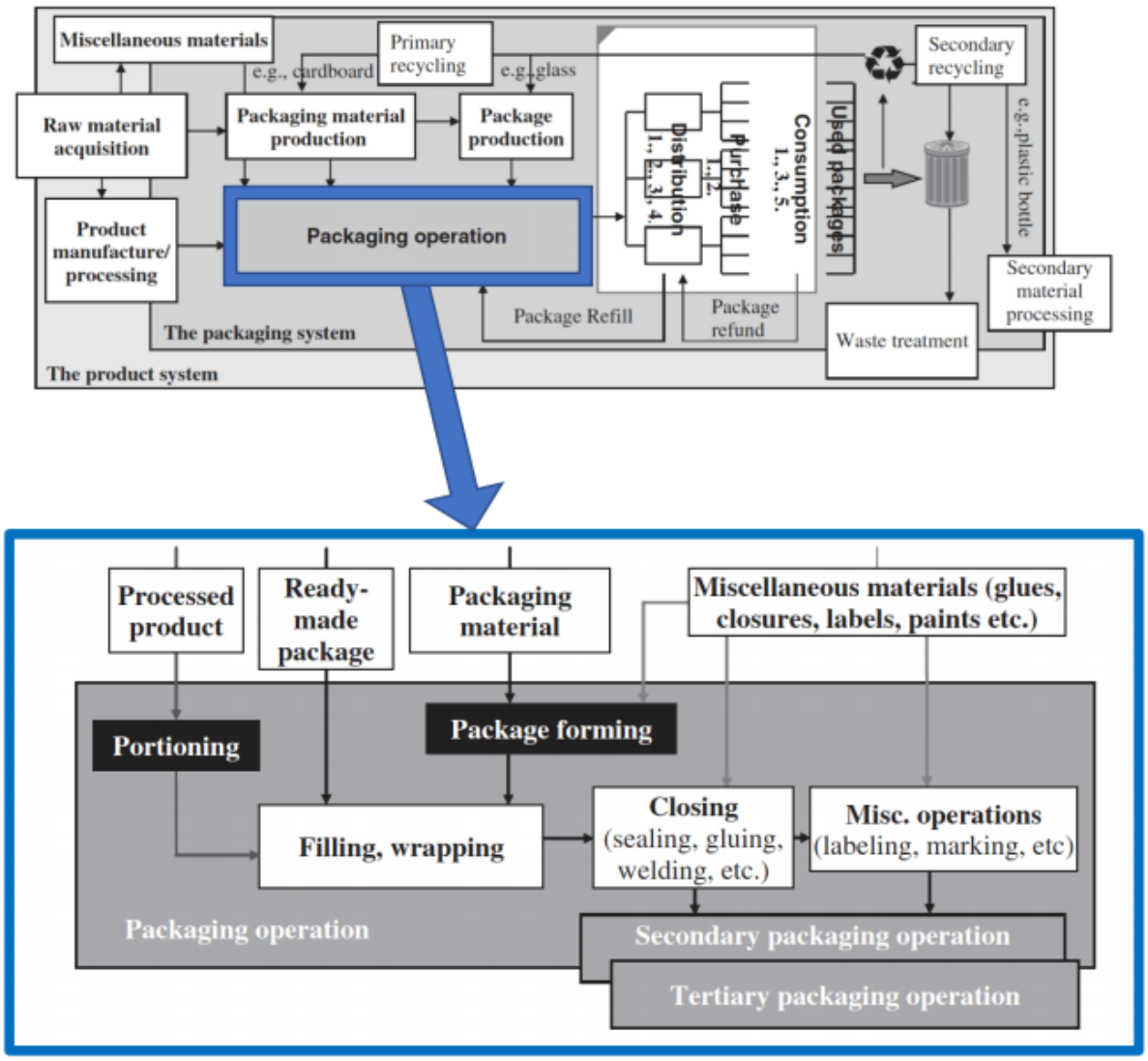

Figure 7 Overview of the PackFigure 7 Overview of the Packaging System and steps of packaging operationaging System and steps of packaging operation

1.2 Environmental impact of packaging system

Once the products contained within packages are consumed, the packages themselves lose their protective, containment function, and are often discarded as packaging waste. A common example is litter which is often equated with packaging materials such as glass and plastic bottles, cans, paper cups, paper, and plastic wrappings. Although it represents only a minor part of total wastes, litter is considered to be a hazard to animals, the marine environment, and human health **[22].** Concerning water pollution, it arises from wastewater discharge of some packaging material, paper production, releasing biological oxygen demand (BOD), chemical oxygen demand (COD), volatile suspended solids (VSS), and total suspended solids (TSS) which are all source of water pollution **[23].**

In the case of air pollution, the main source is the packaging material manufacturing process. Generally, CO_2 emissions arise from the decomposition of wood and paper, glass, and steel manufacture. SO_2, NOx the same as CO_2 emissions, are generated from electricity, transportation, and reuse or recovery while extraction and processing of raw materials are the main sources of packaging-related solid wastes **[23].** However, packaging wastes reduction can be achieved from the light-weighting of packages, thus leading to economic growth while reducing the use of natural resources. Moreover, the reuse of packages can also help reduce waste. **[24].**

Besides, in a packaging system, when the packaging material is less or exceeds the optimum use of that material in that system, it results in negative environmental impacts as shown in figure 8 **[25].**

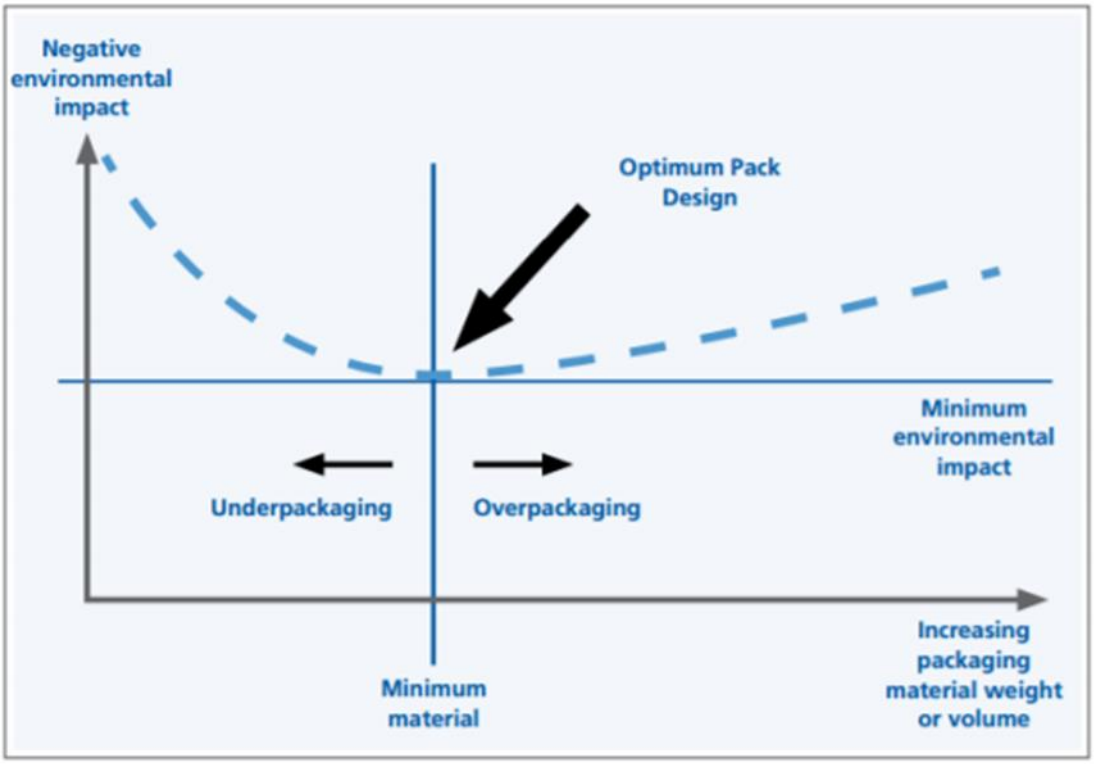

Figure 8 Balance between unnecessary overpackaging and ineffective underpackaging

1.3 Environmental impact assessment (EIA)

EIA methods of a product over its entire life cycle, included a multi-criteria spectrum, integrating the energy and climate dimension (emissions of greenhouse gas) but also other essential environmental aspects, such as material consumption. Among these multi-criteria methods, many are semi-quantitative such as Matrice Environnementally Responsible Product Assessment (MERPA), simplified life cycle assessment (SLCA), the "Materials, energy content and toxicity" matrix (MET), and ad hoc matrix approach. The balance between quantitative and

qualitative data varies for each of these methods. However, they are less rigorous and precise than quantitative methods, which often require expert input for the assessment, and rely on less detailed databases.

Furthermore, the interpretation of the results from these multicriteria tools can prove to be complex if different biases were adopted during the evaluation. Some quantitative and single-criteria analysis methods are based exclusively on quantitative data that limit the subjective part of the assessment and focus on a specific environmental issue (carbon footprint, energy consumption). However, there are also quantitative and multi-criteria analysis methods, that include LCA and the ecological index matrix (EIM) **[26].** The above methods are much more detailed in appendix 1.

Among the methods mentioned above, LCA appears to the most complete and successful method, which also has the advantage of being widely recognized and framed by an international standard. It can therefore be applied as strategic environmental assessment which is considered by Sadler and Verheem (1996), as a systematic process for evaluating the environmental consequences of a proposed policy, plan, or program initiatives to ensure they are fully included and appropriately addressed at the earliest appropriate stage of decision-making on par with economic and social considerations **[27].**

1.3.1 Life Cycle Assessment (LCA)

LCA is a standardized methodology, provided by the International Organisation for Standardisation (ISO) in ISO 14040 and 14044. It is used to identify, quantify and assess sources of environmental impact throughout a product's life cycle. It examines all the activities involved with making, using, and disposing of a product. When carrying out an LCA for any given product, the goals and scope are necessary to ensure consistency throughout the assessment while, the inputs and outputs are quantified using a systematic and internationally standardized process known to be the life cycle inventory (LCI). Thus, at each stage of the LCA, natural resources are consumed and emissions (to air, water, and soil) are released to the environment.

Furthermore, the inputs and outputs compiled in the life cycle inventory are then related to environmental impacts, such as climate change and resource depletion, using scientifically derived methods. An overview of the calculation procedure to estimate the contributions of environmental burdens identified in the inventory analysis phase to the different impact categories is presented below **[28].**

- The abiotic resource depletion (ARD) that includes depletion of nonrenewable resources, i.e. fossil fuels, metals and minerals. The total impact is calculated as :

$E_1 = \sum_{k=1}^{k} \frac{B_k}{ec_{1,k}}$ (-) (1)

- The global warming potential (GWP) which is calculated as a sum of emissions of the greenhouse gases (CO_2, N_2O, CH_4 and VOCs) multiplied by their respective GWP factors, $ec_{2.k}$:

$E_2 = \sum_{k=1}^{k} ec_{2,k} B_k$ (kg) (2)

where Bk represents the emission of greenhouse gas k. GWP factors, ec2,k , for different greenhouse gases are expressed relative to the global warming potential of CO2, which is therefore defined to be unity. The values of GWP depend on the time horizon over which the global warming effect is assessed. GWP factors for shorter times (20 and 50 years) provide an indication of the short-term effects of greenhouse gases on the climate, whilGWP for longer periods (100 and 500 years) are used to predict the cumulative effects of these gases on the global climate.

- The ozone depletion potential (ODP) category that indicates the potential of emissions of chlorofluorohydrocarbons (CFCs) and chlorinated hydrocarbons (HCs) for depleting the ozone layer and is expressed as :

$E_3 = \sum_{k=1}^{k} ec_{3,k} B_k$ (kg) (3)

where Bk is the emission of ozone depleting gas k. The ODP factors ec3,k are expressed relative to the ozone depletion potential of CFC^{-11}

- The acidification potential (AP) which is based on the contributions of SO_2, NOx, HCl, NH_3, and HF to the potential acid deposition, i.e. on their potential to form H^+ ions.

$E_4 = \sum_{k=1}^{k} ec_{4,k} B_k$ (kg) (4)

where $ec_{4,k}$ represents the acidification potential of gas k expressed relative to the AP of SO_2, and Bk is its emission in kg per functional unit.

- The eutrophication potential (EP) defined as the potential to cause over-fertilisation of water and soil, which can result in increased growth of biomass. It is calculated as :

$E_5 = \sum_{k=1}^{k} ec_{5,k} B_k$ (kg) (5)

where Bk is an emission of species such as NOx , NH_4^+ N, PO_4^{3-} , P, and COD and $ec_{5,k}$ are their respective eutrophication potentials. EP is expressed relative to PO_4^{3-}

- The photochemical oxidants creation potential (POCP), or photochemical smog, which is usually expressed relative to the POCP classification factors of ethylene and is calculated as :

$$E_6 = \sum_{k=1}^{k} ec_{6,k} B_k \text{ (kg)} \quad (6)$$

Where Bk are the emissions of different contributory species, primarily VOCs, classified into the following categories: alkanes, halogenated HCs, alcohols, ketones, esters, ethers, olefins, acetylenes, aromatics and aldehydes; ec6,k are their respective classification factors for photochemical oxidation formation.

- The human toxicity potential (HTP) which is calculated by adding the releases, which are toxic to humans, to three different media, i.e. air, water and soil.

$$E_7 = \sum_{k=1}^{k} ec_{7,KA} B_{KA} + \sum_{k=1}^{k} ec_{7,KW} B_{KW} + \sum_{k=1}^{k} ec_{7,KS} B_{KS} \text{ (kg)} \quad (7)$$

Where $ec_{7,KA}$, $ec_{7,KW}$, and $ec_{7,KS}$ are human toxicological classification factors for the effects of the toxic emission to air, water and soil, respectively. BkA, BkW and BkS represent the respective emissions of different toxic substances into the three media. The toxicological factors are calculated using the acceptable daily intake or the tolerable daily intake of the toxic substances. The human toxicological factors are still at an early stage of development so that HTP can only be taken as an indication and not as an absolute measure of the toxicity potential.

- The aquatic toxicity potential (ATP) can be calculated as :

$$E_{BA} = \sum_{k=1}^{k} ec_{B,KA} B_{KA} \text{ (m}^3\text{)} \quad (8)$$

Where $ec_{8,KA}$ represents the toxicity classification factors of different aquatic toxic substances and BkA are their respective emissions to the aquatic ecosystems. ATP is based on the maximum tolerable concentrations of different toxic substances in water by aquatic organisms. Similar to the HTP, classification factors for ATP are still developing, so that it can only be used as an indication of potential toxicity.

The result from the environmental impacts is a quantified environmental impact profile of the product under study. And finally, the interpretation phase involving the analysis of impact data includes a critical review, a determination of how the data will be shared, and a presentation of the results to relevant stakeholders. These results from the interpretation are then used to make improvements**[29].** The software and database used to assess environmental impacts are in general SimaPro which is considered to be one of the world's leading LCA software packages.

LCA applied to the package helps compare the environmental impact of different packaging products and determine which option makes the most sense. Besides, supply of raw materials for all packaging components, use of the packaging (including the supply chain from product factory to end-user), disposal of the packaging after use are the criteria that should be taken into account when implementing an LCA of packaging (figure 9) **[30].**

Figure 9 Packaged product life-cycle

One problem for life cycle analysis is to combine the different indicators and aggregate them, to get a ranking of all the alternatives. Therefore, a qualitative method to assess environmental loading, among which the analytic hierarchy process (AHP) seems to be an alternative **[31].**

1.3.2 Analytic Hierarchy Process (AHP)

The Analytical Hierarchical Process (AHP) is a Multi-Criteria Decision Making (MCDM) method, generally applied in the process of selection and evaluation introduced in the 1970s, by Thomas L. Saaty that helps to solve complex problems into a hierarchical structure of specific elements that are objective (goal), criteria (sub-criteria), and alternatives. **[32].**

The main objectives of an AHP are to quantify the relative priority of the given set according to the appropriate value scale and to determine the relationship between criteria and alternatives. The whole decision-making process including priorities assessment and

consistency evaluation depends on the perception of the decision-maker **[33 ;34].** To avoid a bias towards either LCA (quantitative approach) or AHP (qualitative approach), Chien-Chung Huang et al, (2004) used cluster analysis to integrate the results of the former two methods for environmental assessment of packaging materials**[35].** Besides, a mathematical model for an AHP can be applied as follow. **[34]**

If there are n elements to be compare, the comparison results create matrix form A with dimension n x m.

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nm} \end{bmatrix} \quad (9)$$

The elements of matrix, or ratio between compared criteria are expressed by the formula :

$$a_{ij} = \frac{W_i}{W_j} \quad (10)$$

Considering the first axiom for reciprocal we have :

$$a_{ij} = \frac{1}{a_{ji}} \quad (11)$$

The next step is to obtain a normalized matrix. The elements of the matrix $B = b_{ij}$. The elements of the matrix B are calculated as :

$$b_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (12)$$

The calculation of the weights i.e. eigenvector $W[w_i]$ forming the normalised matrix B is performed by calculating the arithmetic mean for each row of the matrix according to the formula :

$$w_i = \frac{\sum_{j=1}^{n} b_{ij}}{n} \quad (13)$$

Consistency implies coherent judgment on the part of the decision maker regarding the pairwise comparisons. Mathematically, comparison matrix A is consistent if $a_{ij}\, a_{jk} = a_{jk}$ for all i, j and k. To determine whether or not a level of consistency is “reasonable”, we need to develop a quantifiable measure for the comparison matrix A. When matrix A is perfectly consistent a normalised matrix C in which all the columns are identical is produced.

$$C = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \quad (14)$$

It then follows that the original comparison matrix A can be determined from C by dividing the elements of column i by wi. We thus have :

$$A = \begin{bmatrix} 1 & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & 1 & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & 1 \end{bmatrix} \quad (15)$$

The resulting ratio comparisons are depicted in

$$\begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_2 \end{bmatrix} = n \begin{bmatrix} w_1 \\ w_2 \\ \vdots \\ w_2 \end{bmatrix} \quad (16)$$

In order to obtain the term $n \times w$ the matrix is multiplied by w on the right. More compactly, given that w is the column vector of the relative weights $w_i, i = 1, 2 \ldots . n$. A is consistent if :

$$Aw = nw \quad (17)$$

For the case where A is not consistent, the relative weight w_i is approximately the average of the n elements of row i in the normalized matrix C. Letting $\bar{w}$ be the computed average vector, as shown below.

$$A\bar{w} = \lambda_{max}\bar{w}, \lambda_{max} \geq n \quad (18)$$

In this case, the closer λ_{max} is n time the more consistent compare to matrix A. Based on this observation, AHP computes the consistency ratio as :

$$CR = CI/RI \quad (19)$$

Where CI is consistency index of A and is calculated as :

$$CI = \frac{\lambda_{max}{}^{-n}}{n-1} \quad (20)$$

whereas RI is Random consistency index of A and its value is taken from table 2 where the first row (n) indicates the number of rows i.e. matrix size, whereas second row is Random consistency index.

Tableau 1 Random consistency index

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

If CR ≤ 0.1 the level of inconsistency is acceptable. Otherwise, the inconsistency is high and decision maker may need to reestimate the elements a_{ij} of A to realize better consistency. We compute the value of λ_{max} from $A\overline{w} = \lambda_{max}\overline{w}$ by nothing that the ith equation is

$$\sum_{j=1}^{n} a_{ij}\,\overline{w} = \lambda_{max}\overline{w}_{i,} i = 1, 2\ldots n \quad (21)$$

Given $\sum_{i=1}^{n} \overline{w} = 1$ we get :

$$\Sigma_{i=1}^{n} \left(\sum_{j=1}^{n} a_{ij}\,\overline{w} \right) = \lambda_{max}\Sigma_{i=1}^{n}\overline{w}_i = \lambda_{max} \quad (22)$$

This means that the value of λ_{max} can be determined by first computing the column vector $A\overline{w}$ an then summing its elements .

Choosing the best economical offer is a multiple-criterion decision problem, where could be made conflict between factors of decisions. So, the person who does the choice and the evaluation has to reach a compromise between these factors and to reach the weights for each of them. One of the good solutions which are offered in these conflict situations is the mathematical method AHP. For a better insight into the results, criteria and alternatives are marked with abbreviations.

The following abbreviations for criteria can be considered as : A1 Price ; A2 Quality; A3 Technical characteristics; A4 Functional Features; A5 Ecological characteristics; A6 Operating cost; A7 Economy; A8 Technical support, service; A9 Delivery Time while the abbreviations for bidders can be considered as: P1 Bidder 1; P2 Bidder 2; P3 Bidder 3; P4 Bidder 4; P5 Bidder 5

1.4 Packaging waste management process

In order to protect the environment and to reduce the negative impact of packaging waste and therefore comply with the Directive 94/62/CE on Packaging and Packaging Waste, the

European packaging waste management system which role is to collect, transport, process, and dispose of packaging waste material stand as a possible solution to reduce the generation of packaging waste through a combination of source including, reduction, recycling, and recovery of packaging waste. The different stages of the waste management process are illustrated in figure 9 below **[36].**

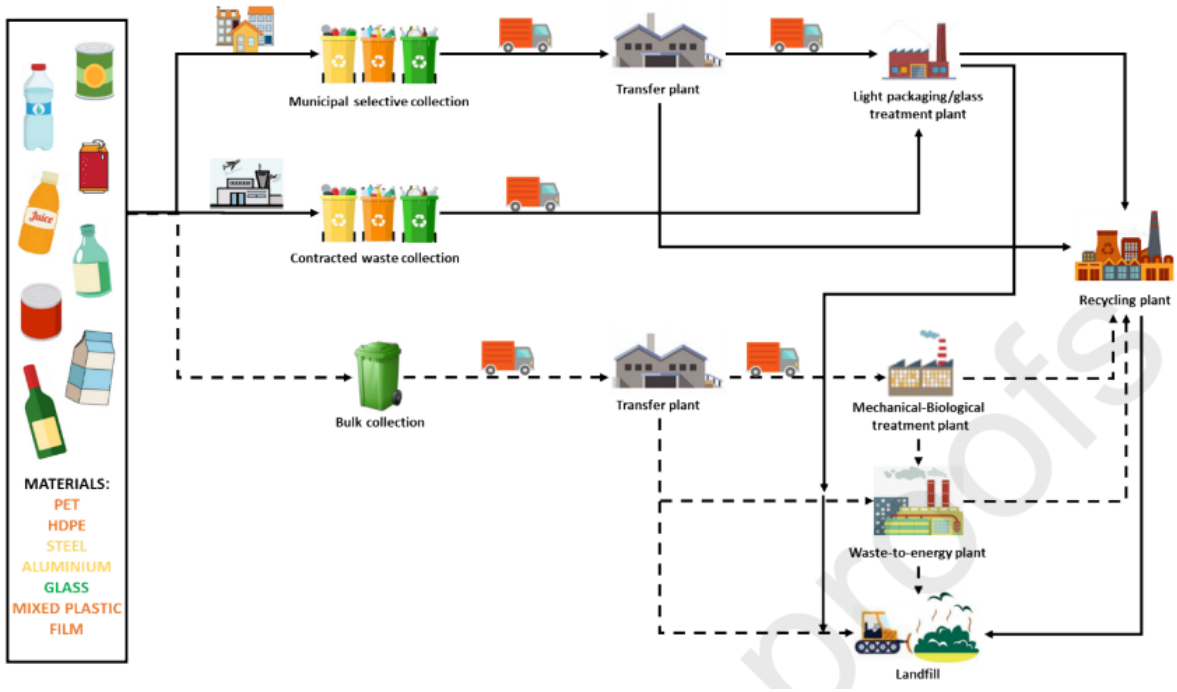

Figure 10 The different stages of the packaging waste management process

1.5 Green Packaging

They have been many approaches to define sustainable packaging also known as green packaging since there is no single universally accepted definition of what is sustainable. However, sustainability can be considered as the ability to achieve continuing economic prosperity while protecting the natural systems of the planet and providing a high quality of life for its people **[37].** Nowadays, sustainable development has emerged as the guiding principle for long-term global development based on three pillars known as social, environmental, and financial **[38].** This approach aims to achieve social equity, environmental protection, and economic prosperity in a balanced manner. Therefore green packaging can be considered to be a product that complies with these pillars.

1.6 Consumers perception of packaging

Demographic and Lifestyle Drivers have considerable implications for packaging.This trend has been driven by several factors including increased life expectancy, investment in

public utilities (better roads), and more. For instance, In countries well equipped with distribution facilities and infrastructural investment, needs for moisture-proof or shock-absorbing packaging are automatically reduced **[39].**

Besides, government authorities from many European countries have decided to push food companies toward an improvement of their products (nutrition, naturality, environmental friendly) and to intervene to improve consumer information on the quality of the products they consume by labeling their products with understanding or interpretative front-of-package (FOP) schemes **[40 ; 41].** Thus helping consumers which nowadays are paying more and more attention to their purchasing decisions when it comes to packaging.

Regardless of this context, more companies are now driving their research towards consumer buying attitudes, as it was found to be applicable for other facets of their behavior. It is in this context that, Leslie Herrmann performed an investigation on consumer's perception of green packaging. Results from the survey showed that only a few consumers knew the meaning of the Mobius loop symbol (figure11) **[42].** much less knew what sustainability meant and few provided a clear and correct definition of sustainability **[43].**

Figure 11 Mobius loop symbol

On the other hand, a pilot study was carried out by Haleh Barmaki to investigate student's attitude to food type's package design and their attitude to the food type's package and its environmental issues **[44].** Results from the study showed that nearly half of participants usually made their choice with the aid of the 'color' element (figure 12) while the majority of respondents consider recycling the disposed of packages than putting them to waste (figure 13).

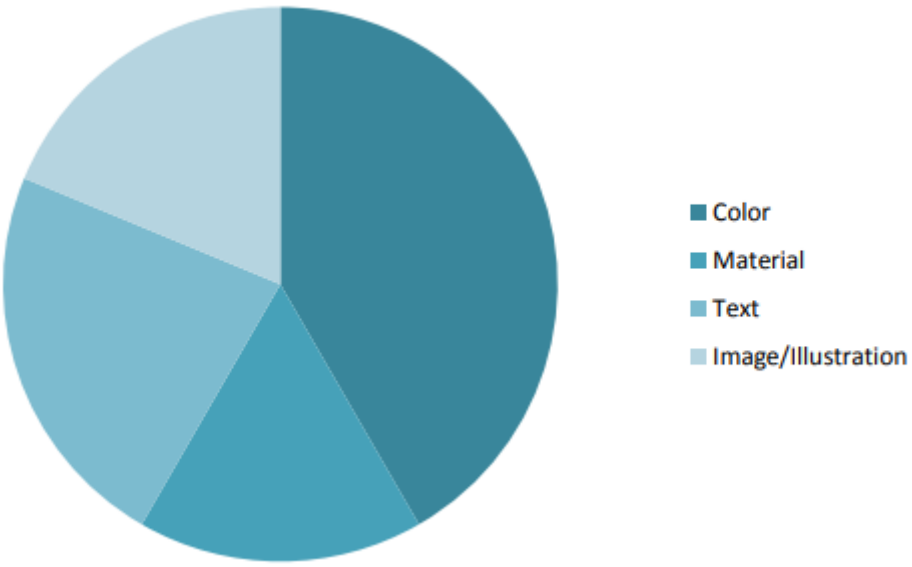

Figure 12 Food Package design

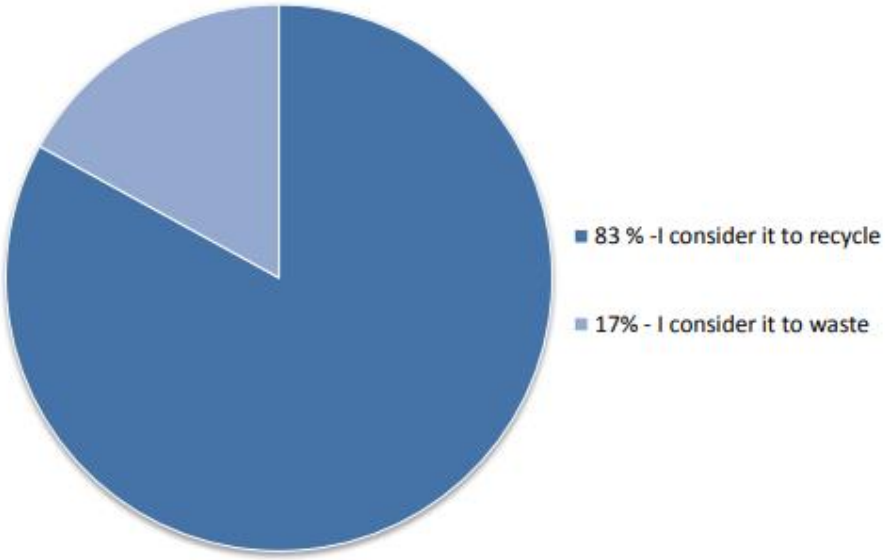

Figure 13 Food package and environmental issues

Furthermore, to select the packaging material that consumers consider to be easy or close to recycling, the majority of respondents (55%) choose paper as a material that they were willing to recycle(figure 14) while concerning the element that recalls 83 % of respondents mentioned about the Mobius loop – recycling logo which indicates that an object is capable of being recycled - not that the object has been recycled.

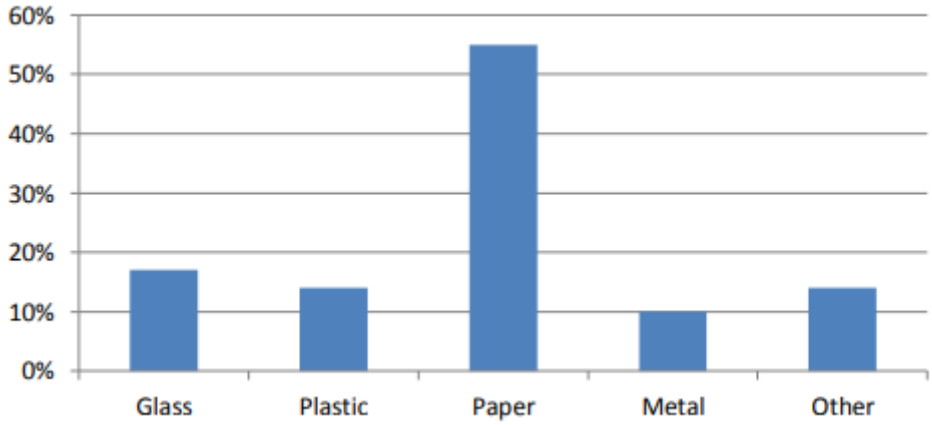

Figure 14 Package material and recycling tendency

The above research has demonstrated that sustainable packaging is not communicated well to consumers. Based on different surveys, consumers could not identify sustainable packaging or did not have a clear idea of what sustainability packaging involves **[45, 46].** Moreover, consumers put more emphasis on a preconceived notion of what makes a package sustainable (e.g., recycling) while disregarding the other pillars of sustainable development such as social and economic impacts. However, based on the 2020 global buying green report, 67% of consumers are now identify as environmentally aware. **[47].** Still, in a follow-up to the 2020 Buying Green report, an investigation from which 15,620 consumers across the U.S., Europe, and South America were called to participate in a questioner on consumers' willingness to pay more for products in sustainable packaging, was carried out by the Boston Consulting Group. The result of this survey is shown in figure 15 **[47].**

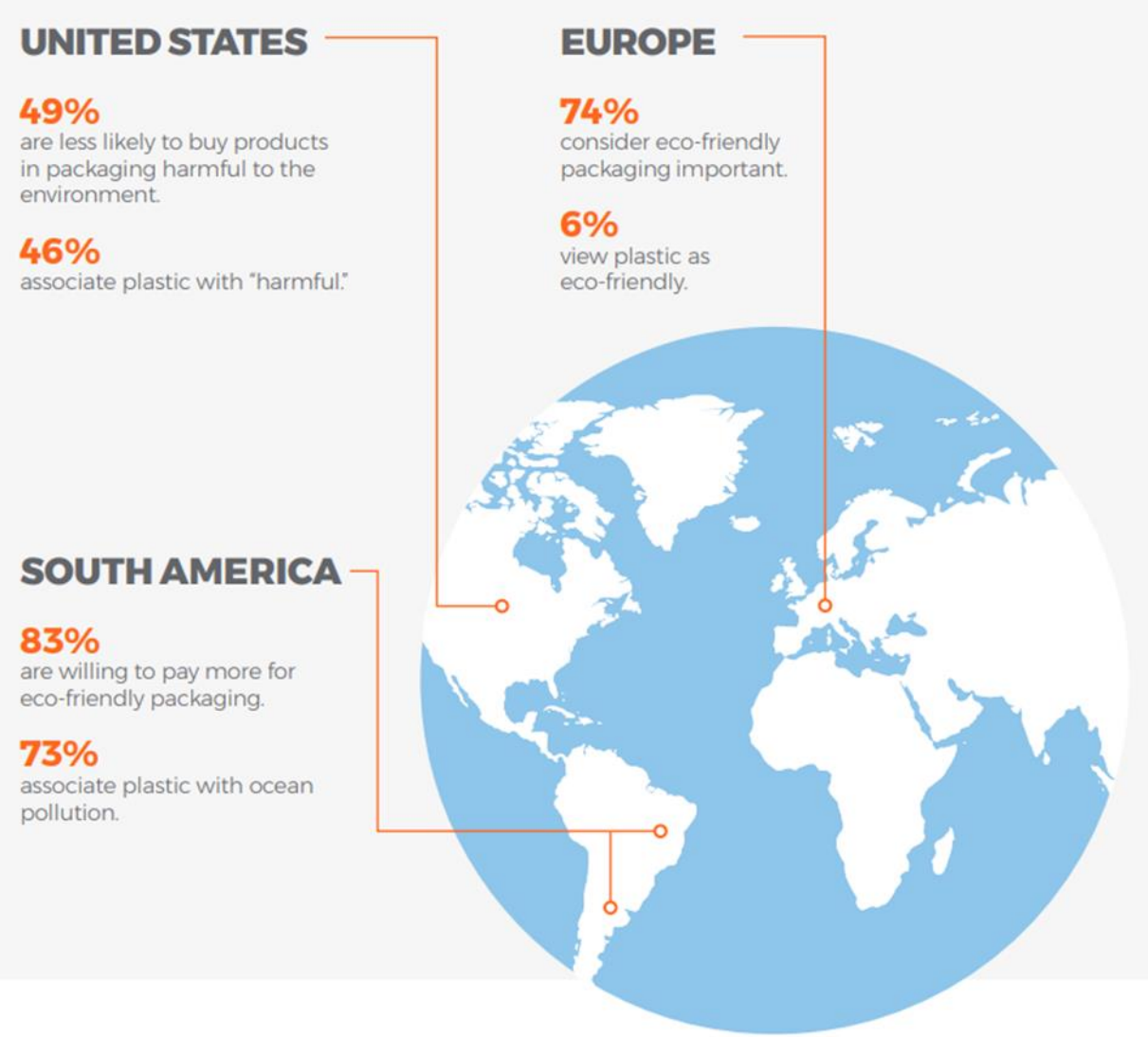

Figure 15 Sustainability global concern

1.7 Objectives

This master thesis aims to assess the sustainable initiatives undertaken by packaging processing firms and packaging waste management systems through 5 empirical analysis, to emphasize their environmental performances and economic performances, to review the mechanisms that explain the relationship between the environmental performance and the economic performance, and finally to propose a strategy to reconcile environmental performances and economic performances.

The activity sectors chosen for analysis are the paper and packaging industry industry in France and in Finland (Stora-Enso) providing renewable solutions in packaging, biomaterials, wooden constructions and paper, the fruit and vegetable packaging and distribution systems of an Italian catering supply chain, the Portuguese packaging waste management system (SIGRE) managed by Sociedade Ponto Verde – Green Dot Society (SPV), and the ARIADNA project on packaging waste management systems in Spain.

The main research questions the master thesis addresses are:

- ✓ Is there an effective correlation between eco-innovative initiatives and environmental performance?
- ✓ What is the correlation between environmental performances and economic performance? And vice versa
- ✓ Is there an effective strategy to be implemented for a positive relationship between environmental performances and economic performances?

2 Evaluation of the link between environmental performance and financial performance

2.1 General context

The need to act in favour of the environment has become essential for companies in search of legitimacy and economic prosperity. Meaning that, for a company to become competitive it must comply with sustainable standards. Moreover, under the influence of increasingly stringent regulatory, social pressures, and stakeholders, decision-makers have no choice but to accept to maintain the legitimacy of their corporate activities and to disclose information about their ecological footprints and their efforts to respect the environment. It follows that environmental investments in the form of pollution control equipment or new clean technologies are essential to ensure the sustainability of the company, despite their very high costs.

In this context, a large number of studies on the relationship between environmental responsibility and financial growth has been investigated including, longer-term relationship based on both univariate **[48 ;49]** as well as multivariate analysis **[50 ;51 ;52]** and short-term relationship based on event studies whose main role is to assess the reaction of financial markets related to the industrial sector based on environmental impacts positive or negative **[53].** However, research results linking corporate sustainability and financial performance remained inconclusive for several reasons **[54].**

First, we have on one side the 'traditionalist' with the approach that, the relationship between environmental performance (measured in terms of resource consumption and emission levels) and economic performance (measured in terms of stock-market performance or financial ratios) is uniformly negative **[55].** In this theory, pollution-reduction measures are predicted to increase production costs and are assumed to have increasing marginal costs. Second, we have the 'revisionist' view with the approach that, the relationship between environmental performance and economic performance is uniformly positive. It implies that any improvement in environmental performance improves economic growth **[56].** A third possible specification for the relationship is the inverse U-shaped curve presenting a level of environmental performance where the benefits of economic performance net the costs for achieving this level are maximised over the whole spectrum **[57].** Figure 16 illustrates the relationships between sustainability performance and economic success **[58].**

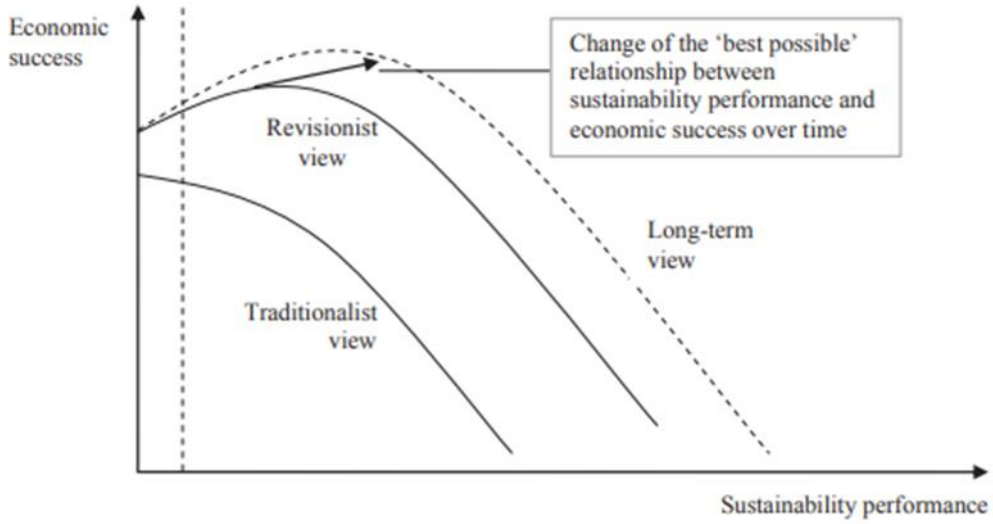

Figure 16 Relationships between sustainability performance and economic success.

Thus it is seen that the methodology applied to deal with the relationship between environmental performance and economic performance may vary from one author to another depending on the expected results. Two approaches emerge from these studies, including short-term studies commonly called event studies in which the financial health of a firm varies according to environmental events, and long-term studies that examine the relationship between environmental performance and economic growth over time **[59]** based on univariate analysis **[60]** or multivariate analysis **[61].**

In addition, the choice of environmental performance measures, the nature of the indicators chosen as well as the nature of the data, and the quantity of data chosen appear to be essential for analyzing the link between environmental performance and economic performance.

The range of metrics aims to cover the full breadth of environmental and economic aspects which may be needed to answer a range of business questions, inform internal decision making, allow communication between business partners or with other stakeholders, or provide overall product system evaluations. The number and the metrics used will depend on the objectives set. For instance, A simple question about the weight of recycled content of specific packaging options will require the use of just one metric. By contrast, an overall assessment and comparison of the entire product and packaging systems will require a lifecycle approach and the use of a wide range of metrics**[62].**

Indeed, choosing the indicators that are best for analysis will depend on some factors including what the business question is; what is there to compare; what is the system boundary where the assessments are being applied, and how the results are being used. Thus, it is obvious that there is no single formula in determining how many indicators or which indicators to be used when assessing environmental or economic performances. Using only one or two

indicators can answer a specific question, but may not give a clear (or complete) picture of actual impacts. In many cases, a set of few indicators that represent the company goals may be more appropriate than a list of a considerable number of indicators.

2.2 Environmental performance (EP)

Environmental performance is a complex notion whose definition may vary whether one is in the public or private sphere. In this regard, two approaches emerge with a category that considers EP as a one-dimensional concept. This category only takes into account either the negative externalities produced by companies who cannot be qualified as efficient environmentally only if they manage to control and reduce the volumes of their discharges into nature. Meaning that companies have an interest in producing more while using less natural resources and generating less waste and negative externalities to comply with current environmental legislation **[63].** The second approach is to consider EP as a multidimensional concept where a company is considered to be environmentally efficient when it has an Environmental Management System (EMS) under the ISO14001 standard **[64].**

To reconcile both approaches Turki (2009) proposes a definition according to which, environmental performance is the result of the managerial and technical efforts of the company in the protection of the environment and the variation of ecological pressures **[65].** Nevertheless, the measurement and evaluation of EP will depend on the selection of the appropriate indicators and methodology to achieve an acceptable environmental quality of life. For instance a plan-do-check-act method will enable top management to gather information on environmental performance, which is also meaningful and reliable enough to base management decisions upon. An exemple of a plan-do-check method is illustrated in figure 17 below.

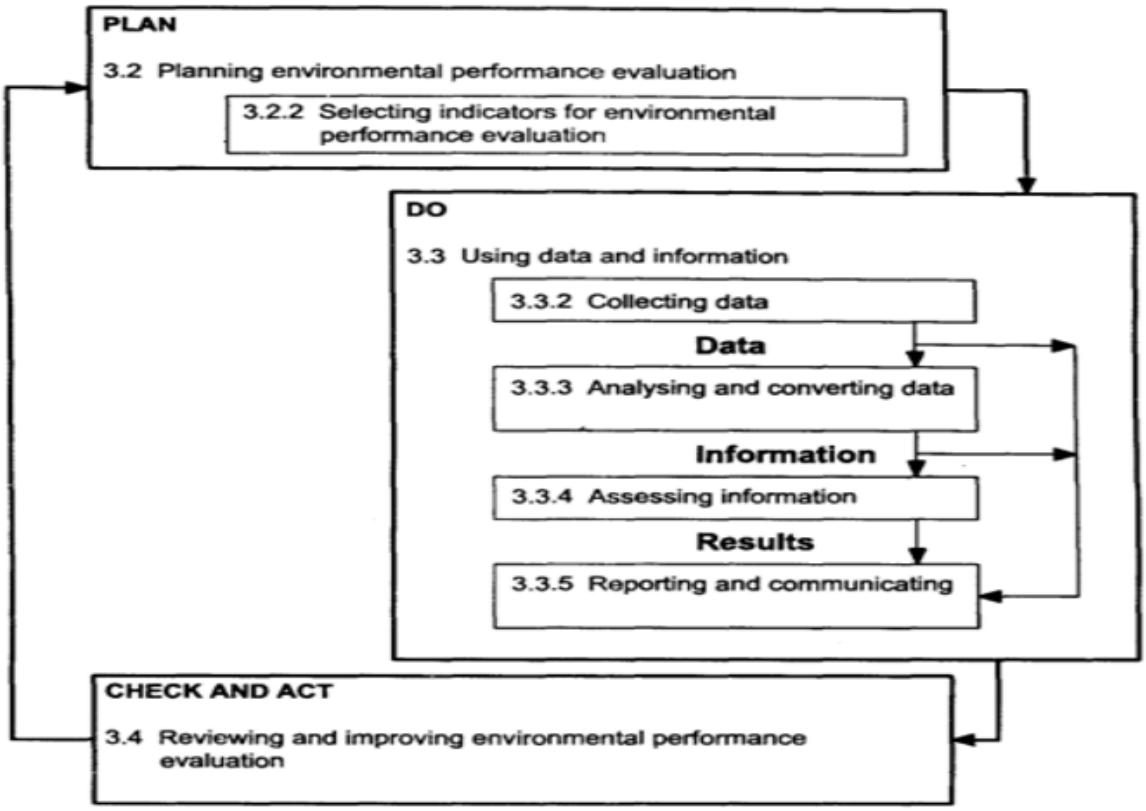

Figure 17 Evironmental performance measurement

Concerning Environmental performance indicators (EPI), they are used to assess environmental conditions at the operation including (a) environmental output indicators that provide an assessment of the linkages between industrial processes and the natural environment at the level of the plant and correspond closely with the outputs from Life Cycle Analysis, (b) Environmental management process indicators equivalent to the "input" indicators that provide information on the status of environmental management at an operation, and, (c) the environmental achievement indicators that cover specific progress towards targets which can be set by the company in its environmental policy, thrown up by baseline audits, established by treaty obligations, or codes of conduct and guidelines to which the company is a signatory **[66].** EPI also covers compliance with existing environmental regulatory requirements, a record of environmental suits and legal challenges to the company based on environmental performance, and environmental initiatives by the company that extends beyond normal operations [**67].**

Three categories of indicators can serve as proxies for the ideal EPI including, type 1 indicators which are the least desirable but the most common because it gives information neither to the existence of an environmental problem nor to its severity, type 2 indicators used to measure the potential for an environmental problem and type 3 indicators that measure the existence of an environmental problem and its physical severity **[68].** A summary of short-term indicators by environmental issue is illustrated in figure 18 **[69].**

Issues	PRESSURE Indicators of environ-mental pressures	STATE Indicators of environmental conditions	RESPONSE Indicators of societal responses
1 Climate change	Emissions of CO_2	Atmospheric concentrations of greenhouse gases Global mean temperature	Energy intensity
2 Stratospheric ozone depletion	Apparent consumption of CFCs	Atmospheric concentration of CFCs	
3 Eutrophication	Apparent consumption of fertilizers, measured in N,P	BOD, DO, N and P in selected rivers	% of population connection to waste water treatment plants
4 Acidification	Emissions of SOx and NOx	Concentration in acid precipitations (pH_1 SO_1 NO_2)	Expenditure for air pollution abatement
5 Toxic contamination	Generation of hazardous waste	Concentration of lead, cadmium, chromium, copper in selected rivers	Market share of unleaded petrol
6 Urban environmental quality		Concentration of SO_2, NO_2, particulates in selected cases	
7 and 8 Biological diversity and landscape	Land use changes	Threatened or extinct species as % of known species	Protected areas as % of total area
9 Waste	Generation of municipal, industrial, nuclear, hazardous waste	not applicable	Expenditure on waste collection and treatment Waste recycling rates (paper and glass)
10 Water resources	Intensity of use of water resources		
11 Forest resources		Area, volume and distribution of forests	
12 Fish resources	Fish catches		
13 Soil degradation (desertification and erosion)	Land use changes		
14 General indicators, not attributable to specific issues	Population growth and density, GDP growth Industrial and agri. prod. Energy supply and structure Road traffic and vehicle stock	not applicable	Pollution abatement and control expenditure Public opinion on the environment

Figure 18 Summary of Short-Term Indicators by Environmental issue

2.3 Economic performance

The performance of an economy is usually assessed in terms of the achievement of economic objectives including, the evaluation of cost and selling price which is a key element for the manufacturer, but also for the consumer, the assessment of profitability for the producer, and for the consumer that consists in ensuring that the marketed price of a good is affordable, but also that it will offer the consumer an attractive return on investment, and life cycle cost analysis that takes a more user-focused approach to the product **[70].** Nevertheless, based on the general rule of evaluating economic performance, it can be estimated that a company creates sustainable value if the profitability generated exceeds the costs incurred (Value = Profitability - Costs) **[71].**

Besides, data collection plays an important role in the assessment of economic performances since it helps to find answers to the research problem, test the hypothesis, and evaluate the outcomes. Indeed, this process of collecting information can be divided into two categories including secondary methods of data collection and primary methods of data collection **[72].**

Secondary data is a type of data that has already been published in books, newspapers, magazines, journals, and online portals. However, this type of data depends on the credibility of the publisher and the reliability of the source. As for primary data collection methods, it can be divided into two groups including quantitative data collection based on mathematical calculations in various formats (questionnaires with closed-ended questions, methods of correlation and regression, mean, mode and median) and qualitative methods which are closely associated with words, sounds, feeling, emotions, colors and other elements that are non-quantifiable. Besides quantitative methods are cheaper to apply and they can be applied within a shorter duration of time compared to qualitative methods.

The available data for each firm in the case study samples used to assess the financial performance was obtained from the secondary methods of data collection and from the quantitative method of data collection based on mathematical calculations which allowed the effective integration of environmental management practices into operations to have an effect on costs and, thus, to affect the firm's net profit margin. Furthermore, a wide range of indicators was employed to measure macro-economic variables that can directly or indirectly enable to judge whether the economic performance of the firm has improved or deteriorated. Nevertheless, indicators that should be chosen to measure economic performance depend on the perspective taken in a study and on its purpose.

2.3.1 Economic Performance Indicators (EPI)

EPI is traditionally implemented to improve economic performances and is therefore used as a tool for decision-making by stakeholders and shareholders. It can be categorized according to the stakeholders that will be primarily interested in the financial or non-financial nature of the indicator parameter or whether the results or the determinants of a strategy are being indicated **[73].** National income, output, and spending are the three key variables that indicate whether an economy is growing, or in recession. Like many other indicators, income, output, and spending can also be measured in per capita terms.

2.3.2 Economic assessment

The implementation of economic analysis can be applied using the tool known as Life Cycle Costing (LCC). LCC is used by decision-makers to estimate the economic costs of

products and systems under a life cycle perspective **[10].** The application of this tool depends on the objective function, structure of the supply chain, and availability of data. For instance, in the packaging system, the LCC takes into consideration its total cost which is the addition of the capital investment cost (cost of packaging machines), and the operating cost (shipping cost, labor cost, packaging material cost, product damage cost, recycling cost, disposal cost, and maintenance cost) **[2].** Table 3. illustrates the cost factors of recyclable, disposable, and reusable packaging systems.

Tableau 2 Cost factors of recyclable, disposable and reusable packaging systems

	Packaging System Alternatives		
	Expendable Packaging		Reusable Packaging
Associated Costs	Recyclable	Disposable	
Shipping Cost	√	√	√
Labor Cost	√	√	√
Packaging Material Cost	√	√	√
Product Damage Cost	√	√	√
Recycling Cost	√	NA	√
Disposal Cost	NA	√	√
Maintenance Cost	NA	NA	√

The mathematical model applied by Vaibhav Mahadev Biradar (2017) to calculate the total cost (sum of capital investment cost and an operating cost) of a packaging system is presented below

- ✓ **Shipping Cost**

The shipping cost of recyclable, disposable, and reusable packaging systems include:

- Suppliers to manufacturer transportation cost (SC_1)

$$S_{C1} = \Sigma_{i=1}^{m} (N_i \times T_i) \times \text{TR} \quad (23)$$

Where, N_i is the number of trucks shipped from supplier 'i' to manufacturer

$$N_i = \sum_{j=1}^{n} \sum_{k=1}^{p} \sum_{l=1}^{q} \left\{ \frac{prod \times nu_j / PC_{jk}}{TC_{kl}} \right\} \quad (24)$$

With, nu_j as the number of j parts required for each product; Prod as the production volume per year; PC_{jk} as the package capacity of j parts in k types packages; $prod \times nu_j / PC_{jk}$ as the number of package shipped; T_i and TR respectively as the travel distance from supplier i to manufacturer (distance in miles) and the transport rate (per mile).

- Manufacturer to recycling center transportation cost (SC_2)

$$SC_2 = \sum_{i=1}^{m}(N_r \times T_r)\text{TR} \quad (25)$$

Where, N_r is the number of trucks shipped from manufacturer to recycling center.

$$N_r = CR_{re} \times N_i \quad (26)$$

With, CR_{re} as the collapsible ration of recyclable packages and T_r the travel distance from manufacturer to recycling center (in miles)

- Manufacturer to disposal landfill transportation cost SC_3

$$SC_3 = \sum_{i=1}^{m}(N_d \times T_d)\text{TR} \quad (27)$$

With, N_d as the Number of trucks shipped from manufacturer to disposal landfill.

$$N_d = CR_d \times N_i \quad (28)$$

Where, CR_d and T_d are respectively the collapsible ratio of disposable packages and the travel distance from manufacturer to disposal landfill (in miles). If the same packages are used for the recyclable and disposable packaging system then, $N_d = N_r$

- Manufacturer to supplier's transportation cost (SC_4)

$$SC_4 = \sum_{i=1}^{m}(N_i \times T_i)\text{TR} \times CR_{ru} \quad (29)$$

With CR_{ru} as the collapsible ratio of reusable packages.

Tableau 3 Shipping cost of recyclable, disposable and reusable packaging systems

Packaging System	Shipping Cost	Formula
Recyclable	$(SC)_{re} = SC_1 + SC_2$	$(SC)_{re} = \sum_{i=1}^{m}(N_i \times T_i)TR + \sum_{i=1}^{m}(N_r \times T_r)TR$
Disposable	$(SC)_d = SC_1 + SC_3$	$(SC)_d = \sum_{i=1}^{m}(N_i \times T_i)TR + \sum_{i=1}^{m}(N_d \times T_d)TR$
Reusable	$(SC)_{ru} = SC_1 + SC_4$	$(SC)_{ru} = \sum_{i=1}^{m}(N_i \times T_i)TR + \sum_{i=1}^{m}(CR_{ru}N_i \times T_i)\,TR$

✓ **Labour Cost**

The labor cost of recyclable, disposable, and reusable packaging systems is based on the average time required for loading and unloading of packages, the number of packages transported per unit time, and the average labour cost oer hour.

- Labour cost of recyclable packaging system

The labour cost of recyclable packaging system is the product of the total labour hours required in the system and the labour rate per hour. The total labour hours (TLH_{re}) required in the system is shown in equation 22.

$$TLH_{re} = (\sum_{i=1}^{m} N_i \times LT) + (\sum_{i=1}^{m} N_i \times ULT) + (CR_{re} \times \sum_{i=1}^{m} N_i \times LT) \quad (30)$$

Therefore, the labour cost of recyclable packaging system is:

$$(LC)_{re} = \{(\sum_{i=1}^{m} N_i \ X \ LT) + (\sum_{i=1}^{m} N_i \ X \ ULT) + (CR_{re} \ X \ \sum_{i=1}^{m} N_i \ X \ LT)\} X \ LR \quad (31)$$

With, LT as the average time required for loading truck; ULT as the average time required to unload truck; and LR as the average labour rate per hour.

- Labour cost of disposal packaging system

The labour cost of disposable packaging system is the product of the total labour hours required in the system (TLH_d) and the labour rate per hour.

$$TLH_d = (\sum_{i=1}^{m} N_i \times LT) + (\sum_{i=1}^{m} N_i \times ULT) + (CR_d \times \sum_{i=1}^{m} N_i \times LT) \quad (32)$$

Thus, the labour cost of disposal packaging system is:

$$(LC)_d = \{(\sum_{i=1}^{m} N_i \ X \ LT) + (\sum_{i=1}^{m} N_i \ X \ ULT) + (CR_d \ X \ \sum_{i=1}^{m} N_i \ X \ LT)\} X \ LR \quad (33)$$

- Labour cost of reusable packaging system

The labour cost required for reusable packaging system is the product of the total labour hours required in the system (TLH_{ru}) and the labour rate per hour.

$$TLH_{ru} = (\sum_{i=1}^{m} N_i \times LT) + (\sum_{i=1}^{m} N_i \times ULT) + (CR_{ru} \times \sum_{i=1}^{m} N_i \times LT) \quad (34)$$

Thus, the labour cost of reusable packaging system is:

$$(LC)_{ru} = \{(\sum_{i=1}^{m} N_i \ X \ LT) + (\sum_{i=1}^{m} N_i \ X \ ULT) + (CR_{ru} \ X \ \sum_{i=1}^{m} N_i \ X \ LT)\} X \ LR \quad (35)$$

✓ **Packaging Material Cost**

The packaging material cost of recyclable and disposable packaging systems include, the number of packages shipped and the average unit cost of recyclable or disposable packages.

- Packaging material cost of recyclable packaging system

$$(PMC)_{re} = \sum_{k=1}^{p} (REP_k \ \times \ REPC_k \ ) \quad (36)$$

Where, REP_k = Number of k type of recyclable packages shipped and $REPC_k$ = Per unit cost for k type of recyclable package.

- Packaging material cost of disposal packaging system

$$(PMC)_d = \sum_{k=1}^{p}(REP_k \times REPC_k) \quad (37)$$

Where DP_k is the number of k type of disposable package shipped.

$$DP_k = (31)$$

DPC_k = Per unit cost for k type of disposable package.

- Packaging material cost of reusable packaging system $(PMC)_{ru}$

The packaging material cost of reusable packaging system depends on the number of reusable packages in the system, the average unit cost of reusable package, and the life of reusable packages.

$$(PMC)_{ru} = \sum_{k=1}^{p}(RUP_k \times RUPC_k) \quad (38)$$

Where, RUP_k is the number of k type of reusable packages in the system and $RUPC_k$ Per unit cost of k type of reusable package.

The number of reusable packages in the system is:

$$RUP_k = \sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{K=1}^{P}\left\{\frac{\{(Prod \times nu_j)/PC_{jK}\}}{(365/DT_{ij})}\right\} + SS \quad (39)$$

Where DT_{ij} and SS are respectively the dwell time for supplier 'i' and product 'j' (in days) And the safety stock of reusable packages. The packaging material cost per year can be calculated by dividing equation 33 by the life of reusable packaging system. The yearly packaging material cost is considered for comparison of three packaging systems.

✓ **Product Damage Cost**

The product damage cost is depending on the product damage frequency and cost of items inside the packages.

- Product damage cost of recyclable packaging system

$$(PDC)_{re} = (PDF)_{re} \times \sum_{k=1}^{p}(REP_k \times REMP_k) \quad (40)$$

Where $(PDF)_{re}$ is the damage frequency of recyclable packaging system, REP_k, the number of k type of recyclable package shipped, and $REMP_k$, the average cost of material inside k type of a single recyclable package.

- Product damage cost of disposable packaging system

$$(PDC)_d = (PDF)_d \times \sum_{k=1}^{p}(DP_k \times DMP_k) \quad (41)$$

Where, $(PDF)_d$ is the damage frequency of disposable packaging system; DP_k the number of k type of disposable package shipped and DMP_k the average cost of material inside k type of a single disposable package.

- Product damage cost of reusable packaging system

$$(PDC)_{ru} = (PDF)_{ru} \times \sum_{k=1}^{p}(RUPT_k \times RUMP_k) \quad (42)$$

Where, $(PDF)_{ru}$ is the damage frequency of reusable packaging system; $RUPT_k$ the number of k type of reusable packages turns per year and $RUMP_k$ the average cost of material inside k type of a single disposable package.

✓ **Recycling Cost**

It is applied for recyclable packaging system and reusable packaging system (if reusable packages are recycled at the end of their life). The recycling cost mainly depends upon recycling rate and weight of recycled packaging material.

- Recycling cost of recyclable packaging system

$$RC_{re} = RR \times WRP_{re} \quad (43)$$

Where, RR is the average recycling revenue per ton, and WRP_{re} the weight of recyclable packaging material. Hence,

$WRP_{re} = \sum_{k=1}^{p}(REP_k \times REW_k)$ with, REW_k as the unit weight of k type of recyclable package

$RC_{re} = RR \times WRP_{re} = RR \times \sum_{k=1}^{p}(REP_k \times REW_k)$

- Recycling cost of reusable packaging system

$$RC_{ru} = RR \times WRP_{ru} \quad (44).$$

Where, WRP_{ru} is the weight of reusable packaging material that recycled, with $WRP_{ru} = \sum_{k=1}^{p}(RUP_k \times RUW_k)$ and, RUW_k is the unit weight of k type of reusable. Therefore, the recycling revenue of recyclable packaging material will be:

$RC_{ru} = RR \times WRP_{ru} = RR \times \sum_{k=1}^{p}(RUP_k \times RUW_k)$

✓ **Disposal Cost**

It is applied for disposable packaging system and reusable packaging system (if reusable packages are disposed at the end of their life). The disposal cost mainly depends upon landfill rate and weight of disposable packaging material.

- Disposal cost of disposable packaging system

$$DC_d = DR \times WDP_d \quad (45)$$

Where DR is the average disposal rate per ton and WDP_d the weight of disposal packaging

material and is equal to $\sum_{k=1}^{p}(DP_k \times DW_k)$, given the disposal cost of disposable packaging system to be equal to DR × WDP_d = DR × $\sum_{k=1}^{p}(DP_k \times DW_k)$.

- Disposal cost of reusable packaging system

$$DC_{ru} = DR \times WDP_{ru} \quad (46)$$

Where DR is the average disposal landfill rate per ton and WDP_{ru} the weight of reusable packaging material that disposed and it is equal to $\sum_{k=1}^{p}(RUP_k \times RUW_k)$, given the disposal cost of reusable packaging system to be equal to DR × WDP_{ru} = DR × $\sum_{k=1}^{p}(RUP_k \times RUW_k)$.

✓ **Maintenance Cost**

It is applied for the reusable packaging system and is considered as a percentage of total cost of packaging materials.

$$MC = \theta \times (PMC)_{ru} \quad (47)$$

With, θ as the fraction of total material costs considered as maintenance cost and $(PMC)_{ru}$ the packaging material cost of reusable packaging system.

✓ **Total Cost**

The total cost of each packaging system is the sum of all the costs of the above cost, and it can be negative or positive.

Tableau 4 Total cost of packaging systems

	Packaging System Alternatives		
	Expendable Packaging		Reusable Packaging
Associated Costs	Recyclable	Disposable	
Shipping	$\sum_{i=1}^{m}(N_i \times T_i)TR + \sum_{i=1}^{m}(N_r \times T_r)TR$	$\sum_{i=1}^{m}(N_i \times T_i)TR + \sum_{i=1}^{m}(N_d \times T_d)TR$	$\sum_{i=1}^{m}(N_i \times T_i)TR + \sum_{i=1}^{m}(CR_{ru}N_i \times T_i)TR$
Labor	$\left\{(1+CR_{re})\sum_{i=1}^{m} N_i \text{ X LT} + \sum_{i=1}^{m} N_i \text{ X ULT}\right\}$ X LR	$\left\{(1+CR_d)\sum_{i=1}^{m} N_i \text{ X LT} + \sum_{i=1}^{m} N_i \text{ X ULT}\right\}$ X LR	$\left\{(1+CR_{ru})\sum_{i=1}^{m} N_i \text{ X LT} + \sum_{i=1}^{m} N_i \text{ X ULT}\right\}$ X LR
Material	$\sum_{k=1}^{p}(REP_k \times REPC_k)$	$\sum_{k=1}^{p}(DP_k \times DPC_k)$	$\left\{\sum_{k=1}^{p}(RUP_k \times RUPC_k)\right\}$
Product Damage	$(PDF)_{re} \times \sum_{k=1}^{p}(REP_k \times REMP_k)$	$(PDF)_d \times \sum_{k=1}^{p}(DP_k \times DMP_k)$	$(PDF)_{ru} \times \sum_{k=1}^{p}(RUPT_k \times RUMP_k)$
Recycling	$-\left(RR \times \sum_{k=1}^{p}(REP_k \times REW_k)\right)$	NA	$-\left(RR \times \sum_{k=1}^{p}(RUP_k \times RUW_k)\right)$
Disposal	NA	$DR \times \sum_{k=1}^{p}(DP_k \times DW_k)$	$DR \times \sum_{k=1}^{p}(RUP_k \times RUW_k)$
Maintenance	NA	NA	$\theta \times (PMC)_{ru}$

Besides, Corporate financial performance can also be measured through either accounting-based measures of financial returns (return on assets ; return on equity; return on investment; return on sales) or through market-based measures of financial value (stock returns; market/book value ratio)**[74;75].**

2.4 Corporate Social Performance (CSP)

According to Visser (2010), the CSP is defined as a configuration of a business organization's principles of social responsibility, processes of social responsiveness, and observable outcomes with the employee, stakeholder, and societal relationships **[76].** However, the CPS highly depend on Corporate Social Responsibility (CSR) defined as a corporate relationship between a company and its employees and their representatives or families, local communities, and the general public to improve the quality of life byways that give benefit to both for themselves and the business development **[67].**

2.5 Analytical tools used to implement the relationship between environmental and economic performance at the firm-level.

There is a wide variety of analytical tools used to implement the relationship between environmental and economic performance at the firm level including multiple regression, correlation analysis, and descriptive statistics. Wided Boubake (2015), examined the influence of environmental performance on the economic performance of 12 paper groups present in France, using longer-term and short-term relationship based on univariate regression analysis making use of panel models. The development of the mathematical model applied by Wided Boubake (2015) is presented in appendix 1 **[77].** As for Weiwei et al. (2020) hierarchical regression analysis was applied to test the link between corporate environmental performance and financial performance of 1491 observations from the manufacturing companies of Pakistan **[78]** while Vinayagamoorthi et al. (2015) attempt to analyze the impact of profitability on environmental performance from Companies in India using descriptive statistics, correlation, and regression analysis **[79],** Hart and Ahuja (1996) on his side applied multiple regression analysis based on dependent variables including the operating performance data return on sales (ROS), the return on assets (ROA), and financial performance data return on equity (ROE) to examined the influence of environmental impacts on the economic performance of S & P500 companies **[80]** whereas Kamal Gnanaweera et al. (2017) also used regression analysis with statistics application to investigate the impact of CEP and CFP of 85 Japanese firms from various industrial categories **[81].**

Besides, a partial least squares model (PLS) was applied for the first time by Moneva et al. (2010) to measure the corporate environmental and financial performance of a sample of 230 European companies [**82].**

The formula generally used to estimate the degree of relationship between two or more variables is the cross-correlation. It measures the strength of the relationship among two variables.

The linear association between the variables is measured by the value of coefficient as identify through the coefficient of correlation below :

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{n(\sum x^2 - (\sum x)^2)(n\sum y - (\sum y)^2)}} \quad (48)$$

Where, r is, a coefficient of correlation between environmental performance and economic performance, and it is used as a measure of effect size (it denotes the magnitude of the relationship between the dependent variable and a specific independent variable), N is the number of obsevations, $\sum x$ the dependent variables, and $\sum y$ the independent variables.

For the case studies to be analyzed, the independent variables include Environmental investments, pollution prevention, recycling, alternative energy, beneficial products, hazardous waste, regulatory problems, ozone-depleting chemicals, substantial emissions, and climate change while dependent variables include operational costs, return on equity (ROE), return on assets (ROA), and return on sales (ROS). In addition to the above variables of interest, the various case studies also include some measures commonly used in the analysis of performance measures as controls. These measures include the size of the firm as reflected by its number of employees, and its total assets (as the log of the firm's total assets).

3 Methodology

In this study, the link between corporate environmental performance and corporate financial performance from 5 case studies was investigated. Both the qualitative and quantitative analysis method was chosen to gain a comprehensive and thorough understanding of environmental performances in the target companies while a variety of tools was used to measure corporate financial performance, corporate environmental performance, and the link between both performances.

3.1 Subjects and aim of the study

Five case studies from 5 five European countries dealing with packaging and packaging waste management systems including Wided Boubake (2015) thesis on **« Eco-innovation, Performance environnementale et impact économique sur les entreprises : étude de cas des groupes Papetiers présents en France » [77],** Maria Eilola (2017) research work on « **The link between corporate environmental performance and corporate financial performance** » **[83],** articles from Accorsi, R. et al (2014) on « **Economic and environmental assessment of reusable plastic containers: A food catering supply chain case study** »**[84],** Paulo Ferrão, et al (2014) on **« Environmental, economic and social costs and benefits of a packaging » [85],** and B.D. SUCH, et al. (2017) on « **A comparative sustainability assessment of two packaging waste management systems in dispute in Spain. The Ariadna project » [86]** was analyzed to propose a comprehensive and understanding strategy to reconcile environmental performance and economic performance in the packaging industry and the packaging waste management systems. A brief presentation of the sample used for the empirical studies is illustrated in the table below.

Tableau 5 Brief presentation of the samples to be analysed

Name of the activity sector	Country	Activities	Size of the company
pulp, paper and cardboard factories	France with subsidiaries outside of France	Pulp, paper, and packaging production	Employs 13,865 people,
2) The Stora Enso Packaging industry	Sweden and Finland, with headquaters in Helsinki	providing renewable solutions in packaging, biomaterials, wooden constructions and paper.	Employs 26000 people in more than 35 countries.
Catering supply chain	Italy	Fruit and vegetable packaging and distribution systems	Not mentionned
Portuguese packaging waste management system (SIGRE)	Portugal	The collection, recycling and recovery of non-reusable packaging waste.	Manage a complex network of processes which include more than 130 distinct entities
ARIADNA project on packaging waste management system in Spain	Spain	The collection, recy-cling and recovery of packa ging waste	Not mentionned

The five case studies have been selected based on a combination of selection criteria defining their quality and comprehensiveness. These criteria include compliance with international LCA methodology standards, the perspective adopted by the study (company) which concerns pollution-prevention strategy that seeks to reduce emissions using continuous-improvement methods focused on well-defined environmental objectives (case study 3, 4, and 5), and innovative environmental management that can lead to the development of firm-specific capabilities and that can be sources of competitive advantage (case study 1, and 2), the time frame (long-term and short-term), the year of the study (less than a decade), and the regional

differences (Each country adopted different legal, economic and operational waste management strategies to achieve their targets)

3.2 Instruments and measures

3.2.1 Evironmental performances

There is a wide variety of tools and indicators across the literature to assess the environmental performance of a company. For the first empirical analysis, the sustainable value was used to assess the environmental performance and the environmental indicators selected for the following includes CO2 emissions (t / year), Water consumption (m3 / year), Energy consumption (kWh / year), Self-produced renewable energy (kWh / year), quantity recycled (tonnes/year), and quantity of waste (dry tons/year). Besides, environmental investment (EI) and certified fibers (CF) were used as independent variables. The mathematical model on how to calculate environmental sustainable value is presented in appendix 2.

As for the second case study, environmental performance evaluation criteria were developed by utilizing several sources including, the Kinder, Lydenberg, Domini Research and Analytics rating's environmental variables (KLD), the GRI (global reporting initiative) framework, Jacobs' CEP framework, stakeholder materiality analysis of target companies, and the sustainability topics covered in their reports. The variables used to evaluate pollution prevention programs include emission reductions such as carbon dioxide (CO2), chemical oxygen demand (COD), and sulfur dioxide (SO2), clean and efficient energy use (to assess renewable energy use and energy efficiency improvement programs), recycling (to evaluates recycling rate and efforts to decrease the amount of waste to landfill), pioneering products in the industry (given points if new products that are more environmentally friendly are introduced), external recognition and awards (points achieved when environmental performance has been recognized by third-parties), and hazardous waste (that measures the amount of hazardous waste the company produces). Results from this empirical analysis concerning the EP was based on a ranking score as presented in appendix 3

As for the three last case studies, LCA methodology was used to evaluate the carbon footprint (CF) associated with the life cycle of packages and the defining key performance indicators (KPIs) for each step within the boundary systems including the carbon footprint, the water footprint, the cumulative energy demand, and others damage categories such as resource preservation, ecosystem quality, and human health.

The environmental performance for the first case study was evaluated for two years (2010-2012) whereas the one for the second case study was evaluated for five years (2010-2015) and for the three last case studies, annual operations were necessary to process the functional unit.

Besides, environmental management measures can vary based on the purpose of the study. Therefore LCA which is a methodology used to assess the environmental outputs of generic activities will use variables that address a firm's attitudes and objectives towards environmental responsibility as well as environmental management structure and processes (case study 3, 4, and 5). This approach known as pollution control is based on techniques of waste removal treatment and disposal, and it usually entails the use of specific facilities that treat the waste or pollution once this has been generated (end-of-pipe approach).

Nevertheless, the main problem with LCA is the amount of complexity that should be considered throughout the process, the considerable time needed to gather data that will help operate with it, and the use of software solutions that remove the margin for error which is needed to make sure that the calculation and simulations are accurate.

Environmental management measures can also be applied for pollution prevention implemented to reduce or eliminate the creation of pollutants through increased efficiency in the use of raw materials, energy, or water during the manufacturing processes. The variables used are known as environmental performance variables that evaluate environmental impacts in physical and monetary terms and mostly applied in innovative environmental management that can lead to firms competitivity.

Indicators such as Sustainable Value approach that measures corporate sustainability performance in monetary terms (case study 1) can be applied to assess environmental performance. Moreover, depending on the context, empirical studies can use information releases regarding emissions, environmental awards, and environmental investment to observe their effects on financial performance (case study 2)

However, it is important to mention that pollution control through LCA can also be applied on both the first and second case study since they are based on processes (efficient use of raw material), systems (effectiveness in achieving eco-efficiency targets), and productivity (economic efficiency in implementing environmental programs). Hence it's unfortunate that these case studies did not applied LCA which includes understanding the packaging process from cradle to grave, as well as the environmental impacts that the paper and packaging industry is making at both micro and macro levels. Without having information on the possible environmental impact of the packaging end of life seems to be problematic since this information will help understand the details and gain insights on what is happening with the packaging and what should be done to improve them in the long run meaning that both the pollution control and pollution prevention are usefull when it comes to assess environmental impacts of a firm.

3.2.2 Economic performances

In order to measure the financial performances of the following empirical studies, dependent variables including ROS and ROE were used respectively to measure corporate financial performances of the first and second samples to be analyzed. While LCC was used for both the third and the fifth case studies. Whereas, the economic assessment for the fourth case study was performed using Input-Output (IO) analysis known as a macroeconomic analysis commonly used for estimating the impacts of positive or negative economic shocks and analyzing the ripple effects throughout an economy.

Accounting-based measures that include return on equity (ROE), return on assets (ROA), return on sales (ROS), and return on investment (ROI) used to measure the financial performance of the firm (case study 1, and 2) are subject to managers' discretionary allocations of funds to different project choices. They reflect internal decision-making capabilities and managerial performance rather than external market responses to organizational actions. The main advantage of accounting-based measures is that they can measure different aspects of financial performance. For example, ROA is a measure of firm's profitability, ROS is a measure of a firm's efficiency and growth in sales is a measure of firm's effectiveness. Thus, by combining multiple accounting-based measures within a single study, a researcher can obtain a more integrated view of environmental performance. However this approach does not take into consideration nonfinancial performance that helps existing and potential stakeholders make better business decisions regarding to environmental and social considerations which are important in the sense of sustainability.

LCC is a useful tool used in economic assessment since it helps to have an overview on the total project cost including the total acquisition cost, total facility management (operation and support) costs, and total disposal cost (case study 3,4, and 5). However, it fails to capture the full dimension of economic sustainability. It has potential contradictions in system boundary to an environmental LCA and includes normative judgments at the equivalent of the inventory level. Further, it has an inherent contradiction between user goals (minimization of cost) and social goals (maximization of value-adding) and has no clear application in a consequential setting. LCC is focused on the indicator of life cycle cost, to the exclusion of many relevant indicators. Therefore, it will be interesting if the LCC can include the value-adding to the economy by type of input, import dependency, indicators associated with the role of capital and labor, the innovation potential, linkages, and the structural impact on economic sectors.

3.2.3 Evaluating the link between environmental performance and economic performance

The long-term and short-term relationship for the first case study was assessed using univariate regression analysis with panel data while for the second case study after calculating the total score for corporate environmental performance per year and retrieving information on ROE figures, the link between those two was evaluated using statistical methods including the Pearson's correlation coefficiency calculated from the five years then finally the correlation coefficiency was computed in Microsoft Excel using PEARSON function. As for case studies number three and four, a Multi-criteria analysis was applied to evaluate the link. Whereas for the fifth case study a combination of LCA and LCC was used to evaluate the link.

The specific objectives of these analyses are to provide a robust statistical integration on the relationship between environmental performance and economic performance, to acknowledge the effect of EP and FP, operationalization variables, industry context, countries, and the observation period of the studies on this relationship. Moreover, these statistical applications can help explain the inconsistent results across this relationship.

The tools and variables used in each empirical analysis to assess the environmental performance, the economic performance, and the link between both performances are presented in table 6, 7, and 8 below.

Tableau 6 Summary of all environmental variable definitions used in the empirical analysis

Company	Environmental assessment method	Data sources	Environmental performance variable	Description of the variables
1	Sustainable Value- environmental index	Environmental reports (2010-2012)	CO_2 emissions	Emissions of co_2 per output (t/year)
			Water input	Total water input per unit of output (m^3/t)
			Energy input	Total energy input per unit of output (KW h/year)
			Self-produced renewable energy	Self-produced renewable energy (KW h/year)
			Recycled quantity	Recycled quantity (t/year)
			Quantity of waste produced	Quantity of waste produced (t/year)
2	Content analysis method	Annual reports, company websites	Pollution prevention	Evaluate the company pollution prevention programs
			Clean and Efficient Energy Use	Renewable energy use and energy efficiency improvement
			Recycling	Recycling rate and efforts to decrease the amount of waste
			Pioneering product in the industry	Points achieving if green new products are introduce
			External Recognition	Receiving awards for environmental improvement
			Hazardous Waste	Measures the amount of hazardous waste produce

company	Environmental assessment method	Environmental performance variables	Description of the variables	Data sources
3	LCA	Carbon footprint	Emissions in term of kg of CO_2eq generated /year	Literature Review
		Water footprint	Total water input per unit of output (m^3/t)	
		cumulative energy demand	Total energy input per unit of output (KW h/year)	
		resource preservation	Self-produced renewable energy (KW h/year)	
		ecosystem quality		
		human health		
4	LCA	Climate change;	Emissions in term of tones of CO2eq generated /year (($t CO_2$ eq.)	SPV internal data and other bibliographic sources
		Photochemical ozone formation	Emissions in term of kg of Chlorofluorocarbonseq generated /year (kg CFC^{-11} eq.)	
		Acidification	moles H^+ eq	
		Water resource depletion	m^3 eq	
		fossil and renewable resource depletion	(-)	
5	LCA	Acidification Potential (AP)	moles H^+ eq	Spanish Green Dot Holders,Public Administration
		Global warming potential (GWP)	kg CO_2 eq	
		Eutrophication potential (EP)	moles N eq	
		Ozone Depletion Potential (ODP)	kg CFC^{-11} eq.)	
		Photochemical oxidation potential(POP)	kg de C_2H_4 eq	
		Abiotic Resource depletion Potential	kg Sb eq	

Tableau 7 Summary of all economic variable

Company	Economic assessment tools	Economic performance variables	Description of the variables	Data sources
1	Multiple linear regression	ROS	Return on sales (%) = pre-tax profit (loss)/operating revenue X 100	Annual reports
2	Accounting based measures financial return	ROE	Return on equity (%) = pre-tax profit (loss)/shareholders' X 100	Annual reports
3	Life cycle costing	Network infrastructure costs		Literature review
		Manufacturing costs		
		Transportation costs		
		Storage and Disposal costs		
		General operating drivers costs		
4	Input–Output (IO) analysis	roe	Rest of the economy	National accounts
		SPV	Packaging waste management – SPV	
		MWS	Municipal Solid Waste Management Sector	
		REC	Recycling sectors	
5	Life cycle costing	water, electricity, diesel, gas, salaries	Operational costing of most of the processes	Panel of Interested Parties

Tableau 8 Summary of Evaluation models used to assess the link between EP and FP for each empirical analysis

Company	Dependent variables	Independent variables	Evaluation model for the link between EP and FP
1	ROS	Environmental investments per year (EI)	Econometric analysis based on the static method and the dynamic method
		Percentage of certified fibers (CF).	
		% of value of created or lost by the group through the use of CO_2($SVMCO_2$)	
		% of value created or lost by the group through the use of water	
		% of value created or lost by the group through the use of energy	
		% of value created or lost by the group through the use of renewable energy	
		% of value created or lost by the group through the use of recycle	
		% of value of waste created or lost by the group through the use of waste	
2	ROE	Corporate environmental performance variables	Statistical computing. Pearson's correlation coefficiencies
3			Multi-criteria analysis
4			Multi-criteria analysis
5			Combination of LCA and cost accounting

4 Results

The results from the five case studies were analyzed and divided into three sequential parts. On one hand, a focus was made on the Stora-Enzo paper and packaging industry in France and in Finland (case study 1, and 2), On the other hand a review of the results obtained from packaging waste management systems (case study 3, 4, and 5).

4.1 Environmental performance

4.1.1 The Stora-Enzo paper and packaging industry in France and Finland

The environmental « Sustainable Value » and the content analysis method were used respectively to assess the environmental performance of the Stora-Enzo paper and packaging industry in France and in Finland. Results for both companies are presented below

Tableau 9 « Absolute Sustainable Value » CO_2 of Stora-Enzo France 2010, 2011, 2012 in million euro

Groupe	2010	2011	2012
Stora-Enzo	-1111.03	-850.26	-562.9

Tableau 10. Environmental « Sustainable Value MARGIN » of Stora-Enzo France 2010, 2011, 2012 in % of year.

Groupe	2010	2011	2012
Stora-Enzo	-10.8%	-7,75%	-5.2%

Tableau 11 the "absolute sustainable values" relating to the "CO2 emissions" and resources of Stora-Enzo France for the period 2010-2012.

absolute sustainable values	2010	2011	2012
CO_2	23	4.9	439.2
Water	-894.96	-668.25	-742.8
Energy	-298.7	-693.9	-289.9
Renewable Energy	-235.2	-128.8	175.2
Recycle	-285.07	-54.81	-379.4
Waste	579.6	690.6	585.2

Tableau 12 Results from the environmental variables of Stora-Enzo Finland for the period 2011-2015.

	2011	2012	2013	2014	2015
Pollution prevention	CO_2 (-13%) SO_2 (-16%) COD (-4%)	CO_2 (-3%) SO_2 (+19%) COD (-1%)	CO_2 (+3%) SO_2 (-9%) COD (-8%)	CO_2 (-3%) SO_2 (+5%) COD (-1%)	CO_2 (-3%) SO_2 (-14%) COD (+3%)
Clean energy	EE -1% Renewables/Internal 47% Biofuels 76%	EE +1% Renewables/Internal 43% Biofuels 78%	EE +3% Renewables/Internal 47% Biofuels 77%	EE + 2% Renewables/Internal 49% Biofuels 79%	EE +3% Renewables/Internal 46% Biofuels 81%
Recycling	Lanfilled (-26%) Recycled (97%)	Lanfilled (-12%) Recycled (97%)	Lanfilled (+29%) Recycled (96%)	Lanfilled (-40%) Recycled (98%)	Lanfilled (-28%) Recycled (98%)
Pionnering products	Micro Fibrillated Celluse	Microcellulose	FLYO+	Bio-plastics	New Natura Concept
Hazardous waste	+123%	-44%	-18%	+24%	+/-0%

The environmental "Absolute Sustainable Value" represents the total Sustainable environmental value created by taking into consideration all the environmental resources made available to the company. It can be seen that although negative, the sustainable values achieved by Stora-Enso France improve over time from 2010 to 2012 (table 10).

Whereas the environmental “Sustainable Value Margin” that expresses the lasting value that the company creates as a percentage of the turnover achieved for the period 2010-2012, shows that the company destroyed on average the equivalent of 7.9 € of sustainable CO_2 value per 100 € of turnover between 2010 and 2012 (table 11) thus allowing an evaluation of its environmental performance.

By comparing the sustainable value margin to the “Absolute Sustainable Value” it can be seen that the positive/negative signs do not move, which means that the company which uses all of its resources in a more efficient way than the average (Benchmark) and which creates value, also has a positive “Sustainable Value Margin”. The “Absolute Sustainable Value” relating to each resource of Stora-Enzo France shows that there is a fluctuation in terms of value created by the firm from one year to another (Table 12). It is therefore seen that two years is not enough for the eco-innovative initiatives undertaken by Stora-Enzo France to improve its environmental performances.

If comparing these results with the one from case study 2 (Stora-Enzo based in Finland) for the same year period (2010-2012) it can be seen that CO_2 emissions have lowered slowly during the review years. However, the figure has usually improved by a few percent. In general, 2015 emissions from Stora-Enzo Finland were reduced by 3% from the previous year, COD figure has slightly improved during each review year while the company sulfur dioxide level has improved in some years and worsened in others. For example, in 2011 it improved by 16% and in the following year, worsened by 19%.

Regarding other variables, the same fluctuation was still apparent in terms of value created by both firms from one year to another with an exception for Stora-Enzo Finland when it comes to the recycling aspect. The firm has been successful in reducing the amount of waste to landfills with an exception for the year 2013 when landfilled waste amount increased by 29% from the previous year.

Indeed, environmental impact assessment requires an objective and rigorous analysis. However, the choice of the methods used to assess environmental impacts can be subjective and arbitrary. Wided Boubake (2015) and Maria Eilola (2017) research work evaluate the environmental impacts of the paper and packaging industry in France and in Finland and proposed ways to improve environmental decision-making including a sustainable value approach for the first case study and content analysis for the second case study. Results from both case studies indicated that investing in eco-innovations contributes to achieving better environmental performance over time with considerable fluctuations from one year to another.

However, alternatives choice which includes not just a particular company goal, but also broader societal goals such as the protection and promotion of environmental quality will seem to be a great compromise. Therefore, LCA can also be applied in addition to the above methods since it is based on efficient use of raw material, effectiveness in achieving eco-efficiency targets, and economic efficiency in implementing environmental programs. Moreover, content analysis is time-intensive (manually coding large quantities of content is extremely time-consuming, and it can be difficult to automate or computerize effectively) and subjective which means it always involves some level of personal interpretation, which in turn affects the reliability and validity of the conclusion and results.

4.1.2 Packaging waste management systems

The functional unit (FU) for case study number 3 is represented by the transportation of 1200 t of fruits and vegetables throughout the food catering chain (FCC).

The system boundaries For the reusable plastic container (RPC) packaging system configuration included the following steps:

- ✓ The RPC manufacturing process ;
- ✓ The transportation activities from package suppliers to the pooler and from the pooler the disposal center ;
- ✓ The transportation activities between the pooler, farmers, distribution center (DC), and customers with a frequency depending on the packaging lifespan;
- ✓ The RPC washing treatment;
- ✓ The end-of-life scenarios (i.e. landfill, incineration, and recycling).

The carbon footprint (CF) was adopted as a metric for assessing the environmental impact of both packaging systems under analysis. The LCA demonstrates that the environmental impact associated with the single-use network is mainly caused within the manufacturing phase, due to the great volume of the packages required over the year. However, transportation significantly affects the sustainability of the RPC system. In summary, the analysis shows that for the case study in question, the adoption of an RPC system will lead to a reduced of the environmental impact in terms of CO_2eq emissions.

For case study number 4, the Unit Function selected for reference was “total packaging waste managed by the SPV under SIGRE in 2011”. The results from this case study showed that materials with less impact on the environment are glass and paper packaging waste with an added value in terms of environmental performance for SIGRE (varying between 29% and 58%) except for the category mineral, fossil, and renewable resource depletion, which is relatively minimal**.** The author explains this result on the one hand by the good quality of these materials and on the other hand by the profit generated due to the recovery of these materials.

The results obtained have also shown that the recycling of packaging waste is the key process to avoid environmental burdens for all categories of environmental impact. In addition, the various activities of collecting, sorting, transporting, treating, eliminating, and recovering waste are offset by impacts avoided thanks to the material and energy recovery processes. This good recycling performance results from the balance between the impacts generated by the recycling of packaging waste (e.g. consumption of natural gas to melt glass), and the benefits linked to the incorporation of secondary materials in new products thus avoiding the use of virgin raw materials. Overall, the net result of the various management operations of SIGRE showed signs of optimism in terms of environmental benefit.

To assess the relative merit of the current system, the environmental impacts of urban waste management within SIGRE in 2011 (Baseline 2011 scenario), were compared with two hypothetical alternative scenarios :

- ✓ "Landfill Scenario" – considered that all packaging waste would be collected and sent to landfill.
- ✓ "Energy recovery Scenario" – considers that all packaging waste would be collected and sent for incineration.

The results presented include the direct and indirect emissions resulting from the operation of the system, including, for example, direct emissions resulting from the disposal of packaging waste into landfill, as well as indirect emissions associated, for instance, with the production of electricity that is consumed in the packaging waste sorting operations.

The evaluation of both scenarios was performed for the same mix and quantities of waste that have been effectively managed in 2011 under SIGRE and based on the same technologies, and function. The results show that the "Baseline 2011" set is the only one that reduces environmental impacts across all categories. The "Energy recovery scenario" generates increases climate change impacts, while the "Landfill scenario" is the worst option, with a clear increase of all impact categories.

For example, concerning the climate change category, the "Baseline Scenario 2011" entails the reduction of GHG emissions equivalent to about 116 kt CO_2eq, while the scenarios "Landfill" and "incineration" represent, respectively, the emission of about 285–280 kt CO_2eq, and this demonstrates the benefits of the current system.

Case study number 5 uses as flow reference (functional unit) all beverage containers placed in the market in Spain in 2014 with certain boundary characteristics. The two scenarios to be compared for this case study were :

- System A. Representing the current real situation of household packaging waste management in 2014 in Spain, where the whole amount of packaging placed into the market is managed by the Green Dot System (GDS) through a collective compliance scheme.
- System B. Representing the hypothetical situation of the management of household packaging waste in 2014 in Spain, if there had been a Deposit Refund System (DRS) working in full performance and without learning curve (with a return rate of 90%) for

the specific beverage containers, coexisting with a GDS for the rest of packaging waste excluded by the DRS.

The system boundaries for this study are :

- ✓ System A boundaries: Green Dot System

This model corresponds to the current household packaging waste management in Spain. In this case, containers hypothetically included in the DRS (waste stream 1) and containers excluded from the DRS (waste Stream 2) will follow the same collection, separation, and treatment model, since currently there is no differentiated management for both containers streams. In this system, household packaging materials are recovered in different ways:

- ✓ System B boundaries: Deposit Refund System and Green Dot System coexistence

This model corresponds to the hypothetical inclusion of a mandatory DRS in Spain to collect certain beverage containers in coexistence with the GDS managing the packaging waste not recovered by the DRS. In this case, waste streams 1 and 2, follow different management ways, which are analyzed separately.

For case study number 5, the author focused his results primarily on the material flow indicator. The results obtained showed that system B seems to be the system that has obtained the best environmental performance with an increase in the recycling rate of packaging of 12.5% and 1.5% compared to the total supported by the solid waste management system as well as a reduction in the quantity of landfill waste and waste to be incinerated, which in volume represents a reduction of 32.1%. However, these apparent improvements in material flows do not directly correlate with a reduction in environmental impact because the processes necessary to achieve these goals have a greater environmental impact.

The overall negative results showed that the savings associated with the material and/or energy recovery of the two systems are greater than the environmental impacts associated with the waste collection and management operations. Therefore, it can be said that the implementation of the two packaging waste management systems analyzed is beneficial for the environment.

However, for all impact categories, except abiotic resource depletion (10.2% impact reduction), the results associated with system A showed better EP compare to system B. Values furthest from 0 confirm with greater certainty that system A is better than B ; in contrast, values closer to 0 have greater uncertainty. Also, in light of the results, it can be said that, as a whole, the introduction of a DRS would cause environmental damage compared to the current system.

Regarding the environmental performance of the packaging waste management system, various conclusions can be taken as follows :

- ✓ The environmental impact associated with the single-use network is more considerable compare to RPC due to the great volume of the packages required over the year. However, transportation significantly affects the sustainability of the RPC system.
- ✓ Materials with less impact on the environment are glass and paper packaging waste with an added value in terms of environmental performance.
- ✓ Recycling of packaging waste is the key process to avoid environmental burdens for all categories of environmental impact.
- ✓ Till now the Green Dot System is still the less polluted packaging waste management system

The appropriate tool for considering environmental impacts over the packaging life cycle is LCA that can be performed at different levels depending on the purpose of the study, or the state of development of a new product or a new packaging. However, the inconvenience with the LCA approach is the amount of complexity that should be considered throughout the process, the considerable time needed to gather data that will help operate with it, and the use of software solutions that remove the margin for error which is needed to make sure that the calculation and simulations are accurate.

4.2 Economic performance

4.2.1 The Stora-Enzo paper and packaging industry in France and Finland

Return on sales (ROS) and Return on equity (ROE) was respectively used as a measure of corporate financial performance of Stora-Enzo France and Stora-Enzo Finland. it has been noticed that on average, the paper groups of the first case study are profitable including Stora-Enzo France (average ROS = 5.14%) while the ROE in Stora-Enzo Finland varies between the same range of negative to approximately 15.0% followed by a negative return on equity figure once during the review period as shown in the table below.

Tableau 13 ROE of Stora-Enzo Finland

	2010	2011	2012	2013	2014	2015	2016
Stora Enzo Finland	13.5%	5.6%	8.3%	-1.3%	1.7%	14.6%	7.2%

4.2.2 Packaging waste management systems

The three principal actors of the catering chain implicated in the economic assessment include the vendors, DC, and customers. The results showed that benefits were noticed with vendors and farmers for adopting the RPC system while DC and customers experience higher costs for traceability transportation and handling activities.

Whereas the economic impact of SIGRE in the Portuguese economy, in terms of gross value added, wages and total revenue showed that for each Euro of value-added generated in SIGRE 1.25 euro, are added to the rest of the economy (multiplier effect of 2.25). Moreover, for every Euro of wages paid by SIGRE, an extra 1.30 euro of wages are paid for in the rest of the economy. Finally, for each Euro of turnover in SIGRE an extra 1.04 euro of turnover circulate in the rest of the economy Moreover, these conclusions are in accordance Green Dot System applied in Spain and that remains economically the most profitable packaging waste.

4.3 Link evaluation of EP and FP

4.3.1 The Stora-Enzo paper and packaging industry in France and Finland

The analysis of the correlation coefficients between the different variables of the year 2012 and the ROS2012, as well as between the different explanatory variables delayed by one year (2011) and two years (2010) and the ROS2012 was applied through two linear regression models (the static model and the dynamic model) to assess the link between EP and FP for case study 1. As for case study 2, The link between CEP and CFP was evaluated bidirectionally: from CEP to CFP and from CFP to CEP. One year lag was used between CEP and CFP meaning that, when the link was evaluated from CEP to CFP, corporate environmental performance figure was from the year 2011 and financial performance figure from 2012, and when the link was evaluated from CFP to CEP, financial performance figure was for example from the year 2010 and environmental performance figure consequently from 2011. The author here used Pearson's correlation coefficient to calculate the link between CEP-CFP and CFP-CEP over the five years.

In general, the results obtained from the first case study with the static model show that current environmental initiatives and investments in eco-innovative actions seem to be associated with an improvement in the current profitability of paper companies, while with the dynamic model the results are much more unstable.

Thus showing that environmental actions have a positive effect from the first year of their implementation and that only environmental investments and the percentage of certified fibers have a positive and long-term influence on FP, unlike environmental SVM which has no

dynamic relationship with FP (year t-1, t-2). However, its impact is immediate in the short term (from year t).

As for case study 2, The results for Stora-Enzo showed a figure close to zero meaning that there is no correlation between environmental performance to financial performance. In conclusion, based on the above analysis it can be said that the link between the environmental performances and economic performances in terms of eco-innovation is time-sensitive.

4.3.2 Packaging waste management systems

For the case study, 3 parameters such as RPC lifespan, disposal treatments, and network distribution can profoundly affect both the environmental and economic analysis, potentially leading to different conclusions while for case study 4 the strong impact on added value and wages for the packaging waste management system is because the use of primary factors of production represents only a small proportion of the total turnover of SIGRE-SPV. The municipal waste system has multipliers lower than two because waste collection and sorting require few purchases of goods and services to other sectors when compared to primary factors, such as labor and financing costs. Regarding recycling, metals, and paper the highest indirect effect is on value-added and wages. Concerning total revenues, there is a smaller variation of the multiplier by type of material. Globally, municipal waste systems (MWS), paper, plastic, building construction, gross sales, and electricity are the sectors that benefit the most (directly and indirectly) from the activity of SIGRE.

As for the fifth case study, the introduction of a DRS in Spain because according to several indicators, it carries a higher environmental impact, mainly due to more impacting processes involved in the increment of the overall recycling rate and also has an important economic cost to the society.

4.4 Synthesis of the results

This master thesis aims to carry out systematic literature review of the quantitative and qualitative studies based on 5 empirical analysis in order to analyse green management of packaging industry, and packaging waste management systems on financial performance and to emphasize on the environmental variables and statistical methods used, financial performance variables, current gaps, mechanisms that explain the relationship between the environmental performance and the economic performance and methodological inconsistencies. The reason is to add a contribution to the debate and to find whether the real benefits of environmental performance practises in firms are indeed related to the consumers, society, stakeholders, shareholders. The case studies were choseen in order to assess the link

between environmental performance and economic performance both in packaging upstream and downstream.

As already metionned past research has shown that (1) the relationship may not be uniform , which highlight that determinants of environmental profit needs to be identified (2) no uniform distribution in dimensions considered in measuring financial performance, suggesting to cluster relevant financial measuring factors based on environmental practices and (3) the relationship may not be static across time, which means that changes in the determinants of environmental profit over time need to be discussed.

Indeed environmental practices aims to eliminate environmental polluants or waste and to develop sophisticated environmental management practices. In this study the implementation of environmental practices applied in the empirical studies was waste treatment, emission reductions, recycling, environmental innovations, and environmental management system with a focus on improving environmental performances and to gain competitivity as to comply with environmental directives.

Throughout the analysis different type of environmental performance measures have been used by the Authors. Wided Boubake (2015) used environmental sustainable value approach that measures corporate sustainability performance in monetary terms. In this sense companies create value whenever they use a resource more efficiently than their peers as shown in figure 19.

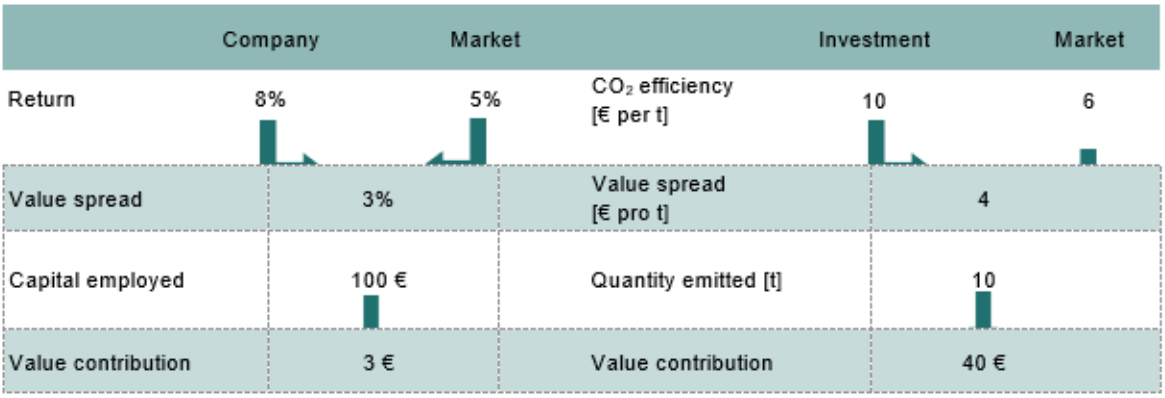

Figure 19 Value-oriented analysis of resource use

The example illustrated above explains that when assuming an investment, such as a share, produces an annual return of 8%. To assess whether this was a good performance, we need to compare it with a benchmark (generally the market average). Assuming that the market has only produced an annual return of 5%, the investment has achieved an additional return of 3%, also known as the value spread. To determine how much value has subsequently been

generated, this value spread simply needs to be multiplied by the capital employed. Assuming an investment of 100 €, the value spread comes to 3 €. **[87].**

The environmental variables used to assess the environmental performance of the french paper and packaging industry were emissions, recycling, alternative energy, waste reduction environmental index, water, and energy. While Maria Eilola (2017) considered recycling, alternative energy, pollution prevention, waste reduction, energy efficiency, and compliance record as environmental variables and applied content analysis as the tool used to assess environmental performance.

As for R. et al (2014), Paulo Ferrão, et al (2014), and B.D. SUCH, et al. (2017), LCA was applied as a tool to assess environmental impacts whereas emissions footprint, water footprint, depleting substances emissions, and environmental health and safety were used in general as environmental variables. Concerning financial performance, two different types of firm performance measures were used Throughout the analysis including return on sales (ROS) for the first case study, and return on equity (ROE) for the second case study while LCC was applied for case study 3 and five and input-output for case study 4.

Furthermore, analysis of the correlation coefficients between the different financial variables and environmental variables (case study 1) show that current environmental initiatives and investments in eco-innovative actions seem to be associated with an improvement in the current profitability of paper and packaging companies with the static model, while with the dynamic model the results are much more unstable thus showing that environmental actions have a positive effect from the first year of their implementation and that only environmental investments and the percentage of certified fibers have a positive and long-term influence on FP, unlike environmental sustainable value margin which has no dynamic relationship with FP however its impact is immediate in the short term. As for case study 2, results for the same paper and packaging industry but this time-based in Finland showed a figure close to zero meaning that there is no correlation between environmental performance to financial performance.

However, it has been shown in previous studies that equity return increase due to emission reduction but at the same time result shows that it does not have a significant effect of return on sales. The reason behind that is greenhouse gas reduction increases ROE which reflects the long-run financial performance and it does not have a significant effect on ROS which shows the short-run financial performance Hart and Ahuja (1996) **[80].** On the other hand, combining LCA and economic measurement could have been an alternative to obtain a better compromise between FP and EP since LCA is based on efficient use of raw material, effectiveness in

achieving eco-efficiency targets, and economic efficiency in implementing environmental programs. However, previous studies showed inconsistency to this approach. For instance, Lin (2014) conduct research based on ISO 14001certification and found that no significant correlation exists between environmental and financial performance due to ISO 14001 certification **[88].** While Wahba (2008) found that ISO 14001 has a positive and significant impact on the firm market ratio **[89].**

Concerning the packaging waste management systems, the link between environmental performance and economic performance can vary considerably depending on the waste management system applied. Hence process such as recycling seems profitable both in the economic and environmental aspects while that disposal of waste without any treatment is for landfilling and fresh marine water or air is merely a bad practice and polluting environment the same as dumping practices are not sensible it could create serious issues such as groundwater contamination, leakage of toxins, air pollution, and negative effect on flora and fauna.

In conclusion, based on the above analysis it can be said that the link between the environmental performances and economic performances in upstream packaging is time-sensitive while the relationship when applied to downstream packaging has a positive effect when it comes to recycling. Despite the fact that the relationship between environmental practices and their financial performance is still unclear, it, therefore, opens doors to more investigation in this area to build up a standard model for the relationship between financial performance and environmental practices. Moreover, producers and manufacturers should be responsible for the end-of-life of packaging and what happens to it after consumers are finished. In the case of pre-consumer waste, there is even less room for attempting to push this responsibility downstream, as this material is still within the control of the factory, transport, and retail systems. Producers invest time and money into these systems, so it makes sense that they would retain accountability for their operations, including the management of their surplus and waste material.

5 Conclusions

This master thesis aimed to assess the sustainable initiatives undertaken by packaging processing firms and packaging waste management systems through 5 empirical analysis, to emphasize their environmental performances and economic performances, to review the mechanisms that explain the relationship between the environmental performance and the economic performance, and finally to propose an answer to the question what strategy to be implemented to reconcile environmental performances and economic performances.

To answer this question, It has been chosen to focus the analysis first on the packaging processing firms (case study 1 and 2) in general, and especially on the Stora-Enzo paper and packaging industry in France (sample from case study 1) and Stora-Enzo in Finland (case study 2) and second on the packaging waste management systems from (case study 3, 4, and 5). Regarding analysis on packaging processing firms, it has been found that sustainability efforts and eco-innovations are globally profitable from the first year of their implementation however, their effect over time varies depending on the resource and the action in question. Regarding the link between EP and FP in terms of eco-innovation was time-sensitive for the first case study while no correlation was observed for the second case study with correlation coefficiencies varying between -0,152 and 0,627 for CEP-CFP and correlation coefficiencies varying between -0,164 and 0,897 for CFP-CEP.

Looking at the packaging waste management systems, the analysis showed that the RPC system leads to a reduced environmental impact in terms of CO2eq emissions compare to a single-use network. However, the economic return is projected to be negative, resulting in a cost increase per kilogram of the handled food product. Whereas the packaging waste management system based on the eight main clustered processes, including (1) selective collection; (2) undifferentiated collection (concerns the packaging which is still recovered from the processing of undifferentiated waste);(3) sorting;(4) recycling;(5) energy recovery; (6) mechanical treatment; (7) organic recycling (composting and anaerobic digestion); (8) landfill remains the most efficient packaging waste management system in terms of environmental performances and financial profits compare to other systems such as the management of household packaging waste if there had been a DRS working in full performance and without learning curve (with a return rate of 90%) for the specific beverage containers coexisting with a GDS for the rest of packaging waste excluded by the DRS.

Indeed it is unfortunate to find that empirical studies on the link between environmental performances and economic performances in the packaging system do not pay much attention to the relationship between consumer's perceptions of sustainability and eco-prices since the latter could be served as a crucial indicator into the analysis of economic performances. Besides more upstream studies on environmental and economic assessment could allow companies to anticipate the measures to be taken in terms of investment for a better investment return.

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7 Appendices

7.1 Appendix 1 Definition of some environmental analysis tools

Matrice Environmentally Responsible Product Assessment (MERPA) : is a form of simplified LCA. It can be used for evaluating products, processes, services, infrastructure, etc., taking into account their life cycle. This method is based on a 5x5 matrix powered by a control List.

The "Materials, energy content and toxicity" matrix (MET) lists the flows inputs, and outputs for each stage of the life cycle on three criteria: consumption of materials, energy consumption, and toxicity (emissions and waste). A fourth “other” dimension can be integrated.

The simplified and qualitative assessment of the life cycle (SLCA) is a diagnostic method that borrows concepts used during LCA but in a faster, more selective, and simpler way. It allows the qualitative assessment of the impacts of a product on some phases of its life cycle.

The ad hoc matrix approach consists of establishing an environmental diagnosis in the form of a table, considering the environmental impacts related to each stage of the life cycle

The Ecological Index Matrix is a matrix tool allowing the development of an environmental diagnosis of a product over its entire life cycle.

7.2 Appendix 2 Calculation method for the “Sustainable Value” index (case study 1)

The Sustainable Value was calculated in five steps

- The first step in calculating Sustainable Value was to determine the amount of resources used by the business in a given year, which will then be compared to the income generated. For this, the Earnings Before Interest and Tax (EBIT) was used to determine the carbon performance. Thus, taking the case of CO2 emissions, the efficiency of the use of this resource corresponds to the EBIT generated in euros per unit of resource used. Therefore, CO2-efficiency is calculated by relating the EBIT generated by the company to the amount of CO2 emitted.

Step 1 : Company-CO2-efficiency = EBITt /CO2t emmissions

- The second step is to determine the efficiency of the use of CO2 resources by the benchmark (the average CO2 efficiency of a company), in the same way as for companies.

Step 2 : Benchmark-CO2-efficiency = $\sum$EBITt / $\sum$ CO2t emissions

- The third step was to compare the efficiency of the use of resources by the company to that of the Benchmark. For that, a value known as the "Value Spread" (the value created per

unit of resource generated by the company) was obtained from the deduction of the average efficiency of the groups (of the Benchmark) from that of the company.

Step 3 : Value spread = Company-CO2-efficiency - Benchmark-CO2-efficiency

- at the fourth step, the "Sustainable Value is obtained by multiplying the“ Value Spread ”generated by the company, for a given environmental resource, by the corresponding quantity of resources consumed for each year. It is at this stage that we can judge whether a company generates more value or profit than the Benchmark by efficiently using its environmental resources.

Step 4 : « Sustainable Value » = Value spread * Company-CO2-emissions

- At step 5, we have the Marginal sustainable value will be equal to the Sustainable value divided by the company's turnover.

Step 5 : « Marginal sustainable value » = « Sustainable Value » / company turnover

7.3 Appendix 3 Scoring criteria (case study 2)

- Pollution prevention :

a. 0 points : Emission levels have worsened, or remained the same during as in previous year.
b. +1 points : All emission levels have at least remained at the same level when at the same time the amount of at least one emission has decreased significantly, or the amount of all emission levels has decreased to some extent from previous year.

c. +2 points : All emissions levels have decreased when at the same time at least one has decreased significantly. Or many pollutants have decreased significantly.

- Clean and efficient energy:

a. 0 points : The figures have worsened or remained the same as in previous year.

b. +1 point : All figures have at least remained at the same level when at the same time at least one figure has improved significantly. Or all figures have improved to some extent from previous year.

c. +2 points : All figures have improved and at least one has improved significantly.

- Recycling:

a. 0 points : The figures have worsened or remained the same as in previous year.

b. +1 point : Waste to landfill figure has improved significantly or waste to landfill figure has at least remained at the same level when at the same recycling rate is at least 90%.

c. +2 points : Waste to landfill figure has improved more than 20% and recycling rate has remained the same or improved at the same time.

- Pioneering products:

a. 0 points : The company has not invented innovative products that address environmental aspects better than other similar products.

b. +1 point : The company has invented at least one innovative product that clearly addresses some environmental challenge or that has significantly smaller negative environmental impact than competing products.

c. +2 points : The company has introduced at least two products that clearly address some environmental challenge or that have significantly smaller negative environmental impact than competing products.

- External recognition :

a. 0 points : The company has not gained external recognition for its environmental performance.

b. +1 points : The company has been recognized by at least one external party for its environmental performance

c. +2 points : The company has gained extensive external recognition, including recognition for being an industry leader.

- Hazardous waste:

a. 0 points : The figure has worsened or remained the same as in previous year.

b. +1 point : The figure has improved 5-20% from previous year.

c. +2 points : The figure has improved significantly, more than 20%, from previous year.

A strategy to reconcile environmental performances and economic performances in the process of greening packaging

Presented by Patrick Ngogang Mfeyom

ABSTRACT

Packaging is considered to be an essential component of our daily life since it embraces all phases of activities involved in the transfer of goods and services right from manufacturers to consumers. However, once considered as waste, it can become a hazard for both humans and the environment. Therefore, in this context of international climate crises, and with the necessity to comply with European directives, there is an increasingly strong push for packaging to become more sustainable in its production, use, and disposal, as these are linked to direct environmental impacts. Hence, more and more packaging companies and packaging waste management firms are realizing that there is scope for growth if they can carefully orchestrate themselves towards capturing the innovation opportunities in sustainability even though, it has always been challenging to comply with environmental standards while making profits at the same time.

For this study, the link between corporate environmental performance and corporate financial performance from 5 case studies was investigated. Both the qualitative and quantitative analysis method was chosen to gain a comprehensive and thorough understanding of environmental performances in the target companies while a variety of tools was used to measure corporate financial performance, corporate environmental performance, and the link between both performances.

The conclusions were that most of the environmental effects of packaging and packaging waste are related to production, waste management, and distribution. It has also been shown that none of the developed tools works towards an agreement on a conceptual framework to assess the environmental and economic performance of packaging processing and packaging waste management system. Besides, practices such as resource and energy saving, recycled packages, reducing packaging materials, and technology investments help package processing and package waste management firms to improve their environmental performances which can be directly correlated to their financial performances.

Keywords: environmental performance, economic performance, sustainable packaging

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