ESCOLA TÈCNICA SUPERIOR D'ENGINYERIA INDUSTRIAL DE BARCELONA

GRAU EN ENGINYERIA EN TECNOLOGIES INDUSTRIALS

Project: $SCCO_2$

Development of a scorecard to measure the carbon footprint of a product throughout the supply chain of a large consumption Company

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I would like to dedicate this project to all those people who have supported me during my degree, to the friends I have made and to my family, who have been there at all times.

I would like to thank the support and patience of my tutor, Sergio; and the dedication of my English teacher, Alan.

This project would not have been possible without all of them.

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1. INTRODUCTION

This project mainly gives an overview and insight on how we are affecting the environment with the decisions we make when purchasing a product. I decided to embark on this project due to my concern regarding the increasing deterioration of the environment because of CO_2 emissions combined with my interest for logistics and supply chain related activities.

I was heavily inspired by a website I found of an association of companies (AECOC) that aims to optimise and improve each step of the supply chain to increase competitiveness and boost value of the product for the customer

After thinking about different ways to link both ideas, I decided to tackle the CO2 emissions and global warming problem from a logistical point of view, by developing a **Scorecard.**

1.1. HOW DO WE USE A SCORECARD AND WHY WOULD WE USE IT

A scorecard is a tool that evaluates different aspect and features of a product in order to measure the carbon footprint of a product by considering different aspects such as the raw material, the logistical requirements to reach the customer or the packaging of the product.

After examining all the determining factors individually, the scorecard is able to calculate a score for each product and quantify the impact of each factor in the consumption of the product.

The main objectives of the project are separated in two different levels:

- Companies: A tool that helps companies and authorities to measure their global impact thoroughly and of their products on the environment.
- Consumers: It will give the consumer an insight into what the impact of the product they are purchasing is in order to raise awareness and improve the available information for the consumer.

The project will be divided into different phases:

1. Describing from a theoretical point of view global warming and the main consequences attached to it.
2. Creating the **Scorecard**.
3. Individually calculating the carbon footprint for a few sample products.
4. Knowing the opinion of consumers.
5. Interviewing a manufacturer in order to find out whether it is viable to add the scorecard indicator to the production process.

The scope of the project is to create a simple and accurate Scorecard. Simple in order to facilitate the handling of it by users In an easy and intuitive manner, and accurate to emulate the results of individual studies. As I mentioned earlier, to ensure and verify the results of the scorecard, I will study each product individually to compare the result of my study and from the scorecard.

Some companies already calculate their global impact. However, their approach is more traditional since they are heavily focused on the impact generated by processes in which they have a direct intervention, without regarding the whole product life cycle. *"Today, it is becoming clear that companies must go beyond their traditional internal approaches and consider the entire product life cycle when measuring environmental impact*" (Aurik, 2010).

Therefore, by including another indicator that controls and audits each step of the supply chain, companies will be able to calculate their full impact from the start to the end of the supply chain taking into account all the different parameters.

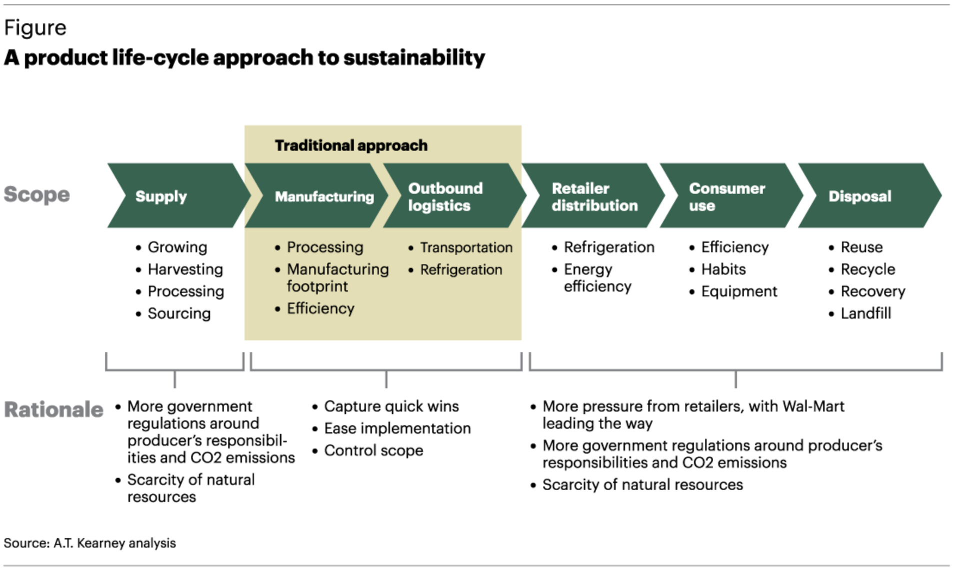

Figure 1 - A product life-cycle approach to sustainability

2. GLOBAL WARMING AND EMISSIONS

In order to properly contextualize and explain the problem behind CO_2 emissions, it is important to explain the different approaches our global leaders are adopting, the local situation in Spain and how we are hoping to address this problem .

2.1. CURRENT GLOBAL SITUATION

2.1.1. DEVELOPED COUNTRIES

At the moment, in global politics there are two different currents of thinking. Inside of them we can also find another differentiating factor: the prosperity of the country, whether the country is developed, developing or a 3rd world country.

On the one hand, we have leaders like Donald Trump who have repeatedly reported that they do not believe in climate change and it is a conspiracy plotted by emerging countries such as China to drive the economy of global powers down and attack the US manufacturing core.

On the other hand, European leaders drive the change towards a cleaner alternative with initiatives that favour the use of clean energies, the approach to a new sustainable economic growth or the use of green transport in their main cities. Countries like Germany and France, are passing new laws to ensure that their industrial core shifts towards a model where sustainability is a top priority.

Countries like China and Canada, have recently adhered to these policies in the Paris Agreement. Regardless their recent adherence they have already started taking measures in their countries and even in the case of China, starting to lead initiatives for international cooperation against global warming and CO_2 emissions.

Even with all the efforts being made from all around the world, the situation is not even close to being solved. Global emissions are still raising rapidly because of emerging economies with no regard for sustainable growth. In addition, the economic development of countries leads to more consumers not only of products but also of energy, incrementing the energy demand by 2,1 % only in the last year according to Reuters (Reuters U.K., 2018). Most major economies have increased their emissions over the last year. Only the improved deployment of renewable energy sources has been able to diminish the effects of carbon emissions, which have increased 6,3 % due to research and expansion of solar, wind and hydropower energy.

2.1.2. DEVELOPING COUNTRIES

Nevertheless, renewable technologies are only available in developed countries, causing developing economies such as China or India to be responsible for 63 % of the global carbon emissions.

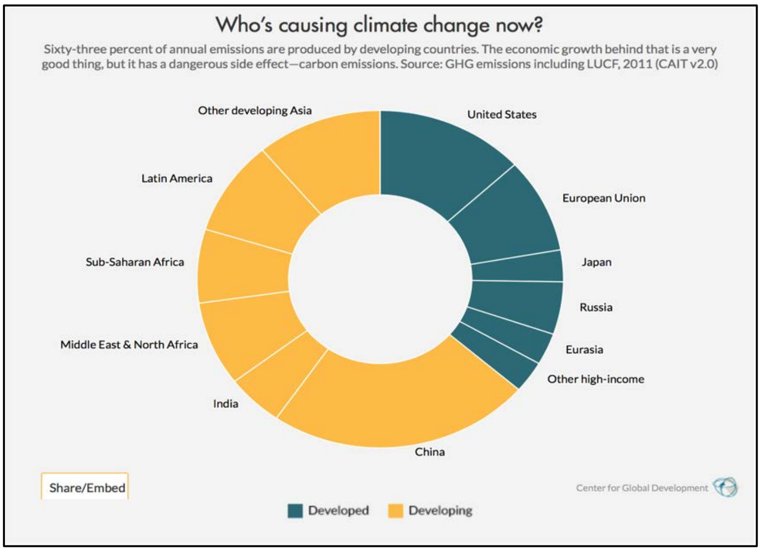

Figure 2 - Global emissions by country (Centre For Global Development, 2015)

These countries rely heavily on fossil fuels to sustain their growth. Some of these countries cannot afford switching to cleaner energy sources due to the high investment required and the long payback period.

Furthermore, the reliability, accessibility and price competitiveness of fossil fuels , makes them an excellent choice for countries trying to grow out of poverty. Countries like India (5% of global emissions), would need to spend the equivalent of 10 times what they spend on health and education in order to switch to a clean alternative (Davey, 2016).

At the moment, developing countries see themselves in a dilemma between economic growth and increasing carbon emissions. For them it is an easy choice as it is reasonable that they would prefer to improve their situation. However, from a developed country's point of view, it is essential that we find alternatives to economic growth that do not involve increased rates of carbon emissions.

In order to provide new alternatives, developed countries should start incentivizing R&D projects that would not only benefit developing countries but also themselves. Wealthy countries could invest in the implantation of clean energies in emerging economies by involving their banks in loan operations and therefore creating international economic ties. However, the current investment of developed countries is very low, only reaching 0,2 % of developing countries' GDP for adaptation and mitigation in 2014 (Davey, 2016).

2.2 SPAIN

Spain is considered an advanced country in the matter. However, in the last few years we have distanced ourselves from fast moving countries like Germany or France, by not adopting new policies in favour of sustainable growth.

In 2017, CO_2 emissions raised by 7,4 %. Due to the drought, in the last third of 2017, we were not able to produce as much hydro-powered energy as we did in the previous year. Furthermore, the lack of flexibility and rigidity of our energy model, meant that we had to substitute what before was a renewable energy source with zero emissions by imported fossil fuels. Also, political and economic interests by important business people have not helped to transition to a cleaner model.

However, the Spanish government has placed climate change at the top of their agenda.

The EU climate change adaptation strategy with three main objectives:

- Promoting action to encourage all EU members to consider suitable adaptation strategies by providing funding to cope with the consequences of climate change such as floods, droughts or other extreme weather conditions.

- "Climate proofing" action at EU level to adapt exposed and vulnerable industries to the effects of climate change, to create a robust and strong infrastructure (European Environment Agency, 2016).
- Improved decision-making abilities through the use of more precise and accurate information to minimize knowledge gaps on the adaption of cities and industries to climate change by using tools such as **Climate- ADAPT.** This is a platform that allows users to share and access information on different aspects related to the effects of climate change in the EU such as current and future vulnerability of regions, expected climate change in Europe or National and transnational adaptation strategies (Climate-adapt.eea.europa.eu, 2016).

2020 climate & energy package with three key targets:

- Reduce greenhouse emissions by 20 %.
- Achieve 20 % of green renewable energy supply.
- Improve energy consumption and production efficiency.

In order to accomplish these targets the EU is acting on different areas at the same time. Some of the most critical are:

- The **emissions trading system** (ETS) covers around 45 % of the EU's greenhouse emissions. This system is operating in 31 countries and works on the "cap and trade principle" (Climate Action - European Commission, n.d.). A cap is set on the total amount of the emissions of greenhouse that can be emitted. The cap is to be reduced gradually to ensure global emissions fall. "Within the cap, companies receive or buy emission allowances which they can trade with one another as needed" (Climate Action - European Commission, n.d.).

  At the end of every year, companies have to resituate their extra allowances in order to meet their forecasted emissions, otherwise heavy fines are imposed. Companies that are able to reduce their target emissions can use them in the next year or sell them to other companies in need of more allowance. This system brings more flexibility to the industrial sector, gives economic incentive to reduce emissions and ensures the shrinkage of global industrial emissions.

- **Renewable energy national targets** joining together to raise the usage of renewable energies by 2020 (Climate Action - European Commission, n.d.). Target for each country is variable depending on their capacity to produce renewable green energy. By 2020, 20 % of the energy consumption will come from a renewable source.

2.3 INDUSTRIES

Since for this project I would like to develop a tool that permits companies measure their impact, it is interesting first to know what the current situation is.

Industries represent a significant source of carbon emissions. In 2017, 36 % of the carbon emissions were originated from manufacturing industries. Industries that worked directly with raw materials represented 70 % of the emissions (Global-greenhouse-warming.com, n.d.).

During the last two decades, industries have been able to considerably reduce their emissions due to technological breakthroughs, improvements in energy efficiency and a higher percentage of clean renewable energy consumption The most significant drop was in developing countries where more recently newer technologies have arrived and therefore reducing the impact. Also, some countries like China find themselves in a more advantageous economic position allowing them to start taking the environment into account.

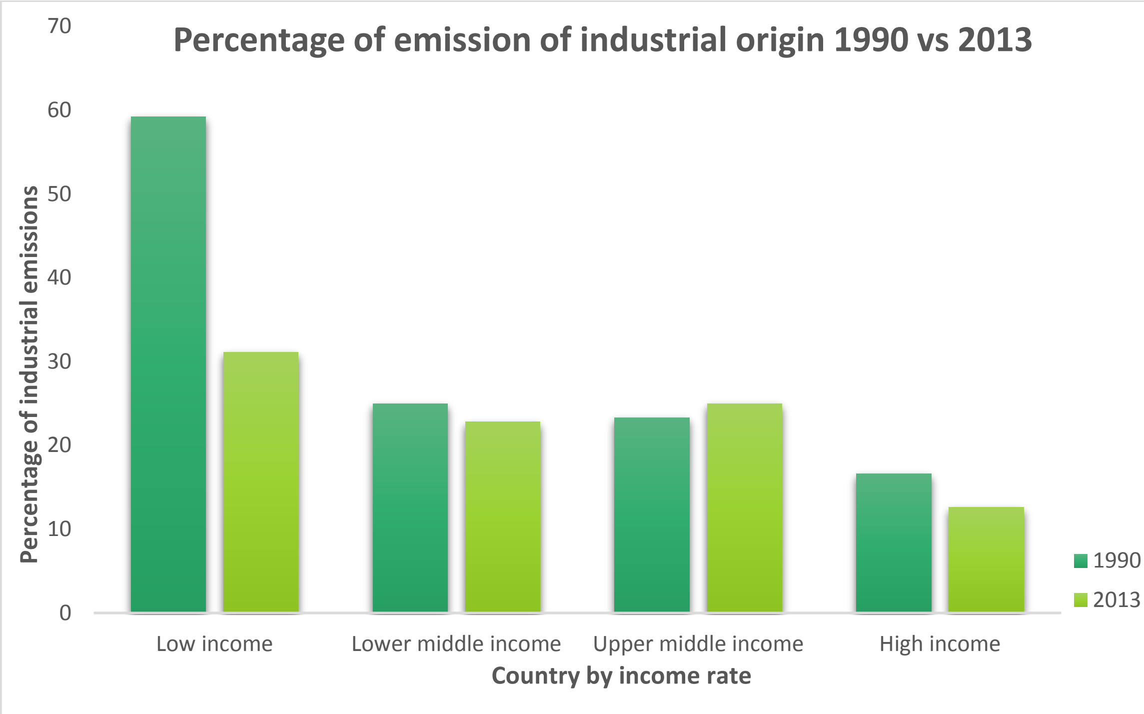

Figure 3 - Comparsion of industrial emissions (Data World Bank, 2017)

2.3.1 PRODUCT LIFE CYCLE

Throughout the last decade there have been different approaches to design production systems that ensured the sustainability of the process. In order to explain how these strategies impact the environment, I will start by defining the concept "***product life cycle***" and explaining the two different approaches to it: ***"Cradle to Cradle"*** and ***"Cradle to Grave***".

The product life cycle describes the stages through which the product goes through. It takes into account the different forms of the product, since the sourcing of the raw materials, manufacturing, distribution of the seller, use by the consumer and the recovery stage which includes the collection, sorting and recycling of the waste generated by the consumption of the product.

There is a flow that feeds the loop that includes the introduction of raw materials and resources and a flow that contemplates the non-utilizable waste.

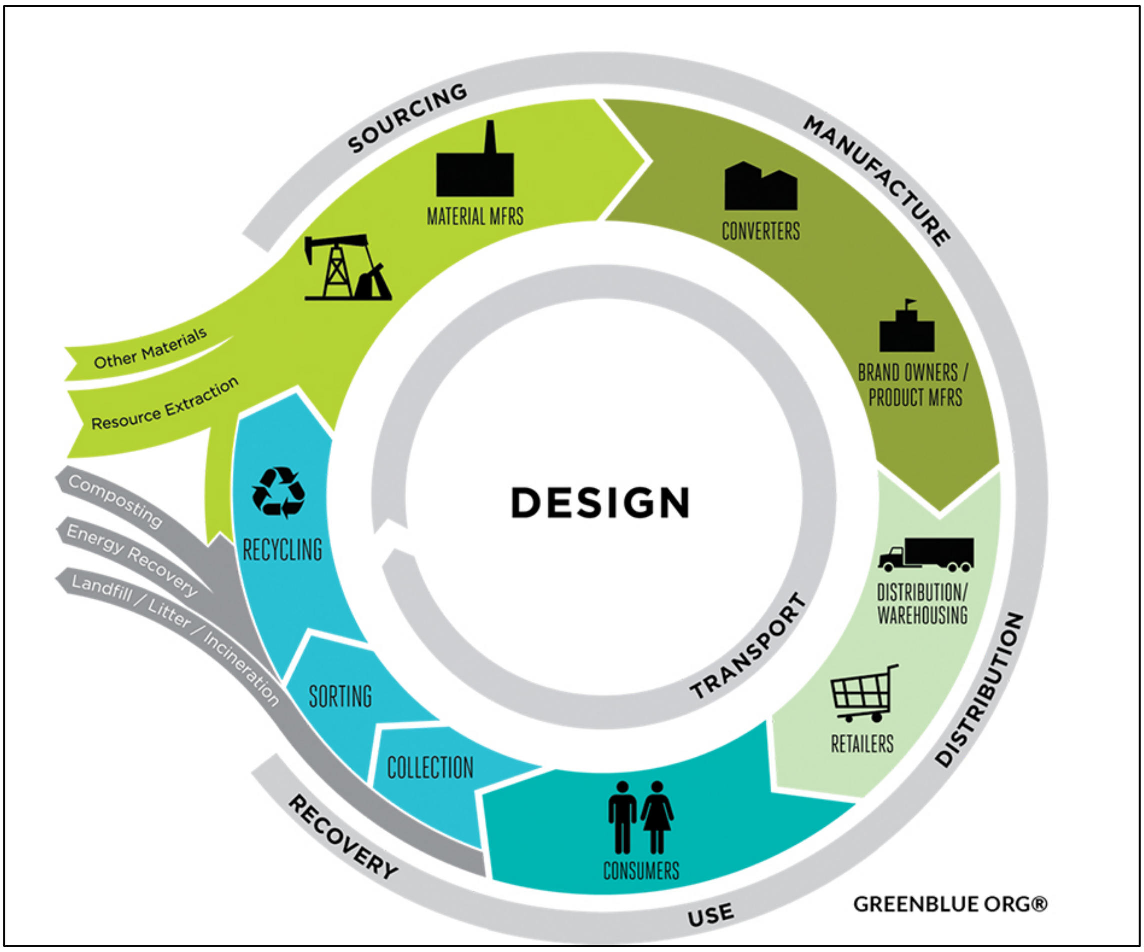

Figure 4 - Product Life Cycle (Read.nxtbook.com, n.d.)

The **Cradle to Grave (C2G)** model does not consider the product life cycle. Companies following this approach are aiming to cut cost in order to boost profit without taking into account the ecological cost of their operations. In a C2G model a plastic bottle may have several "lives". Nevertheless, the bottle is not recycled but downcycled, in other words, the plastic of the bottle loses its properties and eventually it will reach a point where the plastic will be no longer usable.

The **Cradle to Cradle (C2C)** model was introduced by William McDonough in his book ***Cradle to Cradle: Remaking the Way We Make Things*** in 2002. He presented "*an integration of design and science that provides enduring benefits for society from safe materials, water and energy in circular economies and eliminates the concept of waste" (William McDonough, 2018)*. This framework has two different principles:

- Everything is a resource for something else.

- Use of clean and renewable energy.

Companies are now considering how they impact the environment at each step, and what they can do to manage and reduce this impact. They are starting to design products that can be fully recycled without having to downcycle any of the components. Some companies have started an initiative to substitute all of their C2G material such as adhesives or synthetic materials by C2C materials that can be utilized for other purposes.

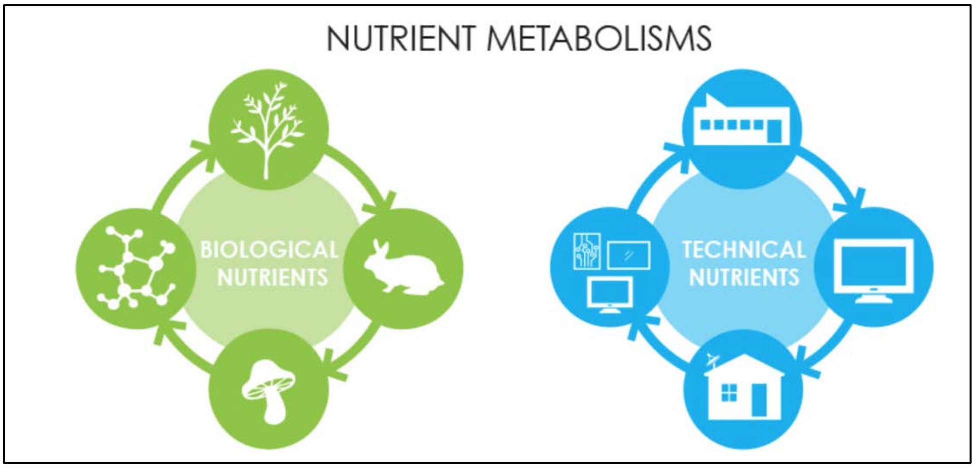

Figure 5 - C2C model (William McDonough, 2018)

3. SUSTAINABILITY

According to the Business Dictionary, sustainability can be defined as "continued development or growth, without significant deterioration of the environment and depletion of natural resources on which human well-being depends" (BusinessDictionary.com, n.d.)

3.1. THE PRINCIPLES OF SUSTAINABILITY

The five principles of sustainability spread themselves among 5 different problems. I will be explaining the principles not only from a theoretical angle but also from J.Reichmann's perspective, who explains the problem and gives some possible solutions to the five aforementioned problems.

3.1.1 THE MATERIAL DOMAIN:

The main premise behind this domain is to "contain entropy and ensure that the flow of resources, through and within the economy" to ensure minimal loss of the material or energy. J.Reichmann considers that we are extremely inefficient in the use of raw materials and energy. He defined this as "**the efficiency problem".**

In order to ensure a better performance there are some modifications we could make to our energy and consumption model:

- Improve resource productivity by reducing waste products derived from the usage.
- Lengthen product life cycle and durability of goods through new processes.
- Control and avoid any possible leakages in the material/energy loop and recycle any of the non-renewable resources being used.

3.1.2. THE ECONOMIC DOMAIN:

We need to create a model that allows us to adopt an accounting system that considers the inputs on the ecosystem. J.Reichmann believes this is a problem of scale since we have saturated our ecological productive space.

- Align the world's economy with the current regeneration rate.
- Include new economic indicators that consider the well-being of life in productive systems.
- Design new laws and policies to incentive or penalise depending on the ecological performance of industries or countries.

3.1.3. THE DOMAIN OF LIFE:

Ensuring and maintaining the current biodiversity is mandatory. J.Reichmann did not offer a view on this domain because he offers a more economical and industrial view of the problem. However, some ideas to improve the current situation:

- Reserve spaces for bio-regeneration for endangered species.
- Enhance and incentivize biological diversity in areas with human interference.
- Avoid biodiversity displacement because of natural resources exploitation.

3.1.4. THE SOCIAL DOMAIN:

Maximize social freedom and potentiate through social programs self-growth of individuals and of society by default. J. Reichmann believes that we are on the path of social equity through left wing policies but we have not yet arrived at an optimal point where we can consider full social equity. In order to reach this status, we shall:

- Make tolerance a cornerstone of our society, by elevating the concept of democracy through inclusion of others regardless of sex, race or religion.
- Ensure the same opportunities for people with different economic resources.

- Expand the concept of sustainability in all of our learning platforms in our society.

3.1.5. THE SPIRITUAL DOMAIN:

This domain appeals to the more spiritual and ethereal point of view of the human race towards the connection to the natural world. This deals with philosophical issues of the human being such as the origin of it or where is it going.

3.1.6. THE FIVE DOMAINS AS ONE

The five principles are to be considered as a whole. Due to the nature and the definition of each of them, the five domains interact on both a superficial and profound manner

3.2. GROWTH AND DEVELOPMENT

It is important to distinguish between **growth** and **development.** Economic growth is a narrower term that only considers the economic factors of a country that drives increase in a country's real level of national output measured by macro and micro economic indicators such as GDP. Economic development implies an improvement in the entire social system in terms of income, savings and investment as well as progressive changes in socio-economic structure of country.

3.3. THREE PILLARS OF SUSTAINABILITY

It is now clear that old models which did not consider factors such as resource scarcity or sustainable energy consumption have become obsolete. Therefore, a new model was built which could acknowledge all the different parts of our societies´ ecosystem. Due to this new approach, we now have three main definitions of sustainability:

- Environmental sustainability *"is the ability of the environment to support a defined level of environmental quality and natural resource extraction rates indefinitely"* (Thwink.org, n.d.).
- Social sustainability *"is the ability of a social system, such as a country, family, or organization, to function for an indefinite amount of time at a correct level of social well-being and harmony indefinitely"* (Thwink.org, n.d.).
- Economic sustainability *"is the ability of an economy to support a defined level of economic production indefinitely"* (Thwink.org, n.d.).

These three definitions brings us to the ***Three pillars of Sustainability.***

Figure 6 - Three Pillars of Sustainability

When all the different parts of the system interact with each other, their stability will be determined by their robustness and resilience to fluctuations in the society and in the economic infrastructure. The following equation enables us to compare different products or aspects studying the impact of each variable in the system:

$$IPCT = P \cdot C \cdot T$$

- ***IPCT***: Impact on the different parts of the system.

- ***P***: Population.
- ***C***: Consumption.
- ***T***: Technology involved in the production, distribution and/or usage of the term being calculated.

For this project, since we will be calculating the impact of the product in the system, I will be focusing on the environmental part in order to calculate how each step of the product life cycle affects the system.

3.4. THE CARBON FOOTPRINT VS THE ECOLOGICAL FOOTPRINT

The carbon footprint is the amount of greenhouse gases released into the atmosphere by any activity with human interference. It can be used to study any member of the socio-economic ecosystem such as individuals, companies or even governmental institutions. It is often measured in g of CO_2.

In order to give a good definition of the ecological footprint, it is important to consider these two definitions:

- **Ecological footprint**: The ecological footprint's main use is to measure the demand humans put on natural resources. The ecological footprint works as an accounting balance sheet. It is also comparable to the functioning of a market, with both supply and demand.

- **Biocapacity**: Total natural resources production capacity of a given piece of land or/and water.

Supply	Demand

In this category, we consider all the factors that **<u>supply</u>** us with resources for our activities. • Earths bio-capacity • Current available natural resources • Generation capacity of resources • Absorption capacity	Here we consider all the activities where we **<u>demand</u>** resources in order to perform any activity. • Human activities that require natural resources: farming, fishing • Waste produced by these activities

Table 1 – Ecological footprint as an accounting balance sheet

This picture shows how the natural resources are converted into products and services we use on a daily basis and how each of us is responsible for the ecological footprint.

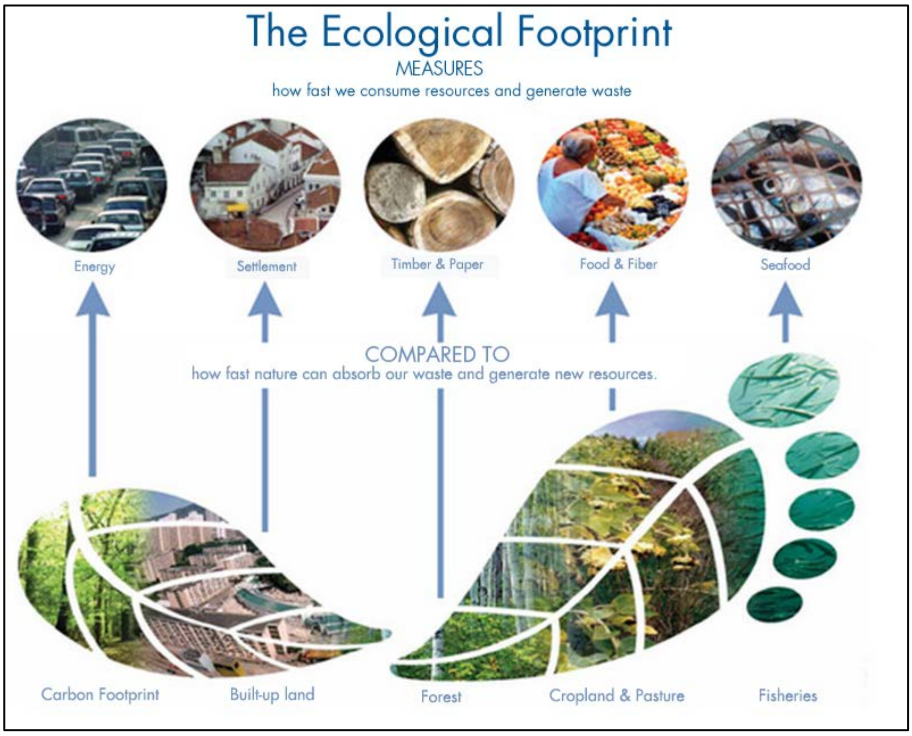

Figure 7 - The Ecological Footprint

As you can see, the carbon footprint strictly focuses on the measurement of greenhouse emissions through the combustion of fossil fuels. It can be considered that since the carbon footprint only measures GHG (Greenhouse gases) emissions, the carbon footprint calculation is a portion of the ecological footprint. Therefore, the ecological footprint can be considered a more thorough calculation since it takes into account all the different impacts at different levels and not only carbon emissions.

The ecological footprint is measured in global hectares. It can be calculated for any region regardless of size or population. The idea behind the ecological footprint is to calculate the biocapacity that corresponds to a unit of matter or energy. There are two possible scenarios:

- **Ecological deficit**: When the given area has a superior utilization rate than the production and absorption rate of the land, the demand exceeds the ability of the ecosystem to renew. These regions meet their demand by liquidating their natural resources, emitting carbon emissions or importing resources.

- **Ecological reserve**: When the recuperation rate of the ecosystem is higher than the resource consumption.

According to Global Footprint Network, we have been in ecological deficit due to the large increase in fossil fuel consumption since the 1980s and by 2005, we already "owed" 2.5 years of the earth's biocapacity.

The idea of the ecological footprint is directly linked to the idea of this project.

4. SCORECARD CREATION

The following two factors are essential for the scorecard to be a useful, simple and accurate tool:

- **Focus on "vital few" indicators:** In order to achieve the simplicity and the user-friendliness, considering many indicators at once could lead to confusion and distraction. Each product will have specific indicators, simulating a profound individual study of the product.
- **Updating the indicators:** Since the scorecard is supposed to study products thoroughly, it is important that it remains updated to current trends. The expected progression of products towards sustainability can cause the obsolescence of the scorecard. In order to avoid it, the scorecard needs constant review and update of the indicators.

Each indicator will have a value. Each value given to the indicator will be determined by the **Manual,** which will be explained in detail later on.

To reach a final score for the product, the following formula will apply:

$$EIR = \sum_{i=1}^{n} V$$

- ***EIR:*** Environmental Impact Rate
- ***n:*** number of indicators being considered in the calculation: i = 1 at the beginning.
- ***V:*** Value given to the indicator.

The ***Environment Impact Rate*** is the summation of all the indicators. The higher the number the higher the impact on the environment.

To provide thorough and accurate indicators, first a research was done, to determine which indicators would suit best.

5. DEVELOPMENT OF THE INDICATORS FOR THE SCORECARD

There are different tools for every product in the actual market and they are being designed as a 'cradle to grave' mechanism.

The axis of the project is the creation of a 'cradle to cradle' tool, with which it will be easy to calculate the carbon footprint of products.

There is a clear trend towards mandatory medium-term compliance with labelling, reporting the carbon footprint of a product. Likewise, the carbon footprint can serve as a tool to optimize processes, especially those related to the efficient use of raw materials and energy.

To be able to create the scorecard, the first step to take will be defining the indicators, explaining in detail how they intervene in the measurement, to later adapt them to each type of product.

As mentioned previously, 20% of the carbon footprint is normally taken into account to calculate the impact of a product, which only involves the production. But we have to know what happens with the other 80%: the raw materials, transportation, etc.

This project is meant to calculate in a simple manner the life cycle impact of products, distinguishing four main groups from which the entire different indicators will unfold: TRANSPORTATION, PACKAGING, RAW MATERIALS AND PROCESS.

5.1. TRANSPORTATION:

There is a huge percentage of the impact related to it. It is considered extremely important for the distribution of products as the only way to reach consumers. Carbon footprint assessment for transport focus mainly on CO_2, emissions from fossil fuels as CH_4 and N_2O emissions are normally much lower than CO_2 emissions related to fossil fuel combustion. Each mean of transportation will have its exclusive average CO_2 impact.

	Consumption [g CO_2/(MT km)] [a]	*TT* [b]	TT [c] (Refrigerated)
Train	30 - 100	0,16	0,38
Lorry	60 - 150	0,21	0,42
Aeroplane - airfreight	500	1	2
Vessel – sea freight	10 - 40	0,05	0,10

Table 2 - Transportation Indicators

The tendency on markets is the adaptation for consumer tastes and preferences, which they demand non-autochthonous and fashionable products. Purchasing Kilometre zero and season products can reduce impact on transportation. Ultimately, is a consumer that may adapt to markets offer, and not the market to a consumer whim.

[a] See, https://timeforchange.org/co2-emissions-shipping-goods

[b] ***TT*** (Type of Transportation) – It is a correction coeficient, made to simplify the calculations in the scorecard.

[c] See, page 341. *Transport, Energy and* CO_2 (International Energy Agency, 2018)

In transportation is only considered the final product shipment. Ultimately, if the idea is to calculate the transportation of raw materials, it can be considered the raw material as if it is a product, and it can be just summed up to a further calculation.

Therefore, 5 indicators will be taken into account:

INTERNATIONAL TRANSPORTATION:

It is determined if the final product is local or imported. The variable ***IT*** (International Transportation) which can be 0, if there is no International transportation. And 1 if there is. So if it is a local product the Impact on International Transportation will have no weight on the calculation.

TYPE OF INTERNATIONAL TRANSPORTATION:

It is determined which type of transport, mentioned before, is used. ***TTI*** *and* ***TTL*** (Type of Transportation ***I***nternational or ***L***ocal) possible values it can adopt, in ***Table 2****.* They are a simple proportion taking into account that Airfreight has the maximum value (1: no refrigerated; 2: refrigerated) so the other values are proportional to it.

KILOMETERS TRAVELED:

How many kilometres are done between the factory and the distribution warehouse. ***KTI***

DISTRIBUTION:

Kilometres done during distribution along the final warehouse and the Supermarket or other types of grocery shops. ***KTL***

LOAD:

Weight of the product (in Kg). ***K***

To calculate the total impact on transportation the following formulas will be used:

$$\boldsymbol{I_{International\,Transportation} = 0,5^{d} \cdot IT \cdot TTI \cdot KTI \cdot K}$$

$$\boldsymbol{I_{Local\,Transportation} = 0,5 \cdot TTL \cdot KTL \cdot K}$$

Note that if it is a Kilometre zero product, or it is not imported, only local distribution will be considered.

[d] 0,5 is a fix value. As the quantity of product will be measured in Kg and the correction factor is based on 500g/CO_2 per ton and Km, and the data is in tones. The scorecard is meant to make calculations by Kg of product and not by tones, that's why this fix value have been added.

5.2. PACKAGING:

The majority of products are protected or wrapped in different types of packaging. Not only for its conservation but also for commercial strategies. Over-packaging is a problem, which seems to be on the increase at a time when it really should be on the decrease.

These two pictures below show particular cases where a product has more packaging than needed.

Figure 8: A banana has its own natural packaging, the skin, and it is normally sold in bulk but in this case is in sold in a plastic tray with a plastic film. Curiosity: covering fruit with plastic causes it to rot more quickly.

Figure 9: The size of a chip bag is not equivalent to the amount of food actually in the bag. They are inflated with air to appear larger. That means plastic could be reduced in half.

Figure 8 - Over-Packaging Banana

Figure 9 - Over-Packaging Crisps

"There are thousands of different ways that products are packaged in the market. This is really becoming a huge problem, as almost 40% of the packaging found in a typical shopping basket at supermarket retailers cannot be easily recycled." (James Maikle, 2009)

Packaging on the scorecard will have four parameters assigned, three of which are related to the packaging and one for the labelling.

It has been considered that with three parameters for packaging P1, P2 and P3, a product can be perfectly defined in this aspect, if you also consider the fourth parameter, the labelling (L).

The following formula will be used to calculate the average of CO_2 for almost all packaging materials:

$$a \cdot b + x \cdot y = I$$

- ***a*** = $C0_2$ to produce the product from zero
- ***b*** = % of production that comes from zero
- ***x*** = CO_2 to produce from recycled material
- ***y*** = % of production that comes from recycled material
- ***I*** = Average impact

NB: Having the percentage of recycling and the amount of CO_2 produced when you generate that material from zero and from waste, the following simple calculation can be made in order to have numbers as realistic as possible of CO_2 impact during the creation of the packing.

Division of packaging by materials:

PLASTIC:

These are very recent materials that have been incorporated into our civilization in the last half of the 20th century. They are widely used in practically all industrial sectors due to their versatility, ease of manufacture, low cost, resistance to environmental factors, transparency, etc.

Plastic is obtained by the combination of a single polymer or several, with additives and fillers, in order to obtain a material with certain properties.

They can be obtained from natural resources, renewable or not, although it must be specified that all commercial polymers are obtained from petroleum.

Polymers are non-natural materials obtained from petroleum by the industry through synthesis reactions, which makes them very resistant and practically unalterable materials.

This last characteristic means that nature cannot by itself make them disappear and they remain in landfills for long periods.

There are three large families of polymers:

· Thermoplastics (LDPE, HDPE, PVC, PET)

· Thermoelastic (Polyester resins, Epoxy resins)

· Elastomers (NR – Natural Rubber, CR – Chloroplene Rubber)

Thermoplastic polymers have as an essential characteristic that they soften under the action of heat, reaching a fluid state, and when the temperature drops they become solid and rigid again. For this reason they can be molded many times, which favours their recyclability.

There is a diversity of plastics used, they are controlled by laws and in every plastic product you should find one of the signs below:

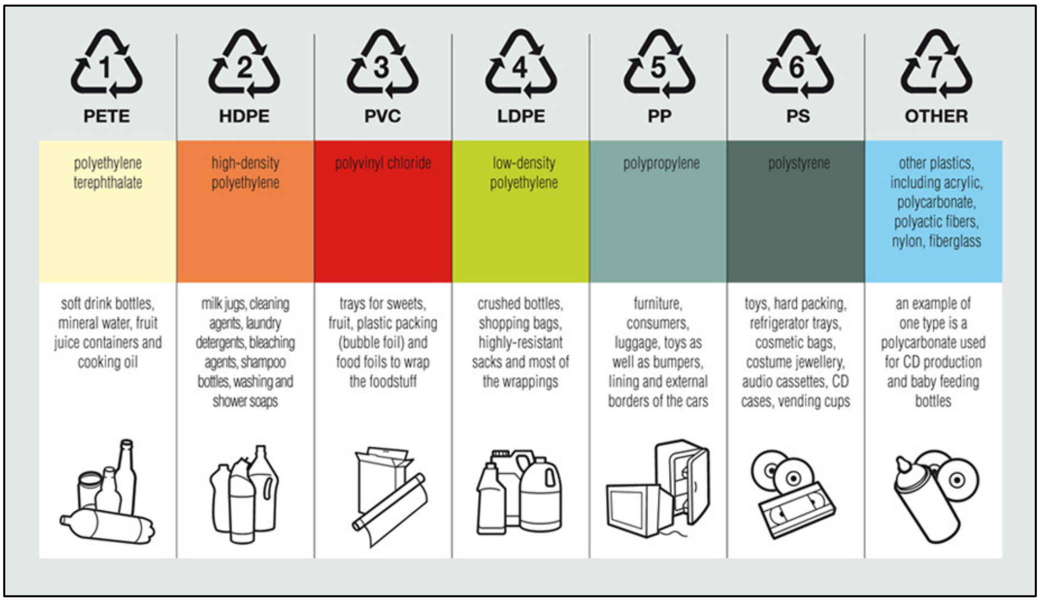

Figure 10 - Comparison between all types of Plastic

Here is data which illustrates the impact of plastic:

- It is estimated that one million birds and 100000 turtles, apart from other marine animals, die every year of hunger, due to the ingestion of plastic bags that block their digestive tracts.

- A plastic bag has an average use time of between 12 and 20 minutes; however, it can take between 15 to 1000 years to degrade.

- With 15 recycled transparent plastic bottles, a polar fleece is manufactured.

- With 15 plastic milk bottles a sprinkler is manufactured.

- For each bottle that is recycled, the energy saved is sufficient to have a TV on for 3 hours or the energy needed by 5 low consumption lamps of 20 W for 4 hours.

- Recovering 2 tons of plastic is equivalent to saving a ton of oil.

- Spain is the third biggest consumer of plastic bags worldwide.

- Spaniards use 250 plastic bags per inhabitant per year.

- 20% of the rubbish collected from beaches are bags and only 1% of them are recycled worldwide.

- The plastic rings from six-packs are almost invisible under water which is why animals cannot avoid them. Seagulls sometimes get entangled while fishing and die by drowning or strangulation; pelicans fish by diving into the water, put their beaks in a ring and are unable to take them out and die of hunger.

The following table contains the packaging indicators that are made of plastic. Depending on the plastic used, the weight (the average will be used to avoid complicating the calculations) and the pollution generated by each of them, the environmental impact will be determined.

Packaging	Type of plastic	Impact [g CO_2 / g]	Average weight [g]	Average impact [g/CO_2]
Plastic bottle (large)	PET	3,4[e]·0,74 + 1,6[f]·0,26 = **2,93**	250	732,5
Plastic bottle (small)			32,5	95,23
Plastic Recipient (e.g. Yogurt Tub)			15	43,95
Plastic Lid	HDPE	1,90·0,70 + 1,10·0,30 = **1,66**	2,4[g]	4,98
Plastic Bag	LDPE	**2,06**[h]	15	30,9
Plastic Label			0,8	2,06
Plastic Tray	PVC	**2,22**[i]	50	111
Plastic Film			5,5	12,21

Table 3 - Packaging - Platic Impact

[e] Production of 1 tone of PET from natural gas or petroleum emits 3,4 tones of CO_2.

[f] Whereas, production of a tone of PET pallets from recycled PET bottle emits 1,4 to 1,8 tons of carbon dioxide.

[g] Calculation done weighting all together 27 different plastic lids, total weight was 66g. So the result was 2,4g/lit.

[h] Its high chlorine content limits its co-processing for technical, operational, environmental and safety reasons. Not considered as recyclable in this project due to its very low rate on recyclability 1%

[i] Not considered as recyclable in this project due to its very low rate on recyclability 0,02%

CARTON AND PAPER:

Paper is one of the great contributions of Chinese civilization. Its antiquity dates back to about two thousand years and to this day has been one of the main vehicles for the transmission of culture and knowledge.

Since the 19th century in its manufacture, wood has been used and thanks to a chemical process that consumes large amounts of water, energy and chemical products, paper pulp is obtained.

The raw materials, the trees, are debarked, chopped and in a digestion process the dough is obtained. This is washed and bleached, and then proceeds to the manufacture of the sheet of paper or cardboard.

It is used in the form of newsprint, packaging, etc. Its share in the total waste is high due to its high consumption per inhabitant and year (141 Kg in Spain).

The following data illustrates the impact of paper:

- Currently, 60% of paper is recycled which is helpful for the conservation our forests and avoid deforestation.

- The recycling of paper reduces the need to resort to trees, which are the main agents that combat the pollution produced by greenhouse gases.

- It also involves the saving of a significant amount of water and energy, as well as a reduction of the polluting agents necessary to manufacture paper in the production plants.

- There is also an economic saving, derived from the reduced need for new paper and the reduction of energy expenditure, but also with respect to the treatment of waste, its storage in landfills or savings in incineration costs.

The following table contains the packaging indicators that are made of paper or cardboard.

Packaging	Type of paper	Impact [g CO_2 /g]	Average weight [g]	Average impact [g CO_2]
Cardboard box	Carton	2,42·0,4 + 0,807[j]·0,6 = **1,452**	160g/m² · 1,41m² = **225,8**	**327,84**
Paper label	Paper		80g/m² · 0,012m² = **0,96**	**1,39**
Paper bag			80g/m² · 1,41m² =**112,9**	**163,93**

Table 4 - Packaging - Paper and Cardboard Impact

As it was difficult to find the impact of producing paper from recycled paper, the use of different data has been resorted to. So, from this data it has been possible to extract the information that was missing.

Data: · 60% of paper is recycled whereas 40% is not recycled.

· Emissions from paper production have dropped about 40%.

· To produce 1 g of paper you emit 2,42 g of CO_2:

$$2{,}42 \cdot \frac{40}{100} + x \cdot \frac{60}{100} = 2{,}42 \cdot \frac{60}{100}$$

$$0{,}968 + x \cdot 0{,}6 = 1{,}452$$

$$\boldsymbol{x}\left[\frac{\boldsymbol{g} \cdot \boldsymbol{CO_2}}{\boldsymbol{g}(\boldsymbol{paper})}\right] = \frac{1{,}452 + 0{,}968}{0{,}6} = \mathbf{0,807}$$

[j] This value 0,807 is the impact it has to produce paper/cardboard from recycled paper. Its been made with a simple calulation (Formula on this page).

ALUMINIUM

It is a material of the twentieth century. Among its properties: Lightness, High conductivity, Great deformability and Resistance to corrosion.

All this allows using it in multiple ways in the packaging industry.

It is obtained by an electrolytic process of alumina, previously obtained from bauxite, the mineral that constitutes the raw material of aluminium. In its production, high amounts of energy are invested, 13500 Kwh per ton of metal.

Here is data which illustrates the impact of aluminium:

- The aluminium that is dispersed in the medium remains for a minimum of 500 years.

- A pot can be made with 8 recycled cans.

- 550 recycled aluminium cans can be made into a chair.

- With the energy needed to make an aluminium can of soda, you could have a TV working for two hours.

- Making aluminium from recycled aluminium requires 90% less energy than making it from ore.

- Each person throws away around 13 kg of aluminium and tin cans per year, which means more than 6 million cans, which could fill 17500 30-ton trucks.

- Aluminium cans represent 2% of the weight of domestic rubbish.

- The energy saved with each recycled can is equivalent to the electric consumption of a 200W bulb or a TV set operating for 1 hour.

- 15000 tons of aluminium end up each year in domestic rubbish.

- The packaging industry is responsible for between 10-12% of aluminium use.

- More than a 75% of the aluminium produced one hundred years ago is still being used due to the recycling processes.

The following table contains the packaging indicator that are made of aluminium.

Packaging	Impact [g CO_2 /g]	Average weight [g]	Average impact [g CO_2]
Aluminium	11,89 · 0,5 + 2,01 · 0,5 = **6,99**	14,9	**104,151**

Table 5 - Packaging - Aluminium Impact

TETRABRIK

Its commercialization began in 1963. Tetrabrik is a multimaterial container formed by a sheet of cardboard, another of aluminium and another of plastic. The great advantage they offer for the industry is its great lightness and the ability to preserve food in optimal conditions. They are manufactured from paper-cardboard on which the customer's commercial design is printed. Later, they are laminated with aluminium foil and finally with polyethylene film. From the rolls obtained, the packaging plants manufacture the containers. In our country, 4.600 millions of these containers are used annually, 3 kg per inhabitant per year.

In the shopping trolley there is that common article that continues generating a great controversy about its environmental impact. This sophisticated package weighting only 30 grams, composed of exactly 75% cardboard, 20% plastic and 5% aluminium.

Despite its undeniable utility to preserve perishable liquid foods without refrigeration and without preservatives, or the special efficiency of its geometric shape to be transported, this container is still often misused in the corridors of the supermarket because of its difficulties in being recycled once it is emptied and thrown away. And it is that this product marketed by the company Tetra Pak can be formed by up to six different sheets of materials: two initials of polyethylene, one of aluminium, another of polyethylene, the thickest of cardboard and one more polyethylene. Very different layers which are difficult to separate.

The following table contains the packaging indicator of a tetra-brik

Packaging	Impact [g CO_2 / g]	Average weight [g]	Average impact [g CO_2]
Tetrabrik	**2,17**	40	**87**

Table 6 - Packaging - Tetrabrik Impact

GLASS

Glass has been used to make containers to preserve food for several thousand years.

In the process of its manufacture, raw materials are used: sand (silica), soda (sodium carbonate) and limestone (calcium carbonate). To this is added other substances, such as dyes, etc.

The raw materials are melted in furnaces at temperatures of 1500 °C, and the resulting glass in a fluid state at 900 °C is distributed in the moulds that will give it shape. Finally it undergoes an annealing process to give it greater resistance.

It should be noted that high amounts of energy are consumed in the glass manufacturing process.

The consumption of glass is high (33 Kg per person per year in Spain) and they have an important impact on the total volume of waste.

Here is data which illustrates the impact of glass:

- For every ton of recycled glass an energy equivalent to 136 litres of oil is saved.

- An amount of 3000 recycled bottles is equivalent to the reduction of 1000 kg of rubbish.

- For every ton of recycled glass, 130 kilos of fuel and 1200 of raw material are saved.

- All glass bottles and jars can be recycled. But other types of glass, such as windows and light bulbs, are manufactured by other processes and cannot be combined with the scrap of bottle glass from which common containers are made.

- A returnable bottle can prolong its life cycle up to 60 times.

- Globally, 80000 tons of glass is recycled and 920000 tons are thrown away.

- Glass recycling avoids 20% of atmospheric pollution and 50% of water pollution.

The following table contains the packaging indicators that are made of glass.

Packaging	**Impact [g CO_2 / g]**	**Average weight [g]**	**Average impact [g CO_2]**
Glass bottle	3,86 · 0,11[k] + 0,73· 0,89 = 1,07	322	**345**
Glass recipient (e.g. jam jar)		115	**80,5**

Table 7 - Packaging – Glass

[k] Note that a little percentage of glass is not recycled. Although it has a high impact, it generates less rubbish and its easier to degrade.

5.3. PRODUCT - RAW MATERIALS

In order to create the Scorecard, the existent groups of products will be classified. Focusing basically on those products that can be found in a supermarket. This classification will be used as the first selection of the indicators that best suit the product.

To be able to select these products we have based the categories on existing ones used by various online supermarkets: Caprabo, Carrefour, Mercadona and Ulabox.

All the information regarding grams of CO_2 per grams of food has been taken from Food Emissions web page (www.foodemissions.com, 2011).

Product categories:

Pantry: Dairy products, Grains, Miscellaneous food crops, Nuts and seeds, Oils and Processed Foods.

The Market: Beans and Pulses, Fruits and berries, Herbs, Meat and Poultry, Vegetables, Roots and Tubers, Seafood.

Drinks: Water, Juices, Soft Drinks, Vegetable Milks and Alcohol (Wine, beer, etc.)

Other categories of products have not been considered for this project in order to gain simplicity and avoid complicating the scorecard. The following categories were not considered but could be, in the future, as a possible improvement for the Scorecard: Baby Products, Cleaning and Home, Perfumery and Hygiene, Parapharmacy and Pets.

Moreover, it is interesting to be aware of the following fact related to food consumption:

"*Research led by Oxford Martin School finds the widespread adoption of a vegetarian diet would cut food-related emissions by 63% and make people healthier too*" (Fiona Harvey, 2016)

This quote by Mrs. Harvey is a fact reflected in the following tables where the impact for every non-vegetable product is higher than those which are vegetarian.

Now that a selection of the 3 large product families have been made, we will continue to determine the kind of products we would expect to have in each category and its impact.

PANTRY

DAIRY PRODUCTS

Dairy Products	g CO_2 / g
Butter	1,17
Cheese (Average)	7,54
Sour Cream	0,22
Milk, whole, fresh	1,02
Yogurt	0,19

Table 8 – Raw Materials – Pantry - Dairy Products Impact

GRAINS

Grains	g CO_2 / g
Dry Corn	0,6
Dry Oats	0,31
Rice	2,16
Rice Bran	0,46
Rye	0,25

Wheat	0,26
Wheat, hard white wheat	0,34
Yellow Mustard	1

Table 9 - Raw Materials – Pantry - Grains Impact

MISCELLANEOUS FOOD CROPS

Miscellaneous Food Crops	**g CO_2 / g**
Cocoa beans	0,57
Coffee beans, green	1,66
Sugar Cane	0,04

Table 10 - Raw Materials - Pantry - Miscellaneous Food Crops Impact

NUTS AND SEEDS

Nuts and Seeds	**g CO_2 / g**
Almonds	1,89
Pecans	1,61
Pistachios	1,11
Rape Seed	0,89
Sunflower seed	0,88

Walnuts	0,49

Table 11 - Raw Materials - Pantry - Nuts and Seeds Impact

OILS

Oils	g CO_2 / g
Olive Oil	2,54
Palm Oil	0,44
Soybean	1,48
Sunflower	1,48

Table 12 - Raw Materials - Pantry – Oils

PROCESSED FOOD

Processed Food	g CO_2 / g
Cocoa Butter	1,13
Cocoa Powder	0,2
All-purpose Flour	0,65
Hams	9,31
Hash Brown/Fried Potatoes	3,95
Ice Cream	1,82
Olives	0,13
Pasta	1,24
Whole Wheat Pasta	1,05
Margarine	1,77

Soybean Meal	0,67
Sponge Cake	1,03
Sugar Cookies	1,3
Sugar, Raw cane	3,01
Sugar, Refined Cane	3,93
Cereals	2,16
Tofu	0,71
Tomato Ketchup	2,25
Whole Wheat Bread	0,83
Oatmeal	0,49
Oat bran	0,49
Peanut Butter	1,53
Pita Bread	0,84
Pizza Dough	0,72
Potato Crisps	3,43
Salt	0,22

Table 13 - Raw Materials - Pantry - Processed Food

THE MARKET

BEANS AND PULSES

Beans and Pulses	g CO_2 / g
Beans	0,8
Chickpeas	0,64
Lentils	0,53
Soy beans	0,56

Table 14 - Raw Materials - The Market - Beans and Pulses

Fruits and Berries	g CO_2 / g
Apples	0,23
Apples, Organic	0,19
Apricots	0,23
Bananas	0,27
Black Raspberry	0,57
Cherries	0,24
Figs	1,54
Grapes	0,83
Grapes (for raisins)	0,3
Lemons	0,09
Mandarin Oranges	0,21
Mango, Organic	0,07
Melons	0,14
Nectarines	0,22
Blood Oranges	0,17
Oranges	1,46
Peaches	0,06
Pears	0,34
Pineapple	0,08
Plums	0,22
Pomegranates	0,45
Prunes	0,5
Raspberries	0,27
Strawberries	0,27

Table 15 - Raw Materials - The Market - Fruits and Berries

HERBS

Herbs	g CO_2 / g
Cilantro (Coriander)	0,2
Peppermint	44,92

Table 16 - Raw Materials - The Market – Herbs

MEAT AND POULTRY

Meat and Poultry	g CO_2 / g
Beef meat, Pasture-fed	16,46
Beef meat, Ration-fed	17,59
Chicken meat, large scale, confinement	3,73
Chicken meat, small scale, free-range	5,6
Eggs, Large-scale, free-range	2,02
Eggs, Small-scale, free-range	1,89
Lamb meat, ration fed	24,89
Pepperoni	13,06
Pork meat, full confinement	5,45
Pork meat, pasture access	6,09
Sausages	9,34
Turkey meat, small scale, confinement	4,67

Table 17 - Raw Materials - The Market - Meat and Poultry

Vegetables, Root Crops and Tubers	**g CO_2 / g**
Artichokes	0,12
Asparagus	0,4
Beets	0,02
Broccoli	0,05
Cabbage	0,06
Carrots	0,05
Cauliflower	0,14
Celery	0,05
Cucumbers	0,06
Eggplants (Aubergine)	0,23
Garlic	0,43
Lemongrass	0,03
Lettuce (Average)	0,085
Mushrooms	0,02
Onions	0,13
Parsley	0,07
Peas	0,13
Peppers	0,12
Potatoes	0,15
Pumpkins	0,07
Spinach	0,15
Squash	0,16
Sweet potatoes	0,19
Tomatoes	0,11
Tomatoes, Cherry	0,03

Table 18 - Raw Materials - The Market - Vegetables, Toot Crops and Tubers

SEA FOOD

Sea Food	g CO_2 / g
Catfish, Farmed	2,14
Cod	2,39
Common Carp, Farmed	2,41
Flatfish	2,72
Herring	0,95
Industrial Fish	0,51
Mullet, Farmed	2,41
Mussels	0,24
Norway Lobster	2,44
Oyster, Farmed	5,19
Salmon, Farmed	1,31
Shrimp/Prawn, Farmed	3,2
Silver Carp	2,41
Tuna (Canned)	1,85
Tuna (Skipjack & Yellowfin)	0,9
Tuna, Farmed	1,56

Table 19 - Raw Materials - The Market - Sea Food

DRINKS

Drinks	g CO_2 / g
Beer	0,38
Coffee	2,51

Juices	2,14
Red Wine	0,43
Soft Drinks	1,72
Soy Milk	0,69
Whisky	2,73
White Wine	0,44

Table 20 - Raw Materials - Drinks

5.4. PROCESS

In this project we will differentiate between two types of products.

Those which are already processed (Table 13) and those which are not.

For those which are processed this calculation (5.4. Process) will not add weight to the impact. Otherwise, for all the other Raw Materials the following consideration will be taken into account.

The company, which in this case is the one which will calculate the carbon footprint of its products, must enter its energy consumption in Kwh (monthly or annual) and also the quantity of products produced, monthly or annually, respectively.

It is true that taking into account the consumption of the company is not only adding that part of the energy due to the literal production of the product, but also that you are considering the consumption due to: power consumption of the electrical network, computers, lifts, etc. And in fact, it is precisely because of this question that this calculation can be so interesting.

The calculation, is nothing more than the following simple proportion:

For each Kwh consumed, the impact is 350 g of CO2

6. MANUAL FOR THE SCORECARD USAGE WITH AN EXAMPLE

In order to explain how the Scorecard works (Excel attached) it has been considered opportune to make the manual. But first there is going to be a case study that is going to work as an introduction and first contact with the Scorecard usage.

First of all, this is the scorecard (Figure 11), in which the four parts mentioned in the previous point can clearly be seen (5. Development of the indicators for the scorecard).

Emerald green - Transportation

Violet - Packaging

Red - Product and raw materials

Green - Process

In order to make a comparison of the impact of the distribution, consumption, etc. of the product, an equivalence has been made with the impact per kilometre of the average consumption of a diesel car.[1]

In addition, a chart has been added to plot the percentages of the total impact of the product.

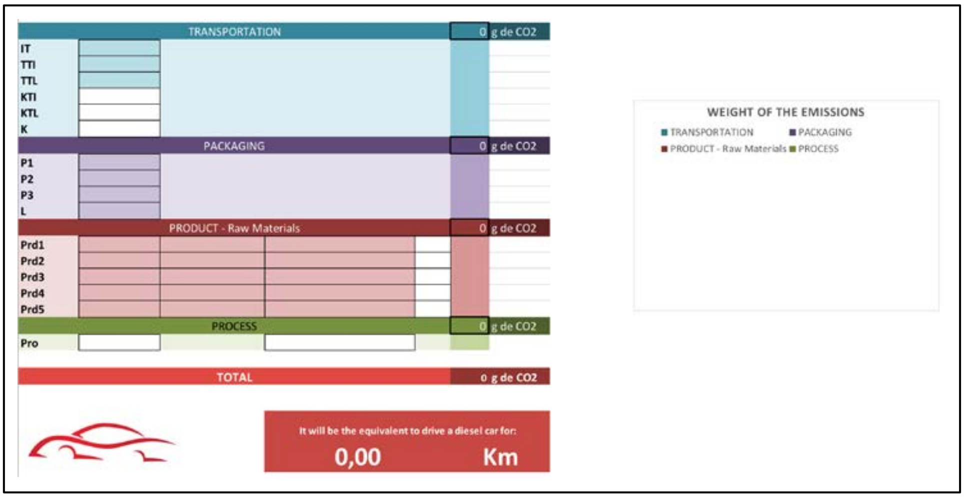

Figure 11 - Scorecard Manual - Layout

[1] NB that for an average of 6 km, the impact is one Kg of CO_2.

6.1. EXAMPLE WITH A CASE STUDY – CAKE

Note the following case: There is a famous American Cake shop – Lolly's Bakery (Based in New York). Due to their good reputation among consumers and the continuous requests for them to send their cakes all over the world, they decided to consider the possibility of internationalizing the company, sending the cakes worldwide.

The owners have always been concerned about the environmental impact of their products. So far they have been aware that its impact was minimal. But now, they have decided to make a study of the impact that their product could have if they were to send their cakes overseas.

Most of their consumers are Spaniards, so they have decided to start their delivery only to Spain.

From our company, $SCCO_2$ (Scorecard CO_2), we have provided a template to fill in with the following fields necessary to make the study.

$SCCO_2$ Template	**Lolly's Bakery**
Method of transportation	Plane (Not Refrigerated)
Distance in Km	6234 Km
Method of Distribution	Lorry (Refrigerated)
Average distance from warehouse to consumer	450 Km
Weight of each product	1225 grams
Packaging	Plastic bag + Cardboard box + Paper label
Ingredients (in grams)	Olive Oil (50 gr) Flour (250 gr) Eggs (150 gr) Yogurt (125 gr)

Amount of power [Kwh] and amount of products[units]. (Monthly or annually)	4925 Kwh /2500 Products

Table 21 - Template for the Case Study: Cake

Having all the required information we will proceed to enter all the values in the Scorecard.

Note that information should be entered in those fields which have a black border (Figure 11) There are two types: Those in which a number should be typed (white background – Figure 12) and those in which you have to select a parameter (coloured background – Figure 13)

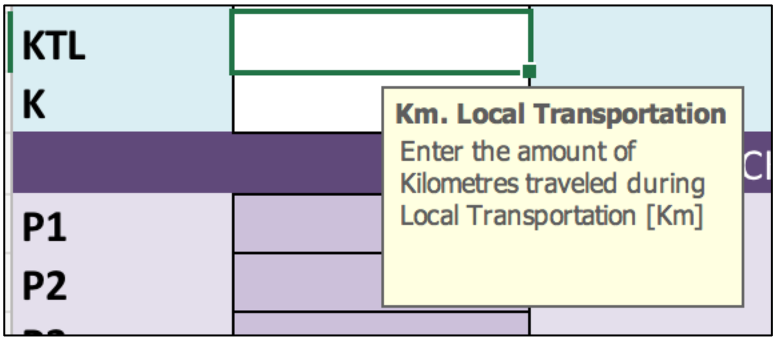

Figure 12 - Scorecard Manual - Number Typed

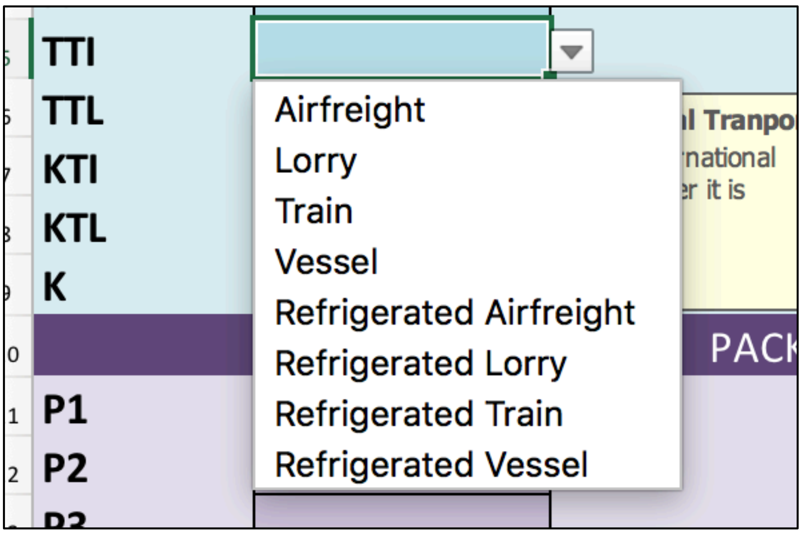

Figure 13 - Scorecard Manual - Selection of an indicator

Also note the importance of how to choose the Product and Raw material: the menus are displayed as you define the product you are choosing, and finally, you enter the weight in grams of the raw material. The example on Figure 14 is done with the 50 grams of olive oil that Lolly's bakery required for one cake (Table 21) .

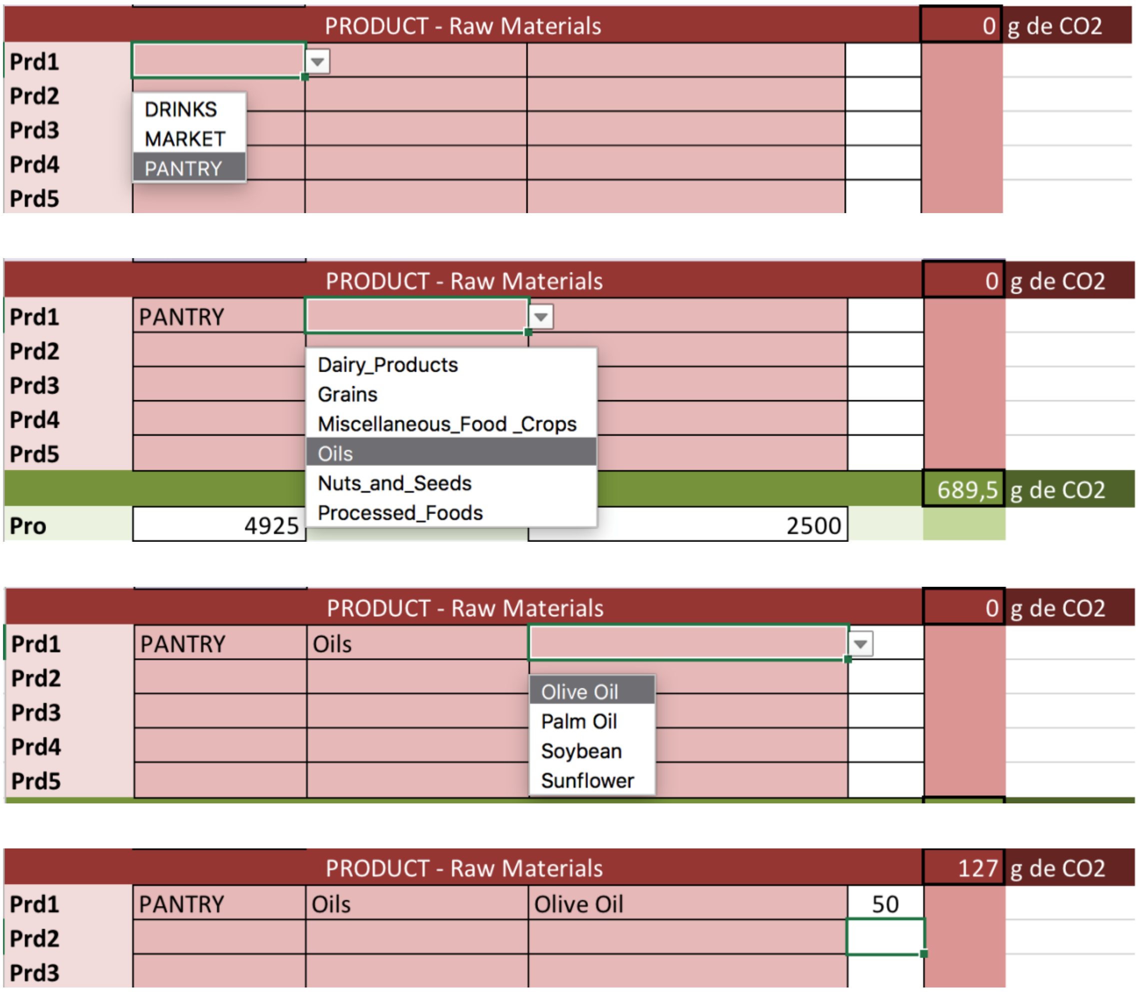

Figure 14 - Scorecard Manual - Selection of the products/Raw Materials

Following the information Lolly's bakery provided we were able to fill in the Scorecard and calculate the impact of the cake, which looked like this (Figure 15).

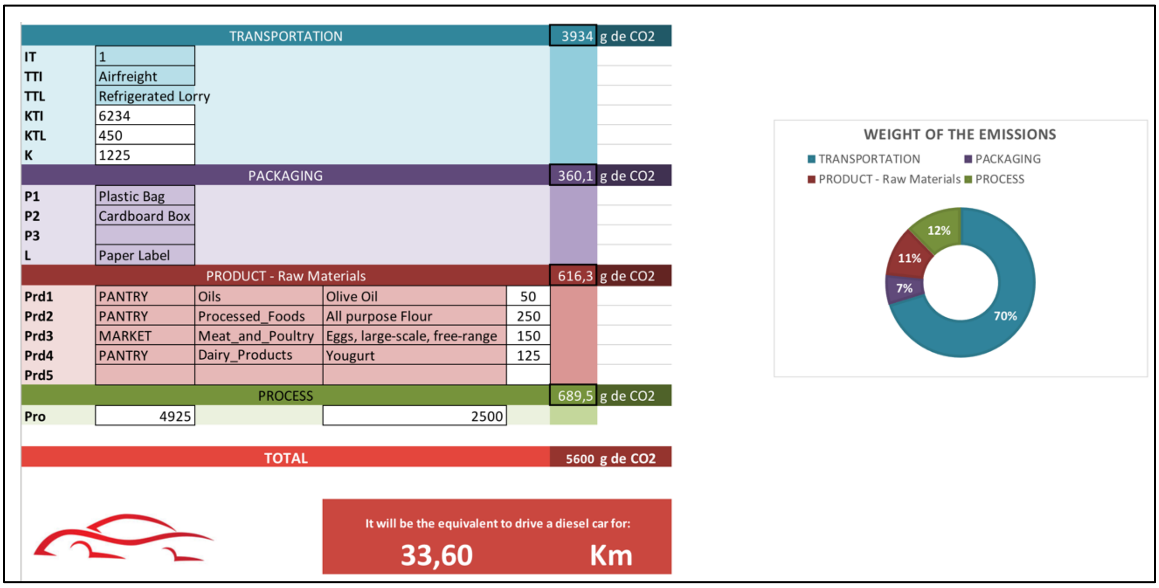

Figure 15 - Scorecard Manual - Lolly's Bakery Impact

For further calculations an Excel with the Scorecard is attached (Annex 3) with the Project so that it can be tested.

6.2. SCORECARD MANUAL

The manual is divided into the following 6 sections: Transportation, Packaging, Product, Process, Result and Graph.

There are four types of box:

1. Those that cannot be modified as they show only a result.
2. Those that cannot be modified and they hide a formula.
3. Those that can be modified and an option should be chosen.
4. Those that can be modified and a value should be entered.

Only the first, third and fourth aforementioned types of boxes are going to be mentioned in the manual. Note that the excel attached is blocked: only those boxes that require information are available to enter data, so that the scorecard can be checked. If a formula is required (box type number two), a password will have to be entered to unblock the document. The password to unblock it is "TFGNuria".

TRANSPORTATION

This part of the scorecard is meant to define the transport. The diagram below (Figure 16) shows what kind of data should be entered.

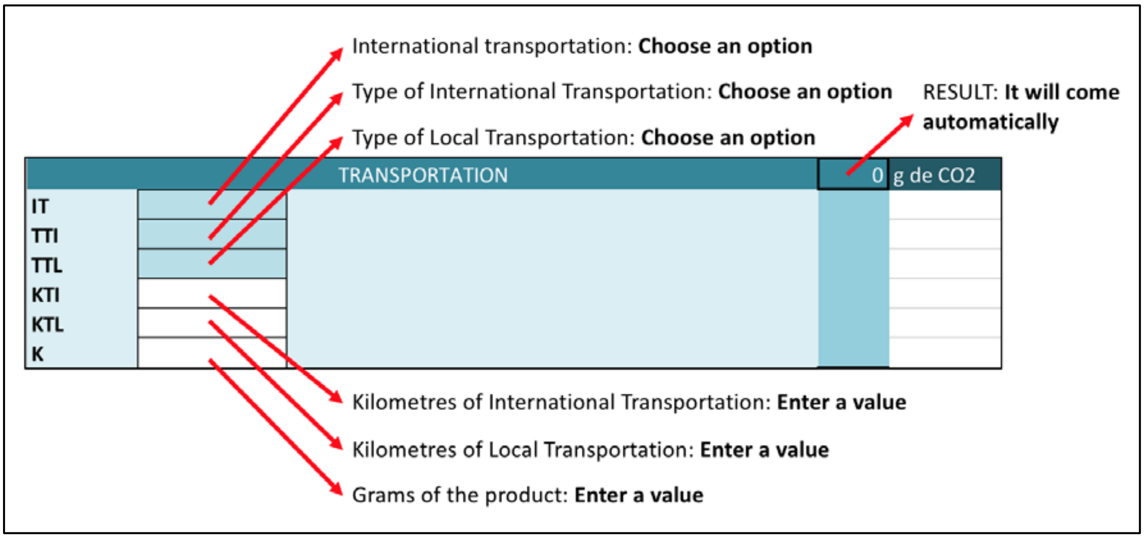

Figure 16 - Scorecard Manual - Transportation

PACKAGING

This part of the scorecard is meant to define what the packaging is. The diagram below (Figure 17) shows what kind of data should be entered. Note that in order to define better the product there are three options (P1, P2, P3) to detail what the packaging is. There is an extra value (L) to define the labelling.

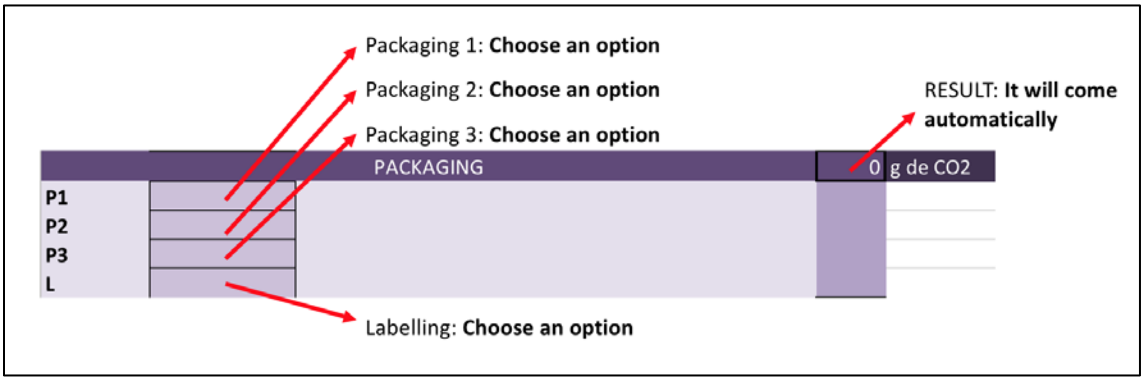

Figure 17 - Scorecard Manual - Packaging

PRODUCT

This part of the scorecard is meant to define the product. The picture below (Figure 18) shows what kind of data should be chosen.

There are three steps to define each raw material and five parameters to define the entire product (Prd1, Prd2, Prd3, Prd4 and Prd5).

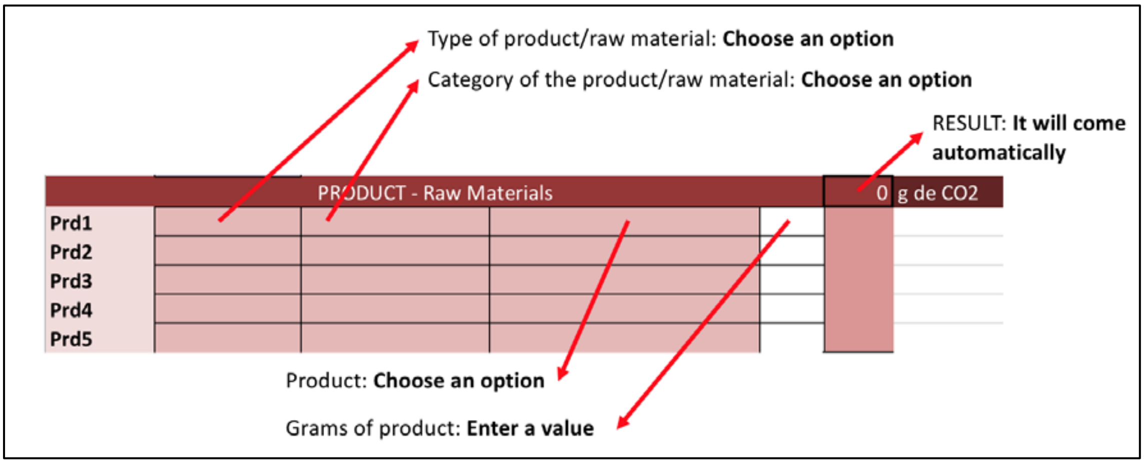

Figure 18 - Scorecard Manual - Product

PROCESS

This part of the scorecard is meant to define the process. The picture below (Figure 19) shows what kind of data should be entered.

The company's energy consumption [Kwh] should be entered and the amount of products they produce in the same period of the energy consumption.

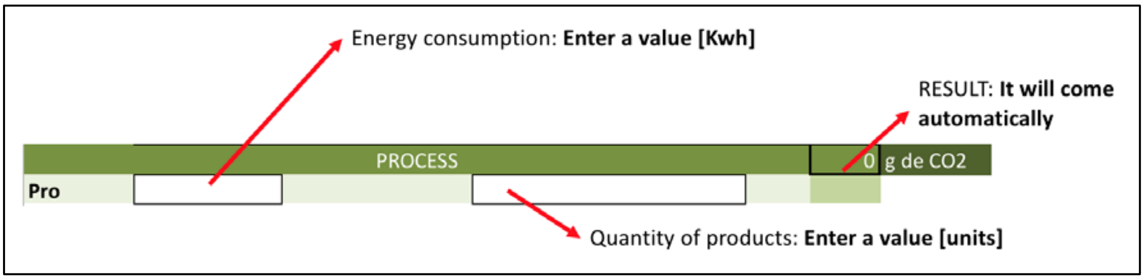

Figure 19 - Scorecard Manual - Process

RESULT

The scorecard returns a value, which is a simple sum of all the previous results. In order to make this result clear a comparison has been made between this and the distance in kms that an average diesel car would cover in order to have the same

Figure 20 - Scorecard Manual - Result

impact on the environment as the product (Figure 20).

GRAPH

This chart is extra visual information which is useful in order to see the percentage of each section and appears automatically once all the values are entered (Figure 21).

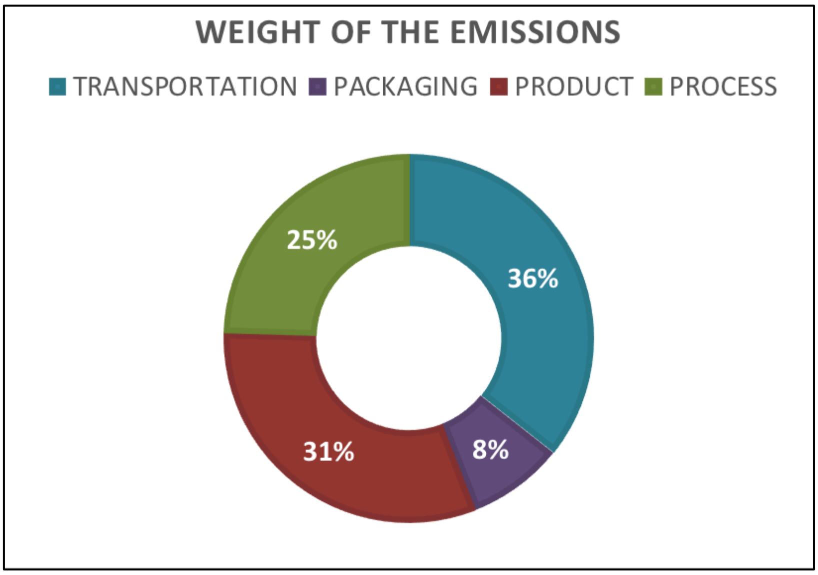

Figure 21 - Scorecard Manual - Graph

7. LOGO DESIGN

As mentioned in the introduction, the purpose of this project, is that all future products would include a CO_2 indicator.

The logo has been designed to include a blank space for the grams of CO_2 which would have been previously calculated using the Scorecard.

Figure 22 is the final design of the logo:

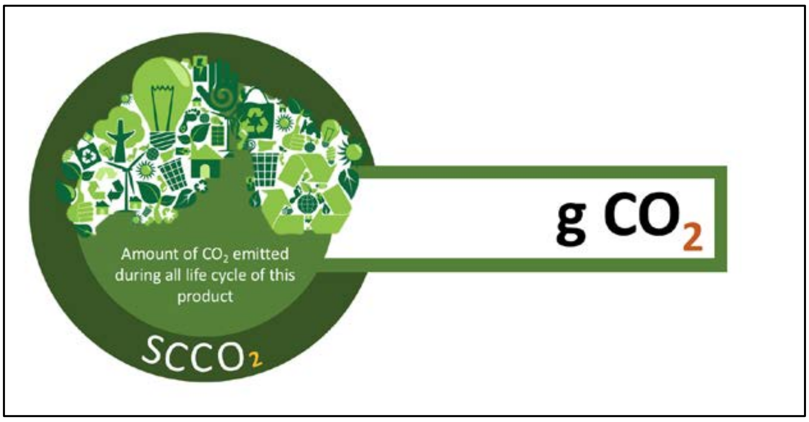

Figure 22 - Logo Design

This logo, which first appeared on the front cover, includes the carbon impact of this project. The calculation of the impact can be seen in section 10.

8. OPINION: POLL + INTERVIEW

The main purpose of this project was to create a scorecard. However, it was not the primary aim, as the objective was to create a tool which could be used by companies, in order to add an indicator for all their products. Their customers would then be able to see what the impact was on the environment.

At this point, having created the scorecard and checked its accuracy, another important step for the project was, not only to know how customers think but also what a businessman running a food company sees in this idea, Would this affect sales positively or negatively? Would you be a supporter of the idea? Do people really think about the environment when making a purchase?

The best way to have all these questions answered was to ask people. This is going to be divided into two sections:

8.1. PART 1 – ONLINE POLL:

A small online questionnaire in which people were asked the following questions:

1. **Sex:** (Empirical and Dichotomous variable) Men or Women
2. **Age:** (Empirical variable) The following division was made in order to see what future generations think about the environment. Which is the main reason why the age range gets wider as the age increases.

    Less than 18

    18 to 25

    26 to 35

    36 to 55

    More than 55

3. **Decide which product you would buy and select it.** (Theoretical and Dichotomous variable)

The question was asked in order to make the respondent aware of the different parameters a product can have. The result of this answer is of little consequence to the study. The idea was to have two products to choose from and to give importance to question four.

People were asked to select one of the options below:

Product A **Product B**

0,59€/100g

Energy value	1606 KJ = 370 Kcal
Proteins	5g
Carbohydrates	
Total	84g
Sugar	37g
Starch	47g
Fats	
Total	2,5g
Satured	1,5g
Dietary fiber	2,5g
Sodium	0,5g
Salt	1,3g

0,87€/100 g

Energy value	1619 KJ = 382 Kcal
Proteins	8g
Carbohydrates	
Total	81g
Sugar	20g
Starch	-
Fats	
Total	2g
Satured	0,4g
Dietary fiber	4g
Sodium	-
Salt	0,5g

*This has been calculated with estimated values and without using the tool. The huge difference between the impact on the environment values is not because of the production itself, as the emissions during it would be similar, but for the offshored raw materials and the over-packaging **product A** has.

4. **The reason why you have chosen product A or B?** (Theoretical variable which expresses taste, preference or opinion)

At this point the most important question was asked. The following study will be based on these results by groups of age or sex, so we can draw some real conclusions. People were asked to select the reason why they had chosen the product before.

The possible answers were:

Brand.

Impact on the environment.

Price.

A specific value in the table.

Packaging.

5. **If you had the opportunity to choose products based on the impact they have on the environment would you do it?** (Theoretical variable which expresses taste, preference or opinion)

This last question was vital to understand how seriously people take the climate change issue and if they would rather choose a product for the impact or for other reasons, if they had the opportunity.

The possible answers were:

I would, I want to stop climate change.

I would, but I do not think it will help significantly.

I would not.

Maybe.

The following conclusions have been reached, after surveying exactly 462 participants. The online poll, which was conducted in Spanish, is added as a link in the bibliography. Moreover, it is in the Annex 1 where the table of content is attached.

Participation was higher among women and men, 289 (62,6%) and 173 (37,4%), respectively.

The most voted option was product B with 268 votes, representing 58%. The circle graph (Figure 23) shows what people have considered in order to select the product. Studying the results and comparing them with product A (Figure 24) it can be determined that people having selected B (Figure 25), take their health and the environment more seriously. Almost half of the participants considered choosing the product using the *new* possible indicator (impact on environment).

Participation among people from 35 to 55 was very high. It shows that a part of our society, which represents the major purchasing group (average age of people with children), have seriously considered buying the product based on the emissions. As shown in the chart, (Figure 26) the older people become, the higher their awareness of what they are going to buy is. Nevertheless, it seems that young people are still not keen on the idea. When choosing the product, their deciding factor is the price (Figure 30).

In addition, this frequency histogram (Figure 31) also shows the tendency by ages and the predisposition to consider the environment when buying a product. Furthermore, the non-consideration of it, contrary to what was expected, has a percentage in all group ages. It is also true that this percentage is much lower and is fixed.

In conclusion, as described in the circle graphs (Figure 24 and Figure 25), people were deciding to buy **product A** for three main reasons (Brand, Packaging and Price), representing 90%. Opposed criteria had people who purchased B, as 92% voted for it because of the impact on the environment or for the fact that in general this second product was healthier. If we combine **product A** and **product B** results, people choosing a product because of environmental reasons are the majority (Figure 23).

It is important for companies to know the impact the addition of this parameter on the product could have on the consumption of their goods.

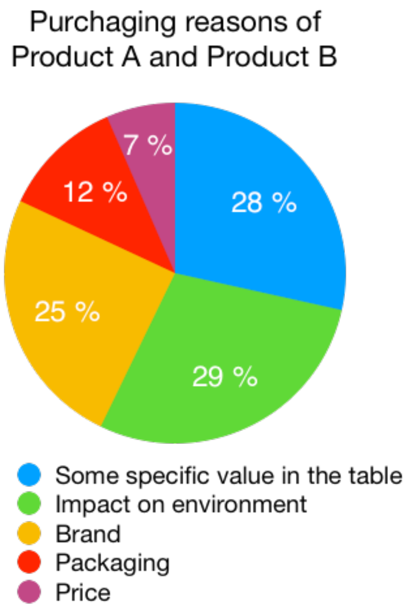

Figure 23 - Purchasing Reasons

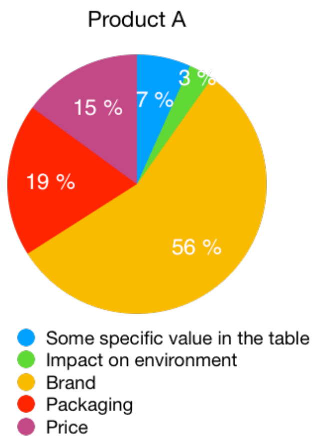

Figure 24 - Product A

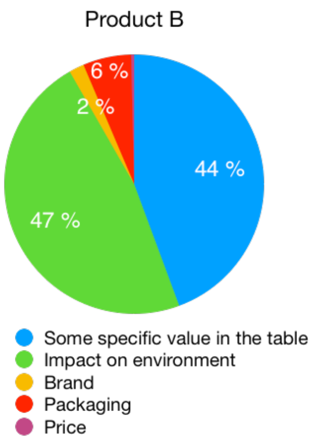

Figure 25 - Product B

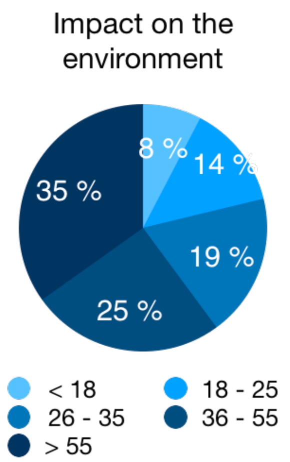

Figure 26 - Impact on the Environment

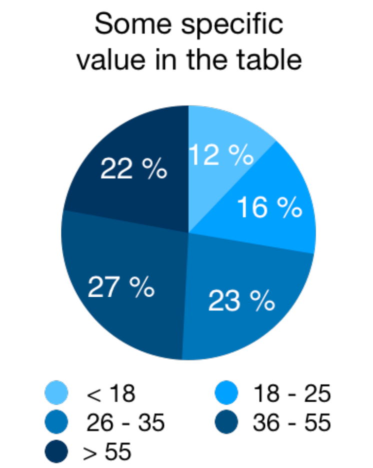

Figure 27 - Some specific value in the table

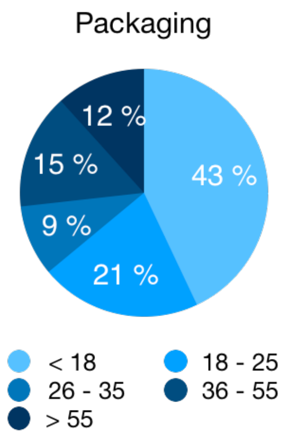

Figure 28 - Packaging

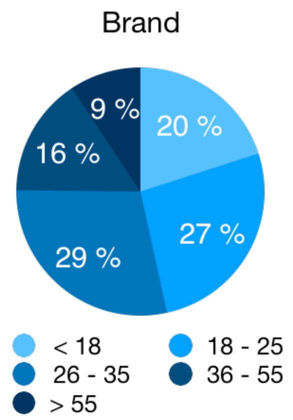

Figure 29 - Brand

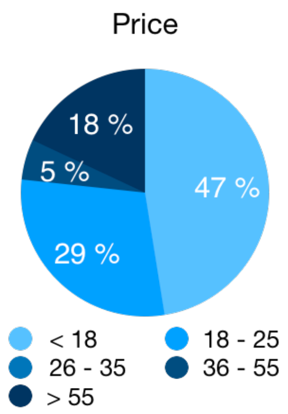

Figure 30 - Price

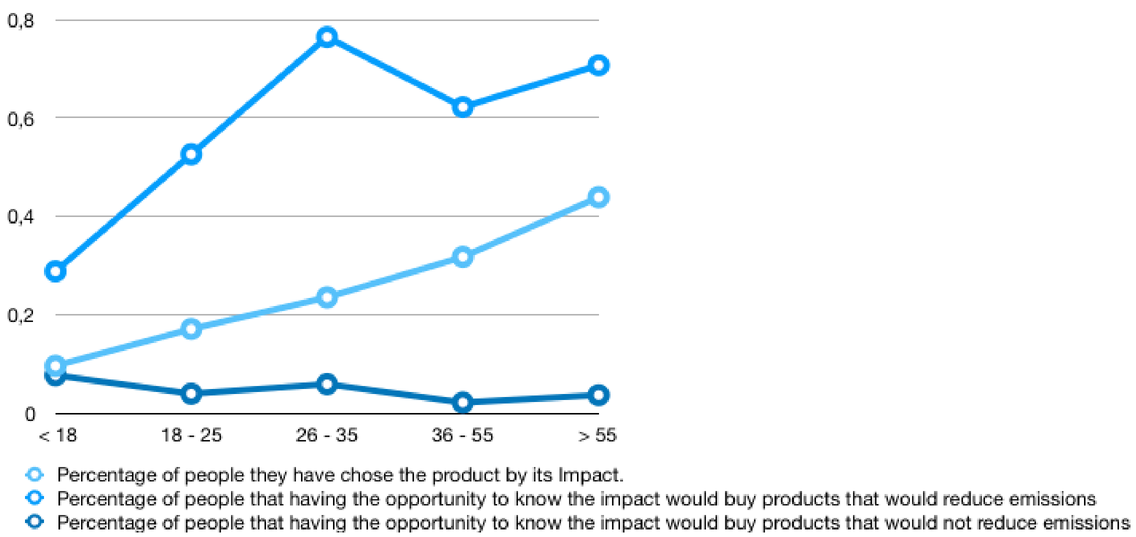

Figure 31 - Combination/Comparison of the Results

8.2. PART 2 - INTERVIEW:

An interview with Manuel Marqués Vilallonga, CEO and owner of *Técnicas De Elaboración De Salsas S.L.*, a company engaged in the preparation of sauces.

He was a participant in the poll without knowing what all this project was about. The main purpose of the project was explained to him before the interview which was originally conducted in Spanish. (The transcript is on Annex 2 as an audio file)

The conclusion of the interview was negative.

On the one hand, it is important to know that, as Mr. Marqués explains in the interview, companies are subject to a large number of obligations and laws, which make the product more expensive. A good example would be the recycling symbol which is not mandatory. Currently, in order to add it, you have to manage and declare your waste, in this case to Ecoembes (A Spanish private company related to the recycling process and redesign – eco-design of new packaging to avoid waste and therefore, CO_2 reduction in emissions). If you do not declare the waste on packaging, you cannot add the logo (Figure 32). Nevertheless, as soon as your product is purchased by a company, the company charges you a fee on packaging recycling, because in the end, it has to be attributed in some way. In the end, if you do not declare it (as a company as a quarter or annual rate), you will end up paying for it, so that your product can be commercialized.

Mr. Marques also thinks that although it is an idea with a good intentions, he does not believe that it will have a great impact on the market. Nor does he believe that due to the fact that their products are local, and that they have a low CO_2 index, consumers will opt for their products. Therefore, a possible investment to include it, he would only see it as one more expense and not as something that would have a positive impact in economic terms.

Even so, he affirms that if other companies began to include it or if it was obligatory, he could not be left behind and without hesitation, the logo would be added to all his products.

Figure 32 - Recicling Registered Logo

9. BUDGET

9.1. HOURS INVESTED IN THE PROJECT:

Brainstorming and Development of the project	15 days x 6 hours	90 hours
Written Project	25 days x 6 hours + 12 days x 3,5 hours	192 hours
Presentation (Development and Practise)	3 days x 4,5 hours	13,5 hours
Learning how to use some Excel functions	3 days x 1,5 hours	4,5 hours
Development of the Scorecard (Different versions)	6 days x 6 hours	36 hours
Development of the logo	1 day x 3 hours	3 hours
English lessons to check the project	5 days x 2 hours	10 hours
Meetings with the supervisor	5 days x 30 minutes + email contact	2,5 hours
TOTAL		350 hours x 35 €/hours = **12250 €**

Table 22 - Hours invested in the project

9.2. TRAVELLING

10 bus tickets (one T-10)	**10,2€**

Table 23 – Travelling

9.3. EQUIPMENT REQUIRED & OTHER WASTES

Computer	1700 €
Book Cradle to Cradle	39 €
Energy Consumption	85W x 350 hours = 29,7 Kwh = 0,12[m] · 29,7 = 3,5 €
TOTAL	**1742,5 €**

Table 24 - Equipment Required

9.4. LOGO DESIGN

Logo Design	**250 €**

Table 25 - Logo Design

9.5. TOTAL BUDGET

The total budget for this project will be:

Total cost without VAT	14252,70 €
VAT 21 %	2993,07 €
TOTAL	**17245,77 €**

Table 26 – Total Budget

[m] Average Price for a Kwh

10. IMPACT OF THE PROJECT

Energy consumption was 29,7 Kwh. Therefore, the impact which was calculated with the Scorecard is shown below (Figure 33).

Figure 33 - Impact of the project

11. CONCLUSIONS

Having finished this project I been able to put into practice much knowledge learned throughout the last 5 years of my degree course.

It has been a good way to learn more about this current topic on environmental impact. A good way to be aware that any action, however small, can have a great impact.

In general, it is a project that has been realized with a lot of dedication. There was a long process to see which was the best strategy to carry out the project and this has had small variations throughout.

This final project, with which I finish my degree, I hope reflects all these years of perseverance, dedication and all the hours that I have invested to look for information that was very difficult to obtain.

I would like to add that the first idea for this project was to make an infinitely simpler tool with which to only differentiate the impact between one product and another (If it was better for the environment or worse). Having been able to create this precise tool with which to calculate the environmental impact of many products that are in supermarkets, for me it has been a real success. However, I would also like to propose as a possible improvement, a tool to calculate the impact for any product in the market.

In addition, I was very surprised to learn that many people in the poll were really interested in the subject and loved the idea. As Mr. Marqués comments in the interview, he does not believe that a CO_2 indicator would be a determining factor for people when buying a product.

I would like to thank all the people who gave me moral support which enabled this project to go ahead.

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