TU Delft

SUSTAINABLE OPPORTUNITIES

In the Fashion industry

MSC Thesis
Strategic Product Design
Alessandro Domenighini
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Sustainable opportunities in the Fashion industry

Easing the transition to a slower, user-inclusive production model for Maium.

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EXECUTIVE SUMMARY

Finding alternatives to the current fashion production is crucial to increase the sustainability of this system and switch to a more circular model, which could significantly lower the impact fashion companies have on the environment and on social issues such as fair working conditions.

Maium has been found to be an extremely interested company that, despite its small size, has great ambitions for sustainability in this sector. Working together made it possible to imagine a future in which also smaller companies can help in changing a system from the bottom up. Usually the biggest changes come from the biggest companies, and they need to drive change. But that does not mean that the rest of the actors in the fashion industry just need to wait for them to act.

This research has been conducted in and for the Dutch market specifically, but the tools and methods applied in it can be implemented in different companies and different markets.

Indeed, it's not just the design solution that brings value to the research, but also the application and reflection on the methods used: it has been a priority to evaluate these tools and reflect on the application possibilities that these have.

In the research, a market and company analysis will be conducted, where the focus will be on the internal operations of the company, and on the external factors that influence it. An overview on the current system and the possible alternatives will be provided.

Moreover, the application and outcomes of the methods will be discussed, focusing on Maium's perspective and use of them, the pros and cons of such tools.

Finally, the design solution provided to the company will be described and a reflection on the whole process will be conducted.

1 INTRODUCTION

In this chapter general data regarding the fashion industry are provided, followed by the expression of the aim of the study and the research questions.

1.1 AIM OF THE STUDY AND RESEARCH QUESTIONS

The value of the global fashion industry reaches 3.000 billion dollars as per 2021, which makes it 2% of the world's Gross Domestic Product (GDP) (FashionUnited, 2021), employing 300 million people along the value chain (Ellen McArthur Foundation, 2017).

The fashion industry has grown double its size in the last 15 years, when we're talking about clothing production (Todeschini et al., 2017).
This is also due to the implementation of fast fashion systems within the production model of global fashion: it would be common sense to think that the production and sales models changed in so much time, yet it is not exactly true: indeed, the fashion industry always has had more or less the same model, which is a linear one, intended as produce-use-dispose.

Within this, in the last decades fast fashion has been adopted, which also can be reassumed in produce-use-dispose linear model, but with much less attention to overproduction and, thus, waste.
This operating model has been proved to be extremely polluting and wasteful, as the fashion industry pollutes more than international shipping and marine transportation combined (Ellen McArthur Foundation, 2017).

The incredible growth the fashion industry has seen is due to the adoption of the fast fashion model by some of the biggest companies in this sector, such as H&M, Zara, Uniqlo, Primark and many others. This model is characterised by massive overproduction and a huge reduction in use-time of garments, making consumers compulsively and continuously buy new clothes, which are much cheaper due to lowered material quality and construction.

This has also resulted in an increased amount of textile waste that is getting thrown into landfills or incinerated.

In just the last few years, this issue is starting to gain relevance thanks to the work of some organisations that are emphasizing the importance of change in this sector.

This research has the intent of exploring the possibilities fashion companies have to switch to a more sustainable production and post-production, in order to reduce waste and possibly become actors of change within the industry. There are many tools and methods that can be used to become more sustainable yet, for their relative novelty, few apply them in their daily operations.

This research is being conducted for this reason: investigating the implementation of such methods in the daily operations of a fashion company, with the intent of increasing its sustainability.

The aim of this study has been to explore the possibilities of improving sustainability in the fashion industry in the Netherlands, both in production and post-production. To reach this scope it has been necessary an approach that was not only theoretical but practical as well. It has been fundamental the collaboration with raincoat company Maium, based in Amsterdam, which has served me as case study for the whole research.

How can Maium **limit the environmental impact** created in the production and post-production of their raincoats, and **include users** in the process?

In order to better set the direction of the study and focus on the right aspects, sub-questions have been formulated:

- *How can sustainability tools and methods best be applied to Maium's practice and business model?*
- *Which barriers are hindering a more sustainable approach to the production and post-production phases in the lifecycle of fashion products?*
- *How can consumers in the Dutch fashion system be included in design for sustainability processes, increasing their role as agents of change?*
- *What strategy does Maium need to follow in order to improve and implement sustainable practices in its production process?*

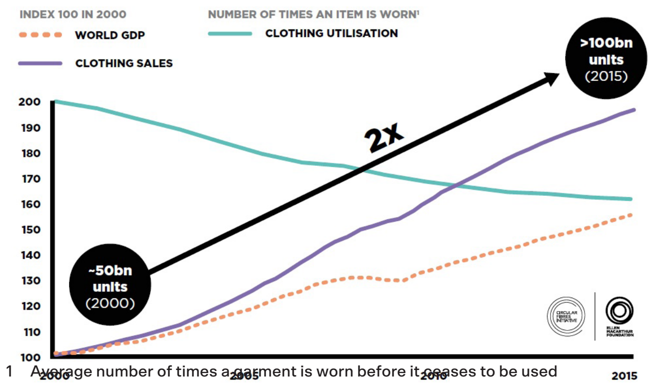
2

CONTEXT

An overview of the context in which Maium operates, and in which the research takes place is provided in this chapter.
First the fashion system in general and during the pandemic is analysed, and then the focus is shifted towards consumers.

2.1 THE CURRENT FASHION SYSTEM

GFA and BCG have found that 82% of clothes, after use, are usually incinerated or thrown away in landfills (2017), a level of waste is almost unmatched in any other industry. Of the remaining 18%, just 1% of it is recycled into new clothes, while the rest is reused in other industries such as house insulation, equaling to a loss of 100 billion dollars worth of materials every year (Ellen McArthur Foundation, 2017).



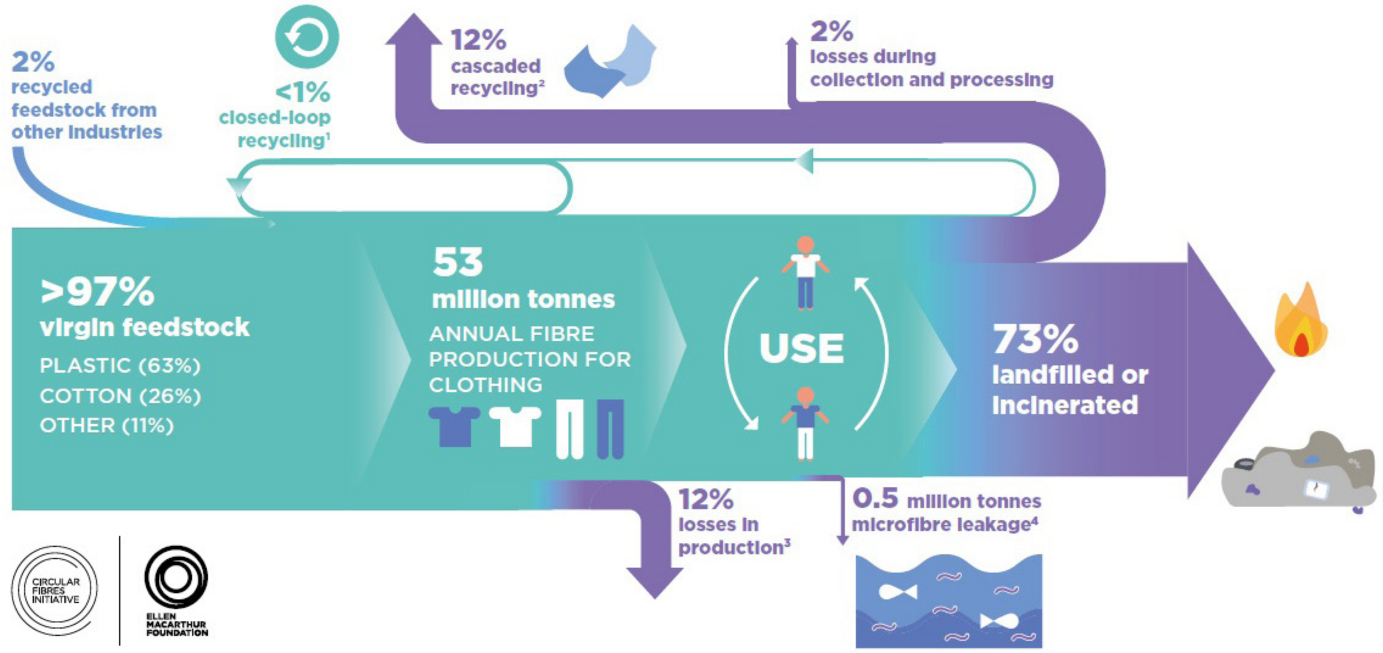
1 Average number of times a garment is worn before it ceases to be used

Figure 1: Growth in clothing sales and decline in clothing utilisation since 2000.
Source: Euromonitor International Apparel & Footwear 2016 Edition (volume sales trends 2005–2015); World Bank, World development indicators – GD (2017)

The waste, though, is not just coming from post-consumer phases, but from pre-consumer as well. The processes in the production phase of clothing and textiles consume large amounts of water and energy, not to mention chemicals that are often dangerous for the environment and human health (Jung and Jin, 2014).
For example, cotton production by itself is liable for 10% of global use of synthetic pesticides (Gam et al., 2010), which are unhealthy for both humans and soil. Cotton is one of the most widely used fabrics, together with polyester.
Apart from their environmental impact, global fashion chains are characterized by bad working conditions.
The manufacturing of clothing is usually outsourced in underdeveloped countries, where the majority of workers are underpaid women (and in the worst cases children), hygienic conditions do not meet health standards, and chemicals used can be dangerous for human health. (Turker and Altuntas, 2014).
In this linear system, waste is present in large quantities: it has also been approximated that 80% ca. of the clothes are thrown away after just the first six months (Baker-Brown, 2017). (Sustainable fashion in a circular economy, K. Niinimäki, 2018)

Luckily, some steps towards fairer working conditions through the production chain are being taken thanks to consumer awareness, yet transparency in the production is still far from a complete reality since it is very difficult to make sure these requirements are met (Ellen McArthur Foundation, 2017).

To summarise, the current fashion system is almost completely linear, following the classic directions of produce-consume-dispose. Large quantities of nonrenewable resources are extracted in order to produce pieces of clothing with short use-times, after which the vast majority of them are going to get incinerated or thrown away into landfills.
This type of model leaves out many economic opportunities that could be leveraged, applies huge pressure on resources while polluting and degrading environments and ecosystems, not to mention the negative impacts it has on different societies (Ellen McArthur Foundation, 2017).



1 Recycling of clothing into the same or similar quality applications
2 Recycling of clothing into other, lower-value applications such as insulation material, wiping cloths, or mattress stuffing
3 Includes factory offcuts and overstock liquidation
4 Plastic microfibres shed through the washing of all textiles released into the oceans

Figure 2: Global material flows for clothes in 2015.
Source: Circular fibres initiative analysis, Ellen MacArthur Foundation, 2017

Fast fashion
Fast fashion is defined by trends that change rapidly and the prices of clothes are low: the production has advanced in a way that markets are driven by extreme consumerism, thanks to cheap apparel, and clothes are intended as disposable (Britwistle and Moore, 2007; Joy et al., 2012).

Due to this perception of clothes' disposability, one natural consequence is a huge rise in waste: GFA and BCG have approximated that fashion industry's waste will increase by 60% from 2015 to 2030, reaching the amount of 148 million tons on a global scale.

Another consequence is resource scarcity: most industries need to find sustainable alternatives which are independent from resources to guarantee their supply (Bell et al., 2012).

For example, areas such India and China are expected to get exposed to stress on their water supply, which will definitely impact the fashion industry considering the cotton production that is present in those countries.

To ensure economic and social growth, companies that are dependent on resources, like almost all fashion companies, need to find sustainable alternatives to this linear production, and possibly switch to a more circular model (Jackson, 2017; Weetman, 2016).

2.2 FASHION DURING THE COVID-19 PANDEMIC

As previously anticipated, even before the pandemic the fashion industry was not in a good position concerning sustainability and economic opportunities: just 60% of clothes were sold at full price, which translated in a loss of billions of dollars in revenue and margin (McKinsey, 2021).

When Covid-19 arrived, the turnover of inventories fell by 33% in just the first three months of 2020, and the orders decrease to a third by the end of April.
Just a few companies managed to creatively face the period of difficulty clearing the excessive stock they accumulated (i.e. Ganni sold past seasons' collection at discounted price).

There are three main priorities fashion brands need to and are starting to have (McKinsey, 2021):

1. **Shift towards a model tailored by demand in a quicker way;**
2. **Reduce the intricacy of collections;**
3. **Recalibrate the price-volume equation.**

The current amount of collections is now starting to be seen as a big inhibitor of the demand-focused model. Gucci, for example, as BoF and McKinsey state in their 2021 survey, has said that instead of the usual five collections per year they will launch two, directing their production towards a seasonless fashion model (among retailers).

The main trend between fashion brands has been a pricing strategy dedicated to markdowns: some fashion companies, such as Levi's, have based their pricing strategy relying on market and consumer data retrieved by artificial intelligence (BoF and McKinsey, 2021).

Figure 3: Gucci will move towards a seasonless fashion model.
Source: Gucci.

The pandemic has accentuated a condition that was already starting to get in the spotlight: more is not necessarily better.

Indeed, it has displayed that fashion brands that do not completely rely on discounting and reducing the complexity of their collections often outrun the ones that do not. Furthermore, if this is connected to a demand-focused model and smart collection management, it leads to a smoother, better fitting the global market, business model. (BoF and McKinsey, 2021).

"Circularity is likely to be one of the key business trends of the next decade. However, it is not the kind of revolution that can be led by a few leaders, while others wait and see."
(McKinsey, 2021)

Companies are now shifting, and need to do so, to a bigger focus on aligning launches to their customers' needs, instead of the conventional fashion model. It can be said that for this change in their production model, they are following the new rule of "less is more".

2.3 CONSUMER SHIFTS

The pandemic has increased digital adoption exponentially, and many brands have leveraged this opportunity by starting or improving their online presence and many people embracing new types of digital approaches such as customer service videos and social shopping.

Covid-19 has increased an already existing sentiment of anti-consumerism, or at least the critique to extreme consumerism, and also set the importance towards sustainable purchasing to a much higher level, which translated in a desire from consumers to switch to circular business models (BoF and McKinsey, 2021).

If companies do not meet consumers' new mindset, the accumulation of stock will worsen in the future: consumers are hugging the "less is more" model that corresponds to industry modifications in the fashion cycle.

McKinsey has conducted an online survey, during the pandemic, where 65% ca. of respondents expressed their desire to buy more high-quality and long-lasting clothes: what is interesting is that most of the interviewees said that the concept on "newness" is now one of the least influencing factors in their shopping habits.

Figure 4: Consumers are shifting towards a less extreme consumeristic approach to fashion
Source: Asos.

2.4 CONSUMER BEHAVIOUR

The biggest, and most obvious, motivation that drives consumers into purchasing sustainable clothes is the growing environmental concern that is affecting a big part of the global population. Closely linked to this, there is the interrelation between fashion industry and negative social aspects (as previously said, one example could be unfair working conditions that characterise the production of some companies).

But there are various and diverse reasons that could push consumers to care more for sustainable purchases, such as veganism and the attention to animal rights in the production of clothes, or the appeal of buying high-quality clothes that carry out a story with them, that belonged to someone else before and that are given a second life.

Sustainable choices in fashion consumption, like most choices, are made because of specific motivations which are driven by internal and external factors to the consumer (Wiederhold and Martinez, 2018).

Internal factors
These are the causes that stand within the mind of consumers, what drives them in terms of sensations, emotions and feelings, but also personal traits and preferences that are matured during the years.

Changing their consumption pattern, favouring ethical alternatives in respect to traditional products is often dependent on an individual's own willingness to do so: if a consumer is extremely attached to a specific brand or store, it is quite difficult for them to switch to another one, even if this might mean making the most sustainable choice (Park and Kim, 2016).

This is what is called brand loyalty, and within the process of deciding it is an extremely important aspect to take into consideration. It could lead people not only to never change their consumption behaviour, but also make them filter information in a selective way: bad events related to the brand might be ignored, while positive information might be set up in a biased impression (Papaoikonomou et al., 2010; Wiederhold & Martinez, 2018).

These options may bring the consumer to extend and bend their conception of what ethics and sustainability mean (Papaoikonomou et al., 2010; Wiederhold & Martinez, 2018).

Another relevant internal factor is knowing what negative effects the fashion industry has on its surrounding environment (Wiederhold & Martinez, 2018): if consumers do not know a problem exists, they are never going to act in a way that may solve the problem itself, in this case meaning they will not consume consciously and sustainably (Austgulen, 2015).

Sometimes consumers feel that sustainable and conscious consumption is a sort of moral obligation, to which they need to stick: this links to the belief consumers have on whether an individual has power to change things or not, and whether spontaneous attempts of individual consumer matter (Austgulen, 2015).

Consumers that believe individual actions have effects on the market are more likely to purchase ethical and sustainable products as they have faith they will make a difference (Wiederhold & Martinez, 2018).

External factors
These are elements that influence consumers from an external source. The most obvious and first overall aspect that influences the purchase of a product, be it sustainable or unsustainable, is always the price (Wiederhold & Martinez, 2018).

The first thing consumers consider when making a purchase is what the benefit for them is (Balderjahn, 2013). This translates into the fact that when buying a product there is a moment in which their concerns for the environment are disregarded in favour of the possibility of paying less (Wiederhold & Martinez, 2018).

Apart from the economic factors, other causes may influence consumers from the outside, such as institutional factors, intended as the necessity of proper infrastructures to buy sustainable products (Wiederhold & Martinez, 2018). Not only this, but also social and cultural aspects have a big incidence: it is almost needless to say that the environment in which an individual is put plays a role in their behaviour as consumers.

3

THEORETICAL FRAMEWORK

This chapter presents the frameworks and methods used in the study. Section 4.1 describes circular economy, first in a general way and then applied to the fashion industry. Section 4.2 explores the motivations and barriers to a more sustainable consumption and the role consumer behaviour has in this context.

3.1 CIRCULAR ECONOMY

The Ellen MacArthur Foundation described the concept of circular economy as

“restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all time”.

The fashion industry is confronting an ever-growing problem of textile waste accumulation, since consumers are induced to think that clothing is a disposable good in consequence of its fast production and consumption (Allwood et al., 2006; Andersen,2017). In order to face and try to challenge these problems several theories and applications have been designed, one of the most renowned is the circular economy.

This concept has already been applied in many different industries, including the clothing and textile industry. Adapting circularity to the fashion industry means to rethink its whole value chain and system of production (Ræbild and Bang, 2017).

As it is known, waste becomes a resource in the logic of a circular economy, where five ways of recovering waste have been identified (Kumar and Malegeant, 2006): maintain/share, reuse, refurbish, remanufacture and recycle.
These are all activities that take part in the technological cycle, where repair and maintenance are linked to the users, reuse and redistribution to service providers, refurbishment and remanufacturing to products manufacturers, and lastly recycling is linked to parts manufacturers.

Value Hill
To ease the comprehension for businesses on how to position themselves in a circular model, a visualisation of a Value Hill has been created by Achterberg, Hinfelaar & Bocken (2016) (Figure 5).

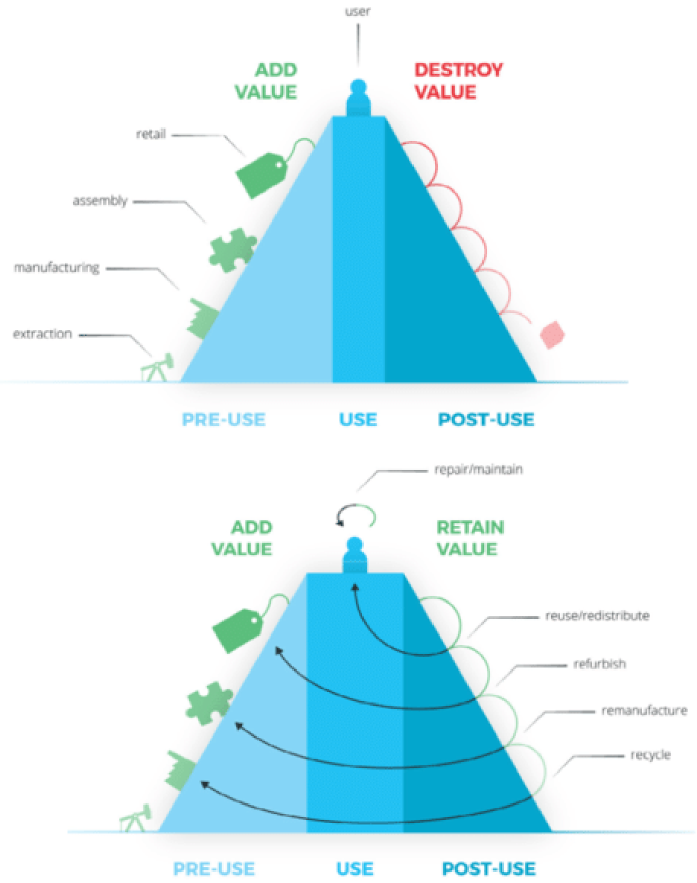


Figure 5: Value Hill of linear and circular business models
Source: Achterberg, Hinfelaar & Bocken (2016).

This concept categorises the lifecycle phases of a product as pre-use, in-use and post-use. Businesses can thus evaluate the implementation of circular strategies as well as define missing partnerships in their network.

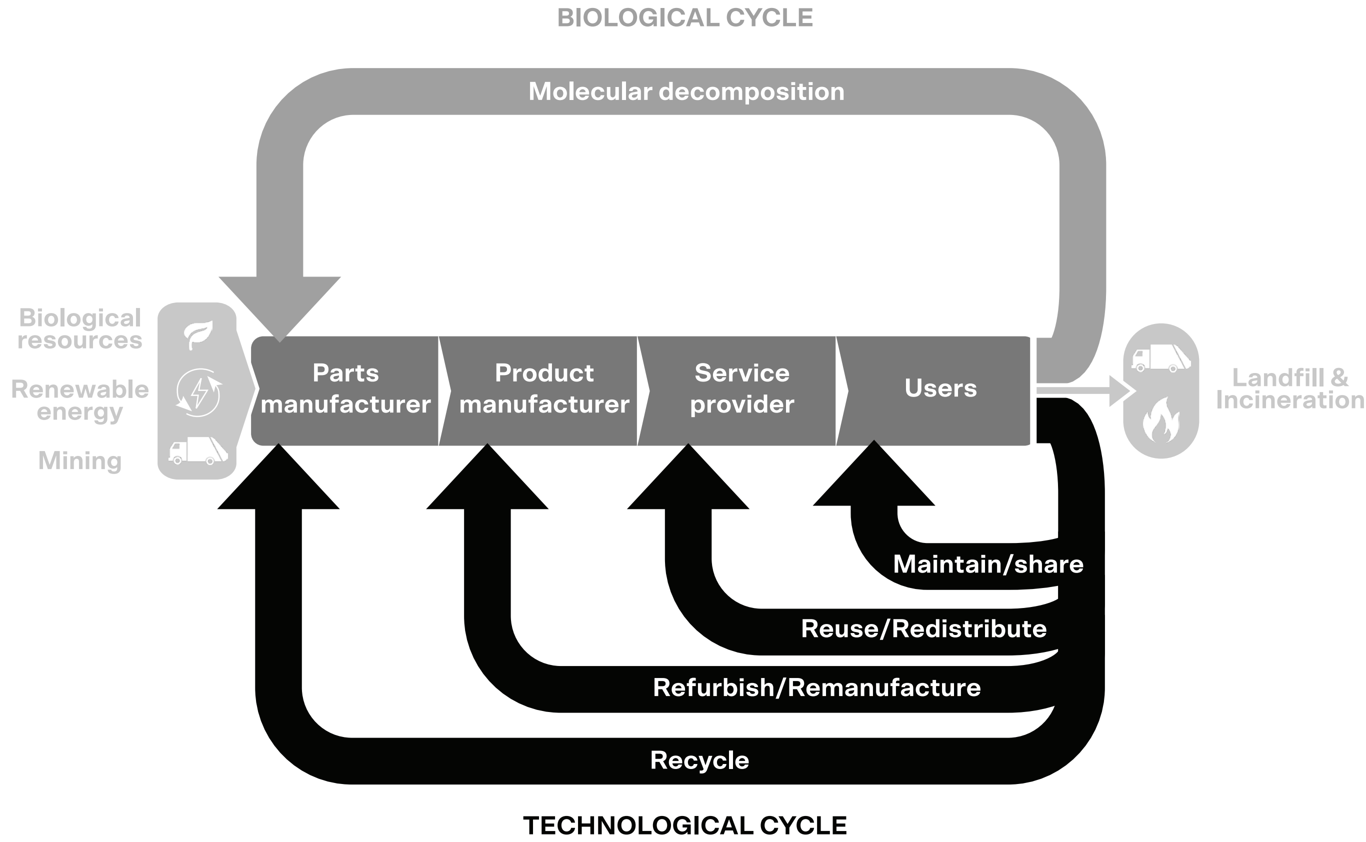


Figure 6: Resource flows and cycles in the Circular economy
Source: Faludi Design.

Circular practices can be implemented in companies’ business models in two different ways, which are extending the product’s life or recycling and regenerating the elements that compose the product (Stahel, 2016).

In the context of fashion, circular practices can be achieved by recycling textile waste and extending the lifetime of garments, aiming at maintaining the products’ and materials’ value as high as possible for the longest time.
By doing this, it would be possible to address problems such as resource scarcity and waste of clothing in landfills.

Roughly 80% of clothes are sent to incineration or landfills, which has a clearly negative environmental impact as it increases greenhouse gas emissions, erosion of soil and groundwater pollution (Yacout and Hassouna, 2016).

There are three types of waste produced by the fashion industry (Leonas, 2017):

1. The waste that is created as a by-product of the industrial processes needed for the manufacture of garments (including textile, water and energy waste);

2. Pre-consumer waste which means scrap and all the garments that come out damaged from the production line or that are impossible to sell;

3. Post-consumer waste which includes the rubbish generated by users after the purchase.

In order to create a change in the fashion economy and switch towards a more circular model, it is important to understand what the possibilities and barriers are, and how the recycling of textiles works.

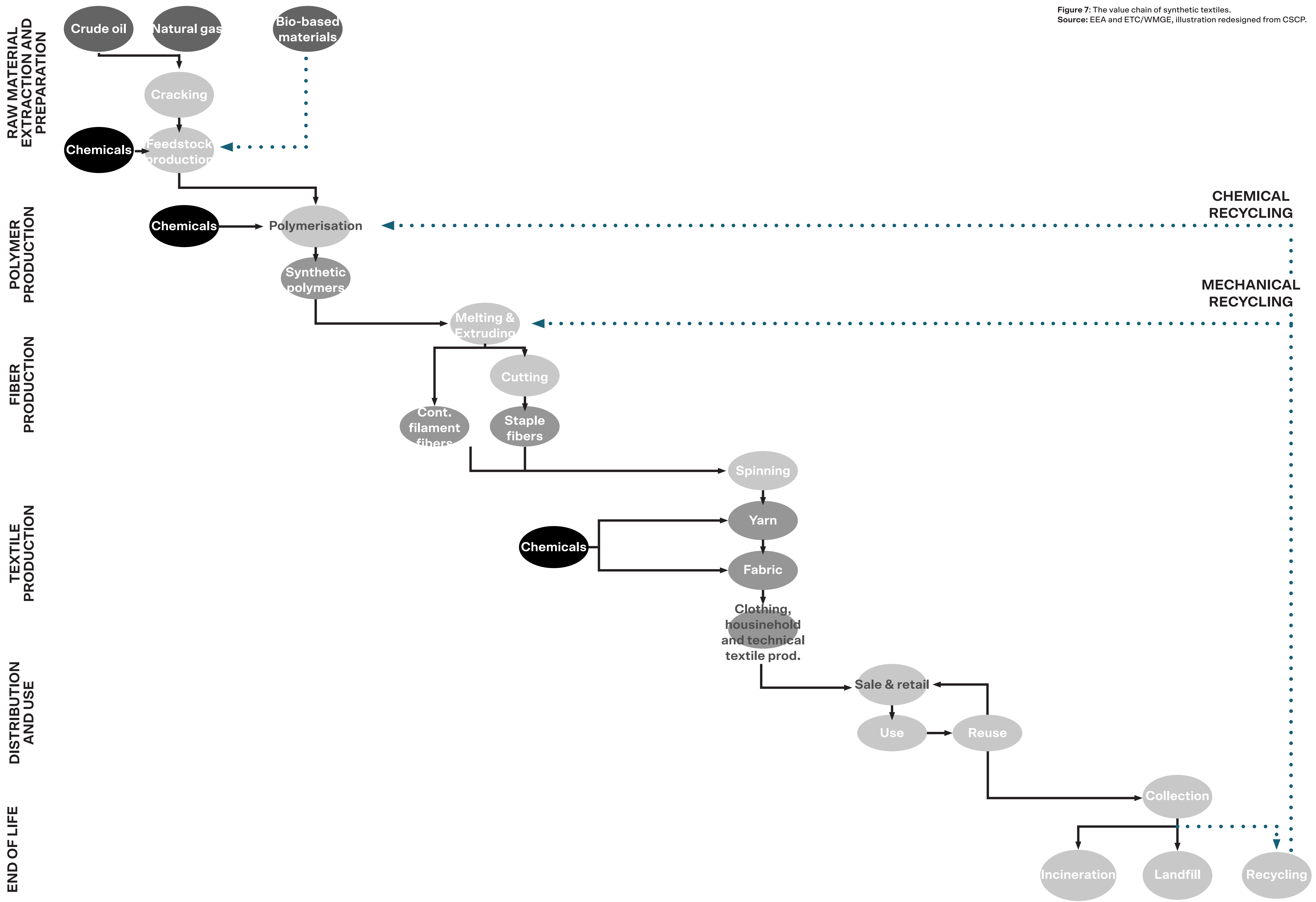


Figure 7: The value chain of synthetic textiles.
Source: EEA and ETC/WMGE, illustration redesigned from CSCP.

3.2 SUSTAINABLE CONSUMPTION
Motivations and barriers

Textiles can be mechanically recycled or chemically recycled; the first approach is intended for the processes in which cutting, shredding and disassembling materials are operated: this process turns waste into secondary raw materials or products without modifying in a significant way the chemical structure of the material.

The second approach, instead, consists in bringing the material back to its monomer state through depolymerisation so that it can then be repolymerised and reused for different purposes.

Recycling of synthetic textiles
Estimations report that European consumers dump approximately 6 million tonnes of textiles annually, more or less 11 kg per individual (Beasley and Georgeson, 2014). Since approximately 60% of textiles are synthetic (FAO/ICAC, 2013), it is estimated that 3,5 million tonnes of plastic textile waste are ditched in Europe every year.

At present, no compelling recycling of synthetic textiles is present and the rare fibre-to-fibre recycling that exists is mostly mechanical recycling of 100% cotton products.
Fibre-to-fibre recycling for textiles consist of mechanical and chemical processes. The majority of recycled polyester is retrieved from PET bottles instead of PET fabrics (Arnold et al., 2021): the collection systems and recycling infrastructures dedicated to PET bottles are already very good.

Chemical recycling depends on using solvents that target the disintegration of specific synthetic fibres. For this to properly happen, it is required that textiles consist just of that same target fibre.

Chemical recycling indeed exists in the industry, but not at an industrial scale yet. The technological advancement that could permit these practices is still under development, and consequently the economic feasibility needs to be considered.

First of all, the collected supply of textile waste is insufficient to support an economically viable recycling sector (Arnold et al., 2021). Adequate post-consumer collecting systems are required to provide enough supply. Secondly, the sorting processes boost the recycling cost and need to be scaled-up. Moreover, the market for recycled fibres needs to be improved and implemented.

Opportunities
Some possibilities to move towards a more sustainable and circular production and consumption (Arnold et al., 2021):

- Sustainable fibre choices: in the design stage, unabated effort needs to be put in the choice of materials;

- Control of emissions of microplastics: the design and construction of garments are fundamental. Strategies to reduce microplastics emission need to be researched and implemented.

- Improved separate collection, reuse and recycling: reuse and recycling are fundamental to cutting down virgin fibres' demand. At the end-of-life stage, meticulous sorting and excellent reuse and recycling can have big potential in the impacts' reduction.

As it is now starting to get clear, the fashion industry has been one of the slowest to adapt to the need of change and switch to a more sustainable, circular model.

The importance of such switch will never be stressed enough: the fashion industry is one of the most polluting in the world, both when it comes to calculating pollution in the production processes and when talking about the waste created after fashion products have been used. The impact of these practices is extremely high in terms of emissions, degradation of the environment, and resources exploitation, and needs to be lowered with any method possible.

Barriers
Unfortunately, there are many obstacles in reaching the final objective. Five main barriers have been listed (GlobeScan – C&A Foundation, 2019):

1. Traditional linear system: the fashion industry has functioned in the same way for years, which is a linear system of production-consumption-disposal. Business stimuli towards a change are very few, and this translates in a higher risk perception if this change is set to happen. It is usually smaller companies and start-ups that are the main promotors of this change, building it from bottom up, but it is the big players in the market that should show charisma and leadership so that circular models can be brought to scale.

2. Limited knowledge of the circular economy: circular business models are not well understood, thus adopted, yet. The big fashion companies are set on the older models and are not prepared for a radical change in their system and through their complex supply chain: unfortunately, it cannot be just one huge company to set the trend for everybody else, but many of them need to switch in this direction in order to change the whole system.

3. Demand for "fast fashion": this trend is difficult to overcome, for the balance of price and style it provides, even though this means increasing exponentially the waste created by the industry and consumers, and lowering the use time of clothing. Specifically for this point, it is the consumer behaviour that needs to change.

4. Consumer resistance to sharing: selling access over ownership might be one of the biggest challenges fashion brands are set to face. The idea of sharing clothing is not so popular between consumers, who now tend to prefer the idea of owning them. Usually, the major concerns related to sharing clothes are hygiene, social shame, cost and durability.

5. Business culture: the difficulty of changing from one business model to another is concrete. Fast fashion models permit high sales targets and profits, while collaborative and circular models ensure sustainable consumption: the choice between the two is hard and many aspects need to be considered, from an economical point of view.

4 METHODOLOGY

In this chapter the research methodology is described. An overview of the three main tools and research methods used in the process is provided.

4.1 LIFE CYCLE ASSESSMENT

Three different methodologies have been explored and put into use. Life Cycle Assessment (LCA) (section 5.1), Whole System Mapping (WSM) (section 5.2) and the Presidio Sustainability Booster (section 5.3): LCA and WSM have been retrieved, studied and applied starting from VentureWell's work (www.venturewell.org). The Presidio Sustainability Booster comes from the collaboration with Presidio Graduate School, a private graduate school in San Francisco (www.presidio.edu). Moreover, these methodologies have been chosen also for their complementarity: Life Cycle Assessment has been used to verify the results of Whole System Mapping.

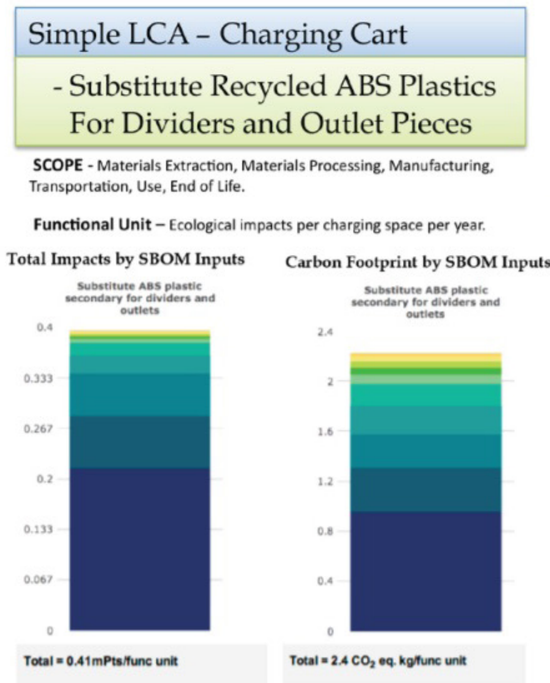
The use of all three of these methods have been facilitated by my chair, Jeremy Faludi, who has been working together with these organisations for years.

The approach to the research has been to conduct 2 reiterations of Life Cycle Assessment and Whole System Mapping, followed by a third step in the analysis in which the outcomes of the first two are put in the perspective of the Presidio Sustainability Booster: this has been done to concretely see what the solution brought by the first two iterations could mean in a business model perspective.

Between the three tools, Life Cycle Assessment is the most famous and used method to quantify the environmental impacts of a specific product or service: its strength stands behind the fact that this method enables researchers to analyse different moments and aspects of a certain product through its life.

LCA can assist in (ISO 14044:2006):

- recognising chances to increase products' environmental performance at various points in their life cycle;
- advising decision-makers in industry, governmental or non-governmental organizations (i.e. for strategic planning, priority setting, product/process design or redesign);
- selecting important indicators of environmental performance;
- marketing (i.e. ecolabelling scheme, environmental claiming, or producing an environmental product declaration).



Input	mPts/func unit
Steel, converter, low-alloyed	0.214
Cable, three-conductor cable	0.0689
Sheet rolling, steel	0.0564
Powder coating, steel	0.0236
Truck and trailer	0.0169
Cable, three-conductor cable	0.00536
Acrylonitrile-butadiene-styrene copolymer, ABS	0.00332
Aluminum, cast, semi-permanent mold (SPM)/kg NREL /US	0.00317
Turning, steel	0.00243
Incineration, plastics, mixture	0.00207

Input	CO_2 eq. kg/func unit
Steel, converter, low-alloyed	0.957
Powder coating, steel	0.352
Cable, three-conductor cable	0.266
Truck and trailer	0.229
Sheet rolling, steel	0.177
Aluminum, cast, semi-permanent mold (SPM)/kg NREL /US	0.0738
Incineration, plastics, mixture	0.0552
Acrylonitrile-butadiene-styrene copolymer, ABS	0.0530
Injection molding, plastics	0.0401
Injection molding, plastics	0.0235

Name	Qty	Material/process	Amount	Units	Total (mpts)	CO2 Eq. (kgs)
Substitute ABS plastic secondary for dividers and outlets					0.409	2.36
Wheels	4					
Wheel rubber	1		0.389	lbs		
Process		Injection molding, plastics	0.389	lbs	0.000476	0.0101
Wheel rubber		Styrene Butadiene Rubber	0.389	lbs	0.00121	0.02
Wheel plastic	1		0.908	lbs		
Process		Injection molding, plastics	0.908	lbs	0.00111	0.0235
Wheel plastic		Acrylonitrile-butadiene-styrene copolymer, ABS	0.908	lbs	0.00332	0.053
Top	1		5	lbs		
Top		Medium density fibreboard	5	lbs	0.00138	0.0204
Dividers	44		2.25	oz		
Process		Injection molding, plastics	2.25	oz	0.00189	0.0401
Dividers		Acrylonitrile-butadiene-styrene copolymer, ABS, secundairy	2.25	oz	0.000744	0.013
Handle	1		20.3	oz		
Process		Heat treatment, aluminum	20.3	oz	2.38E-05	0.000671
Handle		Aluminum, cast, semi-permanent mold (SPM)/kg NREL /US	20.3	oz	0.00317	0.0738
Handle Rod	1		8	oz		
Process		Powder coating, steel	0.75	ft2	0.000201	0.003
Process		Cold impact extrusion, steel, 1 stroke	8	oz	0.000126	0.00187
Handle Rod		Steel, converter, low-alloyed	8	oz	0.000965	0.00431
Bumpers	1		5	oz		
Process		Injection molding, plastics	5	oz	9.57E-05	0.00203
Bumpers		Polyvinylchloride, PVC	5	oz	0.000184	0.00233
Structural Steel bits						
Process		Powder coating, steel	88	ft2	0.0236	0.352
Process		Sheet rolling, steel	111.137	lbs	0.0564	0.177
Structural Steel bits		Steel, converter, low-alloyed	111.137	lbs	0.214	0.957
Wires	1		18.25	lbs		
Wires		Cable, three-conductor cable	18.25	lbs	0.0689	0.266
Outlet plastic	43		0.25	oz		
Process		Injection molding, plastics	0.25	oz	0.000206	0.00436
Outlet plastic		Acrylonitrile-butadiene-styrene copolymer, ABS, secundairy	0.25	oz	8.08E-05	0.00141
Outlet copper	11		0.25	oz		
Process		Sheet rolling, copper	0.25	oz	8.84E-05	0.00108
Outlet copper		Copper, primary	0.25	oz	0.000585	0.00147
Extension cord	1		1.42	lbs		
Extension cord		Cable, three-conductor cable	1.42	lbs	0.00536	0.0207
Connectors	1		9	oz		
Process		Zinc coating, pieces	10	in2	0.000275	0.000359
Process		Turning, steel	9	oz	0.00243	0.00786
Process		Wire drawing, steel	9	oz	0.000412	0.000816
Connectors		Steel, converter, low-alloyed	9	oz	0.00109	0.00485
Large washers	1		2.25	oz		
Process		Milling, steel	2.25	oz	0.000619	0.00214
Process		Sheet rolling, steel	2.25	oz	7.14E-05	0.000224
Large washers		Steel, converter, low-alloyed	2.25	oz	0.000271	0.00121
Misc plastic connec	1		0.5	oz		
Process		Injection molding, plastics	0.5	oz	9.57E-06	0.000203
Misc plastic connectors		Polyethylene terephthalate, granulate, amorphous, PET	0.5	oz	3.24E-05	0.000361
Plastic Cord Clips	1		1.25	oz		
Process		Injection molding, plastics	1.25	oz	2.39E-05	0.000507
Plastic Cord Clips		Polyethylene, HDPE, granulate	1.25	oz	4.03E-05	0.000566
End of Life						
Landfill, manufacture	1	Medium density fibreboard	5	lbs	2.16E-05	0.000587
Incineration, plastics	44	Acrylonitrile-butadiene-styrene copolymer, ABS, secundairy	2.25	oz	0.00207	0.0552
Landfill, aluminum	1	Aluminum, cast, semi-permanent mold (SPM)/kg NREL /US	20.3	oz	1.13E-05	0.000148
Landfill, steel	1	Steel, converter, low-alloyed	8	oz	1.12E-06	1.44E-05
Landfill, polyvinylchlc	1	Polyvinylchloride, PVC	5	oz	2.61E-06	8.01E-05
Landfill, steel	1	Steel, converter, low-alloyed	111.137	lbs	0.000248	0.00319
Recycling	1	Cable, three-conductor cable	18.25	lbs	0	0
Incineration, plastics	43	Acrylonitrile-butadiene-styrene copolymer, ABS, secundairy	0.25	oz	0.000225	0.00599
Incineration, copper	11	Copper, primary	0.25	oz	2.43E-06	2.00E-05
Recycling	1	Cable, three-conductor cable	1.42	lbs	0	0
Landfill, steel	1	Steel, converter, low-alloyed	9	oz	1.25E-06	1.62E-05
Landfill, steel	1	Steel, converter, low-alloyed	2.25	oz	3.14E-07	4.04E-06
Landfill, polyethylene	1	Polyethylene terephthalate, granulate, amorphous, PET	0.5	oz	3.32E-07	9.74E-06
Landfill, polyethylene	1	Polyethylene, HDPE, granulate	1.25	oz	8.19E-07	3.38E-05
Transportation	1	Truck and trailer	2000	miles	0.0169	0.229

Figure 8: LCA example for material substitution analysis
Source: VentureWell.org

It's not an exact science: the level of depth LCAs can reach varies depending on the amount and precision of information researchers gather and put into the databases.

If the intent is to compare some options with others, where the level of detail of information is not extremely high, it is possible to conduct what is called a "fast track" LCA, that might take a few hours to complete. Also, if high precision is needed, a more thorough LCA can be conducted. And this might take even months to complete.
It can also be used for theoretical and scientific purposes, where hypothetically the amount of information and time required could be years.

What does LCA measure
Life Cycle Assessments can measure purely environmental impacts: emissions of carbon dioxide, acidification of water rise and land, particulate matter... It is not about the energy itself, but what are the impacts of producing that energy.

In order to retrieve the information related to specific materials or processes or energy demands, many databases may be used. For this research the databases used have been Idemat (2017), for the calculations regarding Carbon Footprint analysis, and the Ecoinvent (V3.3), for the eco-costs calculations.

How to do LCA
LCA is an iterative process, which leaves researchers the possibility to change, edit, and re-do steps of the whole method in order to reach a satisfying detail level.

There are different steps to take in order to conduct a proper Life Cycle Assessment (ISO14044:2006):

1. Define the scope;
2. Set the boundaries (Figure 9): these can be:
    a. Cradle to Grave;
    b. Cradle to Gate;
    c. Gate to Gate;
    d. Gate to Grave.
3. Specify the functional unit;
4. Create the inventory.
5. Compute and compare;
6. Interpret the result.

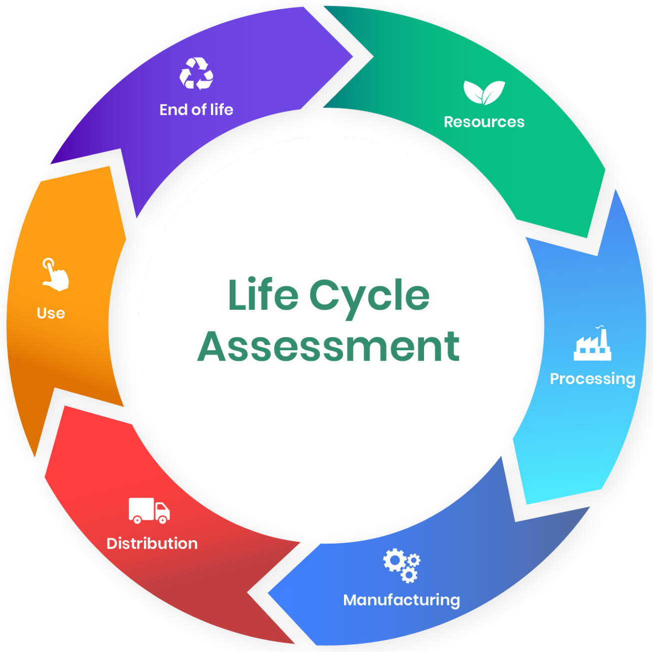
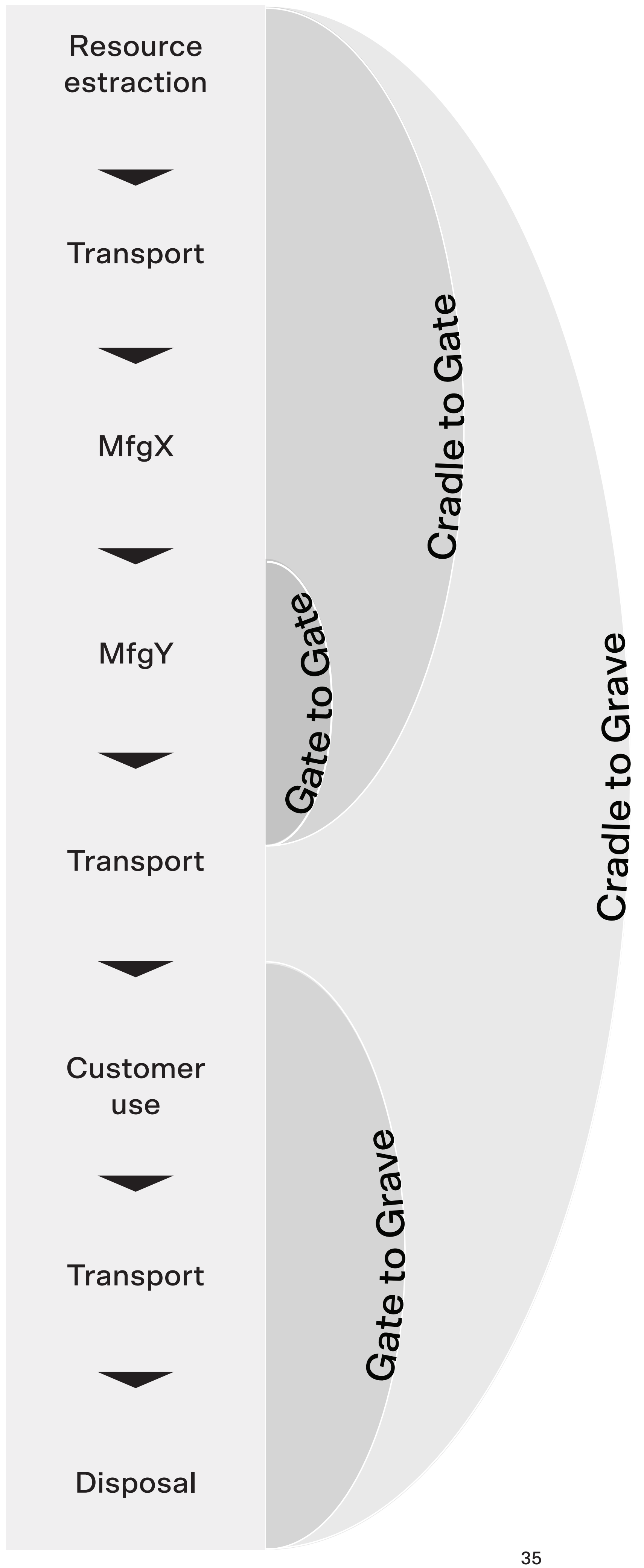


Figure 9: Life Cycle Assessment circle of activities
Source: OneClickLCA



MfgX: One specific manufacturing process that happens in a specific location
MfgY: Another, different manufacturing process that happens in another location

Figure 10: System boundaries visualisation

4.2 WHOLE SYSTEM MAPPING

This methodology is designed for system thinking: it consists in taking a step back and get a broader view on the problem product developers are trying to solve, while keeping an eye both on how to increase the sustainability of the product or service under investigation and on meeting users' needs.
The strength of this approach is that it is concrete, visual and collaborative across branches of knowledge, and helps product developers put every step of the process into perspective, so as to solve the right problems in the whole system.

It opposes the traditional approach to redesigning a product or service by having also adapt solutions, but that may address the wrong problem, or that have the problem focus blurred.

Whole System Mapping is a four-step design method:

1. Define the problem and draw a system map;

2. Set priorities with Life Cycle Assessment and business strategies;

3. Brainstorm solutions on the system map;

4. Decide winners based on the priorities.

Figure 11: Whole Systems and Lifecycle Thinking for sustainable design.
Source: Autodesk Sustainability workshop.

4.3 PRESIDIO SUSTAINABILITY BOOSTER

The Business Sustainability Booster is designed to incorporate sustainable principles into the business model of a company: it consists of a set of questions aimed at determining social and environmental possibilities and barriers.

It is designed the same way a classic business model canvas is (Figure 12), but it is intended to add a more responsible and sustainable view. It includes topics that should be considered in the design process of the business model so as to increase the social and environmental impact the company has on the market.

It applies in practice the Scheme of Sustainable Development (Figure 14), so that businesses can meet human needs while protecting the environment.

How it works
In addition to the business model canvas, the Sustainability Booster consists also of a 30-piece set of cards in which thought-provoking questions are asked (Figure 13).

Each of the nine components of the business model canvas corresponds to a card, which help the company to analyse different aspects of the business in a sustainability and corporate responsibility-oriented way.

Each card has three main sections:

1. Broad benefit: where the sustainability problem related to the business model canvas component is depicted;

2. Why this question is important: the why and the how this issue is relevant on a strategic perspective;

3. Considerations: more details and thoughts on the relevance of this issue, set so as to help the company interiorise the problem to its activity.

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Competitors Vendors/Suppliers Employees NGO's Communities Government/Regulators Owners/Investors/ Grantors Industry Transformation Organizational Structure	Product/Servic e Design Processes Facilities **Key Resources** Materials Water Energy	Broad Benefit Mindful Impact Customer Behavior Branding Sustainability	Honoring Customers Transparency Emerging Needs **Channels** Impact Accessibility	Importance Access

Cost Structure	Revenue Streams
Return on investment Externalities	Sources of revenue Distribution of revenue

Figure 12: Business Model Canvas.
Source: Presidio Graduate School..

VALUE PROPOSITION
Broad Benefit

What could be the larger value proposition beyond the immediate customer need we could meet?

Why this question is important
Primarily your purpose is to meet a customer need, but conscious companies understand the *full* impacts of the products or services they introduce into society. Taking a systems thinking approach may allow for the discovery of other positive, unintended benefits that enhance the value proposition of an offering, expand markets and make positive contributions to the world. Following the growing trend among consumers who expect business to do more than just make a profit, this examination of multiple potential benefits also helps build a more widely accepted brand image.

Considerations
- How might our product or service further enhance the quality of life (e.g. health, safety, accessibility, education) of our customers beyond its immediate benefit? How might we refine the business model to contribute even more to their ability to thrive?
- Are there opportunities for our product/service to contribute to the solution of larger social or environmental problems beyond its primary purpose?
- In what way does promoting these multiple benefits improve our brand?

Notes:

Business Sustainability Booster (BSB) Presidio Graduate School info.presidio.edu/booster 1

Figure 13: Example of cards present in the set.
Source: Presidio Graduate School..

A distinction between different audiences is then provided, so as to better adapt the approach of the research to the ones it is intended for:

- **Traditional entrepreneurs;**
- **Social entrepreneurs focused on underdeveloped communities;**
- **Social entrepreneurs working in developed countries;**
- **Sustainability-focused entrepreneurs;**
- **Business students.**

The approach varies in relation to the nature of the audience, changing in the amount and type of cards presented, and focus of analysis proposed.

For this research, the audience has been decided to be a mixture between traditional entrepreneurs (for the start-up nature of the company) and Social entrepreneurs working in developed countries.

Thus, the approach has been to present them with most of the cards, apart the ones that sound redundant for their business model, and use them to pinpoint key topics (such as unintended consequences or hidden threats) and explore the impact potential of their business model.

Figure 14: Scheme of Sustainable Development.
Source: https://www.pngkit.com/view/u2t4y3o0i1y3y3e6_scheme-of-sustainable-development/

5

PROCESS

Preliminary research on the market, consumers and company has been conducted: the objective of this analysis has been to formulate a scenario to position Maium in, and get a clear idea of what the opportunities and barriers for my project were.

I started by conducting a 4C analysis, which means investigating the four characterising areas of Context, Company, Customer and Competitors: I shall not dwell in the Context and Consumer findings, as they have already been exposed in the introduction of this research (chapters 2 and 3).

5.1 COMPANY

Maium is a small dutch fashion company, based in Amsterdam; specifically, they sell rainwear. They believe in fair trade and safe and healthy working conditions, as well as providing sustainable clothing to its customers. Their production focuses on recycled PET, which is used in their raincoats and hats that are fully waterproof.

Throughout the years, Maium has started expanding its business from just the Netherlands to other countries in Europe including Belgium, Germany and the UK. Some of the main drivers of Maium are cooperation, sustainable attitude, creative and stylish design and fair trading and working conditions.

They believe that the success of a fashion brand depends on good cooperation and transparency both between partners, and towards clients and the planet.

It has been proactive towards digital marketing and online sales, especially in the last years due to the Covid-19 pandemic, and they are working to provide customers with as much information as possible on their production processes, the working conditions in the factories and everything that comes with a sustainable and responsible mindset (https://maium.nl/en/).

Maium is up to date with the current issues and pushes its limits in the attempt of attracting customers. They are aware of the importance of a safe and sustainable way of producing and keeping apparel, both from the company's and from the consumers' perspective.

They are now exploring new ways of lowering their impact on the environment and educating customers towards a more conscious approach to the consumption of fashion items.

There is a discrepancy between how they position themselves and how they operate: their production is entirely made in China, which is not the most sustainable option possible as they believe, and the fact they're recycling PET to produce raincoats doesn't solve the issue of the end of life of such material. Yet they are considering of changing their production and assembly partners in favor of closer factories.

Figure 15: Maium's website and products.
Source: https://maium.nl/en/

5.2 COMPETITORS

In order to define the competitor base of Maium, the Dutch market was divided into three categories: generic category, product category and product form. These can be seen in Figure 16, along with the competitors that operate in the same general area.

The three categories can be seen as three concentric circles, in which the level of detail and definition of the brand's nature increases towards the circles' center.

“**Generic category**”, the outer circle, refers to the competitors that are in the same product area as Maium: apparel that protects from rain. These competitors do not have a specific design interest, they just sell products that have the intent of protecting from rain (e.g. Hydrowear sells technical wear, ranging from hats to waterproof trousers).

“**Product category**” shows those competitors that have more affinity with Maium, and sell raincoats: these companies do care about fashion design and are similar to Maium in their production.

“**Product form**” represents those competitors that have the same intent as Maium: providing consumers with sustainable raincoats comfortable when cycling.

Figure 16: Maium's competitors analysis.

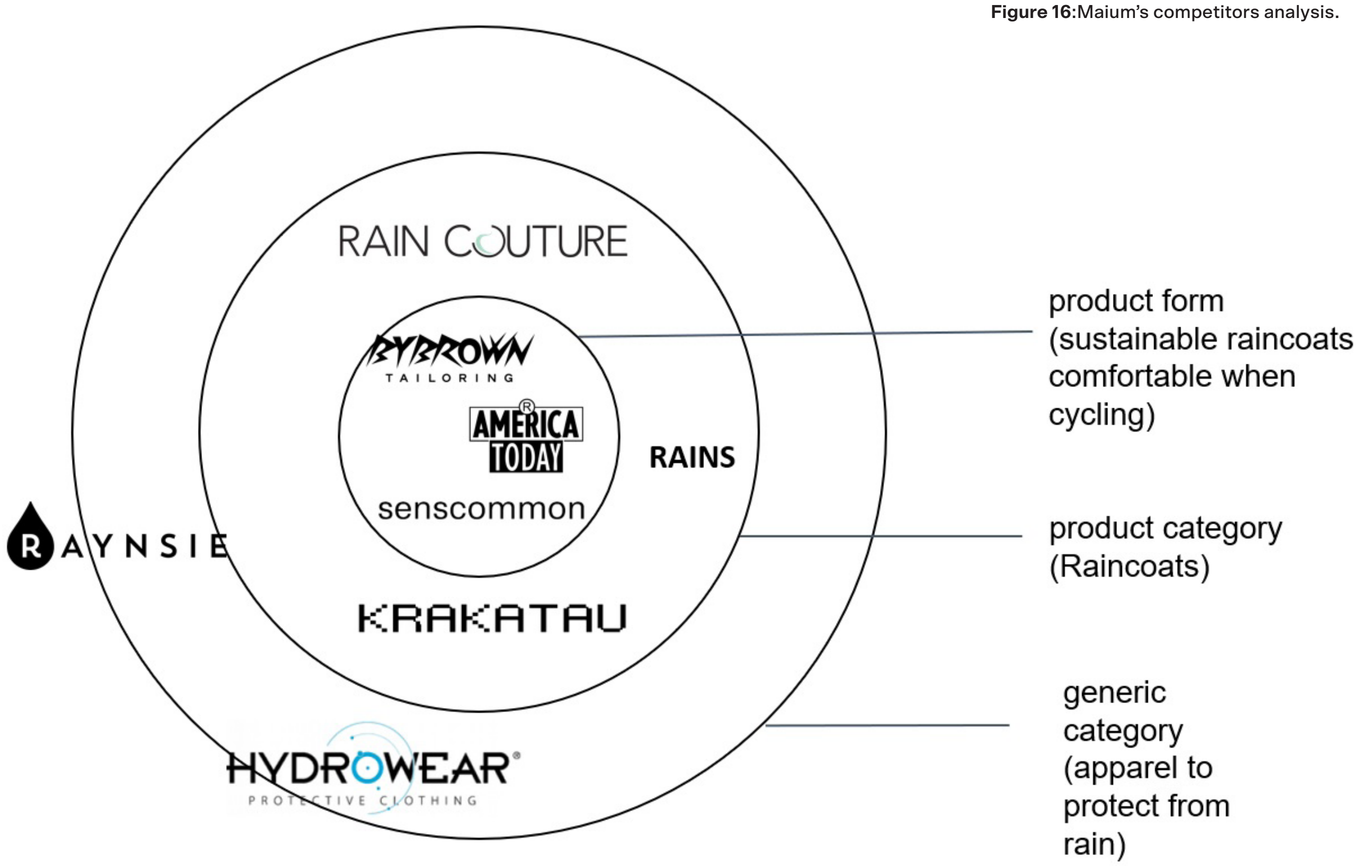


Figure 17: Maium's competition axis.

To get more precise, a competition axis has been created so that it could be possible to position Maium in between its competitors (Figure 17).

The X axis is defined by the traditionality/radicality of the look and form of the products, while the Y axis is linked to the sustainability in the production.

In this context, Maium positions itself in the top right quadrant, but still quite near the center of the graph: this indicates that Maium cares about sustainability, yet the steps towards a more sustainable approach are a few (especially in comparison with other, bigger companies like America Today).

The raincoats' design is indeed quite radical, yet there are some other companies that are even more radical (Bybrow).

STRENGTHS	WEAKNESSES
• Flexibility on the project, thanks to small team; • Ease of communication between «departments» of the company; • Sustainable reputation; • Bigger ease in product management, since the offer is limited to few products;	• Limited knowledge on production processes; • Dependance on Chinese companies for production; • Limited resources to be invested in sustainability pratices (since Maium is still a startup who is trying to impose themselves on the market);
OPPORTUNITIES	**THREATS**
• Consumers are waiting for a strong and real commitment in sustainability from fashion brands, which is still lacking; • The fashion industry is starting to shift towards a less linear production process and economy; • Increase in consumers' sustainable mindset; • New technologies and materials are being introduced into the market;	• Stiff competition; • Losing partnerships;

Figure 18: Maium's SWOT analysis.

Finally, in order to better define the nature of Maium, a SWOT analysis has also been conducted, in collaboration with the company itself (Figure 18).

From this analysis it became easier to understand what could be done with the research, and what could be expected by the company: flexibility and ease of communication within Maium would facilitate the application of the tools and methods, and their enthusiasm would also transfer to their consumers thanks to their sustainable reputation.

Maium's consumer base would embody the opportunity they have to become agents of change and awareness generators.

Unfortunately though, much research would need to be conducted in order to get a more thorough understanding of the production processes, and the application of flexibility and sustainability in practice would not be as easy as expected, as the resources to invest in this are limited.

5.3 MATERIALS & PROCESSES ANALYSIS

The main material used in Maium's products is polyester (PET), and more specifically recycled polyester (rPET) (Figure 19). The material comes from the recycling of plastic bottles, and is then turned into fabric after a set of industrial processes. It is definitely a good step forward instead of using virgin polyester, yet this practice has its limitations.

Before diving deep into the opportunities and barriers of adopting this production approach, it is necessary to clarify what are the industrial processes that transform plastic bottles into fabric.

Figure 19: rPET flakes after being shredded.
Source: https://www.aironegifts.com/r-pet-cose/

The steps prior to the actual processing of the material are collection and sorting: it is important to sort the different bottles by type and colour, so that waste creation in these and the next steps is reduced to the minimum. (Waste2Wear, 2021)

The processing steps are (Waste2Wear, 2021):

1. **Shredding**: PET bottles are grinded into plastic flakes, after this the material is dried;

2. **Melting**: the flakes are brought to their melting temperature so that PET pellets are created;

3. **Extruding**: the melted pellets are forced through an extruder and long filaments are created;

4. **Spinning**: with this process the filaments become yarn;

5. **Weaving**: this final process transforms yarn into fabric that is ready to be used.

One might be induced to think that recycling PET and creating something new out of it is a great step towards sustainable production and consumption, and to a certain level it is. The use of rPET instead of virgin PET (vPET) decreases greenhouse gas emissions by nearly 75% (Laurenz, 2021).
Furthermore, plastic bottles represent a high-quality form of PET source as they have very few impurities. Most of them are not dyed, and even more importantly, they are well suited to mechanical recycling processes.

Figure 20: Extruding, spinning and weaving industrial processes.

One of the first downsides though, is the fact that evidently the demand for rPET comes together with the production of single-use plastic bottles: one positive aspect inherently depends on such an unsustainable production, disposable single-use plastic bottles.

A consequence of this is also that in order to recycle PET bottles into fabrics, an open-loop production is created (FIGURE 21). Once the bottles are used as feedstock for the fashion industry, they get take away from a possible closed-loop recycling system, in which plastic bottles could be recycled into new bottles (limiting process emissions and vPET use).

This is an unlucky consequence to the fact that proper technology that could permit recycling PET fabrics into high-quality PET is not available on a scaled-up market level yet (Laurenz, 2021).

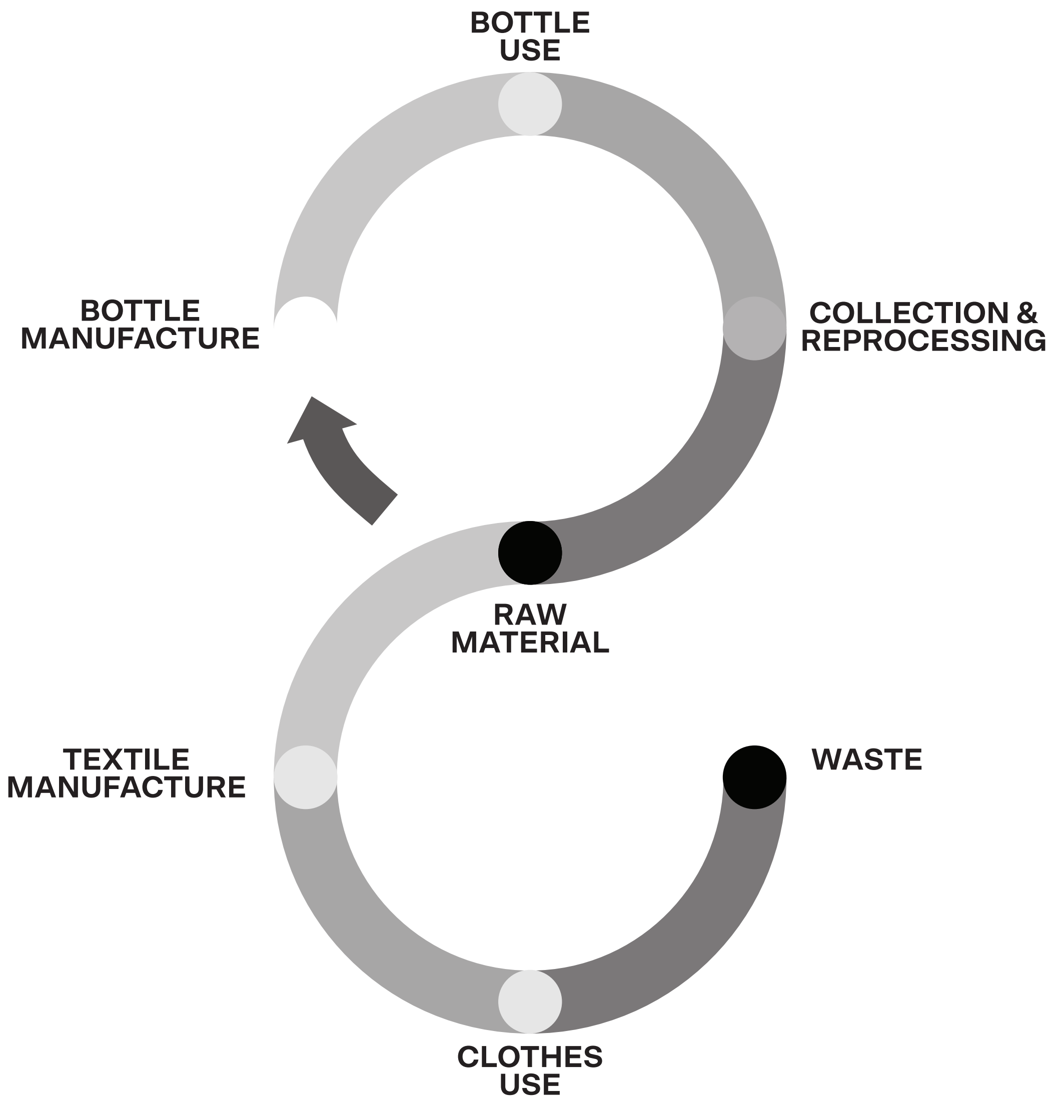
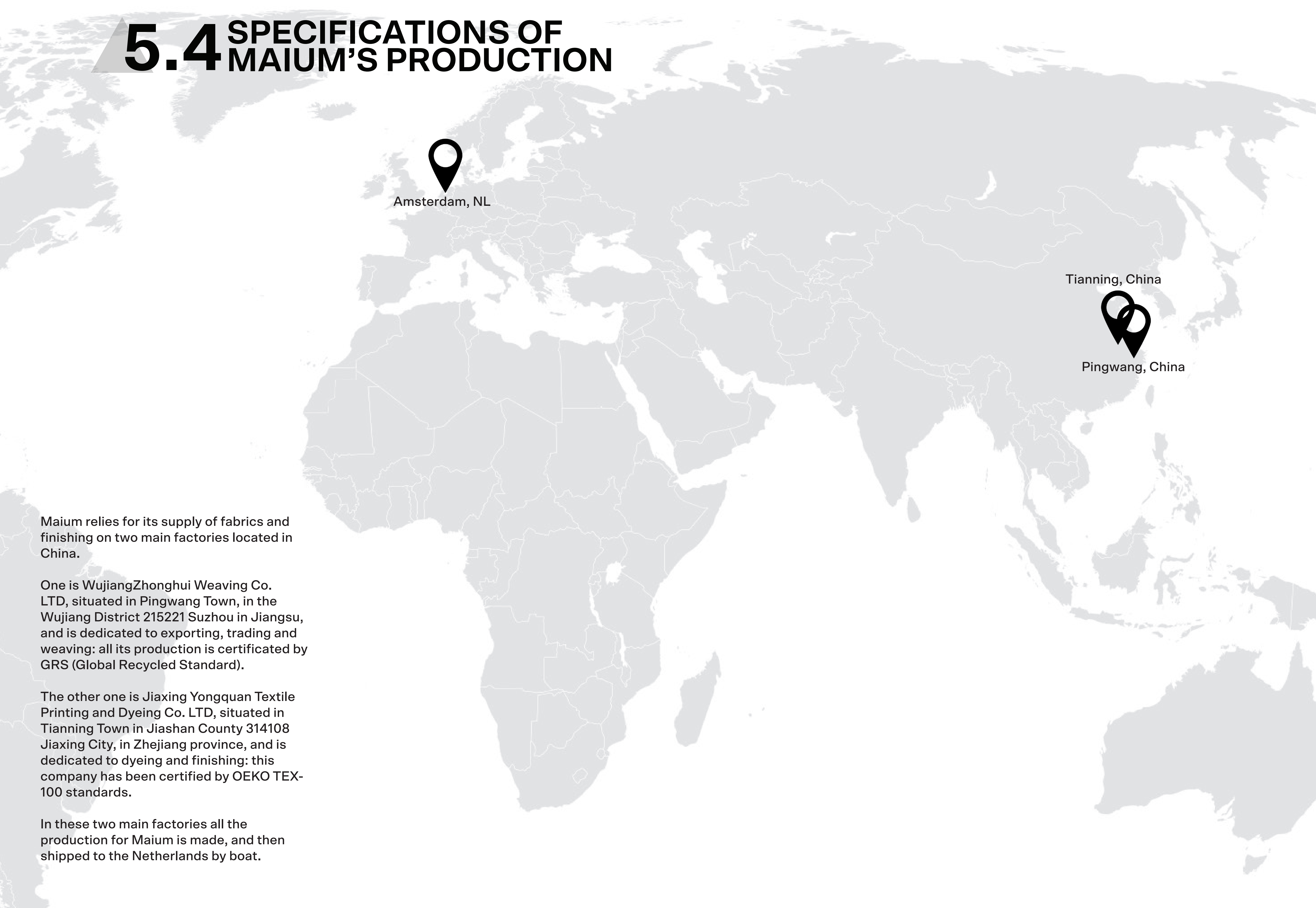


Figure 21: rPET textile production open loop.

5.4 SPECIFICATIONS OF MAIUM'S PRODUCTION



Maium relies for its supply of fabrics and finishing on two main factories located in China.

One is WujiangZhonghui Weaving Co. LTD, situated in Pingwang Town, in the Wujiang District 215221 Suzhou in Jiangsu, and is dedicated to exporting, trading and weaving: all its production is certificated by GRS (Global Recycled Standard).

The other one is Jiaxing Yongquan Textile Printing and Dyeing Co. LTD, situated in Tianning Town in Jiashan County 314108 Jiaxing City, in Zhejiang province, and is dedicated to dyeing and finishing: this company has been certified by OEKO TEX-100 standards.

In these two main factories all the production for Maium is made, and then shipped to the Netherlands by boat.

5.5 FIRST ITERATION
Life Cycle Assessment

As previously said, in order to set the LCA, the scope, boundaries and functional unit needed to be specified.

Scope
In the first phase, the scope has been decided to be a comparison of the impacts of different materials for the Original raincoat by Maium: the reason behind it has been to start from the main model to then apply the approach to all the other ones in Maium stock. At the beginning of the research, possible alternatives to rPET were explored, so that is why the comparison between different materials.

System boundaries
The boundaries chosen for the study have been decided to be Cradle to Grave, because all the production line (from material extraction to disposal) had been considered relevant for the purpose of the study (Figure 22).

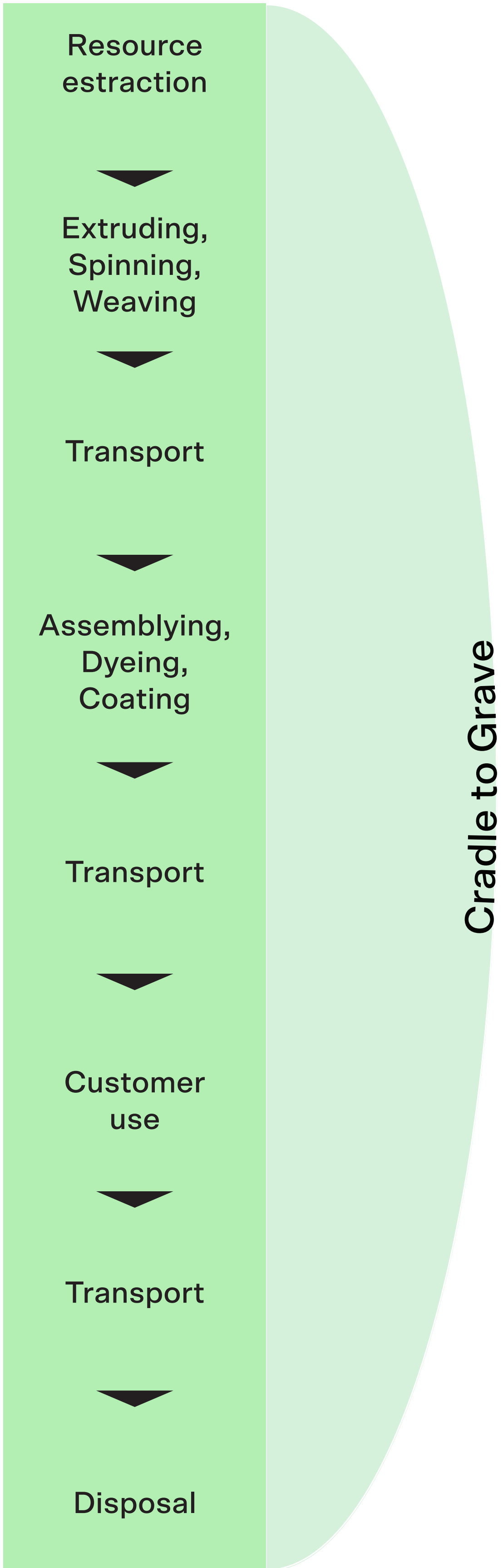


Figure 22: Research system boundaries.

Moreover, to be more specific in the system boundaries, the scope emissions have been taken into consideration (Figure 23).
The GHG Protocol describes direct and indirect emissions as:

- **Direct emissions**: these come from sources that the reporting entity owns or controls;
- **Indirect emissions**: these are a result of the reporting entity's activity, but take place at other entities' sources.

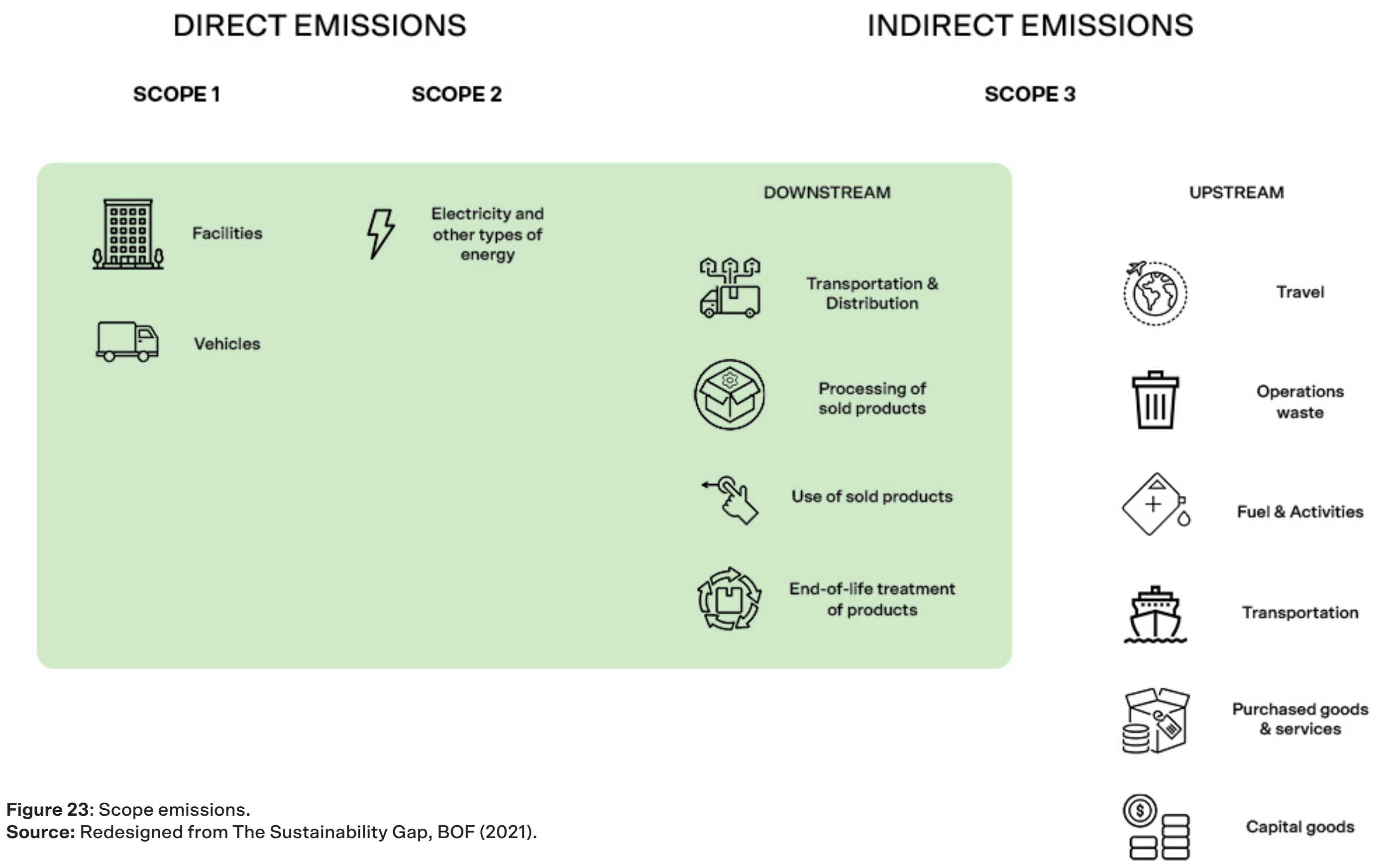


Figure 23: Scope emissions.
Source: Redesigned from The Sustainability Gap, BOF (2021).

As it can be seen in Figure 23, there is an additional categorisation in three scopes (GHG Protocol, 2021):

- **Scope 1**: all direct emissions;
- **Scope 2**: indirect emissions from use of acquired electricity, heat or steam.
- **Scope 3**: other indirect emissions (i.e. outsourced operations, extraction/ production of acquired materials and fuels, electricity-related operations not covered in Scope 2...).

For the research, focus on all three scopes has been deemed relevant, but the Upstream level of the indirect emissions has been left out of the WSM iterations: this choice has been made for the fact that the research and the direction of the design solution were intended to be dedicated to the operations the company and consumers could make, instead of the suppliers, for which there was too little knowledge. This doesn't mean that they have not been taken into consideration when conducting LCAs (for which the data related to that area are included).

Functional unit
The functional unit has been set to be ten years of use of a raincoat, which has been considered to be the average use time of such a garment: this has been based on a combination of factors such as trends, material deterioration and damages to the raincoats.

Inventory
At this point, identifying all the components, processes, transportation system, use phase and end of life was the step to take.

The components of the Original raincoat (in the picture) are the following:

Component's name	N°
Purple textile (100% recycled PET)	1
Black textile (100% recycled PET)	1
Female big buttons (zinc alloy)	13
Male big buttons (zinc alloy)	15
Small buttons (zinc alloy)	1
Carelabel	1
Zippers (nylon)	3
Slider of zippers (zinc alloy)	4
Plastic of slider (nylon)	4
Elastic (silicone rubber)	1
Hat visor (100% recycled PET)	1
Ventilation holes (zinc alloy)	6
Printed plastic logo (silicone rubber)	1
Elastic regulator (zinc alloy)	2

Figure 24: "Original" raincoat components.

The outcome of the comparisons looked like the ones in Figure 25 and Figure 26: the first comparison has been decided to be made between the current production, meaning rPET as main material, in a use time of 10 years per raincoat, and a hypothetical production in which instead of the current production, which is almost all in rPET, a production in which everything in the coat is made in rPET.

In these charts, the impact considered has been the Carbon Footprint and its impact unit was kg of CO2 equivalent, but for the research in general, also the Eco-costs have been investigated.

“Eco-costs are a measure to express the amount of environmental burden of a product on the basis of prevention of that burden.”
(TUDelft, 2020)

“They are the costs which should be made to reduce the environmental pollution and materials depletion to a level which is in line with the carrying capacity of our world” (TU Delft, 2020). Eco-costs have been used as a metric so as to have an idea of the financial equivalent of the environmental impact generated by the production of the garments.

Below the lifecycle stages charts two other charts appear: one of them, on the left, expresses the impacts by component (in this case by kg of CO2 eq.), and the one on the right shows the impacts by life cycle stage.

It is thus possible to quantify how many kg of CO2 equivalent are produced in the production, transport, use and disposal of the raincoat.

At the end it is possible to see an overall score of the two options compared: in this example, both the options have more or less the same environmental impact, with approximately the same level of uncertainty. This means that more information and detail is required.

If just this chart was present, the information it provides would not be helpful enough to choose one option instead of another. It is necessary to consider another metric, the eco-costs.

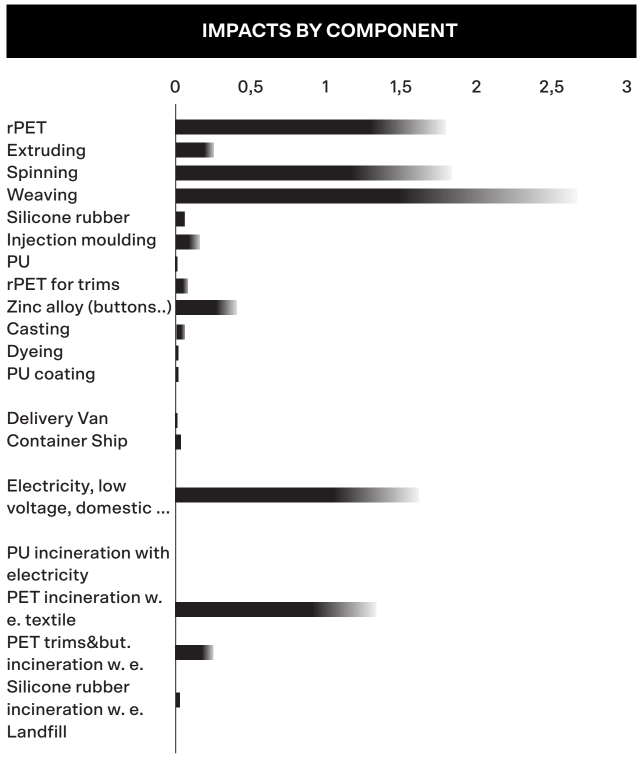
It needs to be noted, though, that the production with everything in rPET has smaller uncertainty levels, even if the difference is extremely small. This would mean that this option is environmentally friendlier than the current production.

MANUFACTURING	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
rPET	2,13	0,639	1	30%	1,3645409
Extruding	0,36	0,639	1	10%	0,2318155
Spinning	2,17	0,639	1	30%	1,3902593
Weaving	3,19	0,639	1	30%	2,0372117
Silicone rubber	2,75	0,022	1	20%	0,0593404
Injection moulding	1,52	0,022	1	20%	0,0328137
PU	5,09	0,000	1	50%	0,0010173
rPET for trims	2,13	0,036	1	20%	0,0768395
Zinc alloy	3,44	0,085	1	30%	0,2923058
Casting	0,90	0,085	1	30%	0,0765
Dyeing	1,92	0,000	1	20%	0,0001916
PU coating	2,50	0,000	1	50%	0,0005

TRANSPORT	Eco-intensity (impacts/ton-km)	Mass per item (ton)	Dist. per item (km)	Items per func. unit	Uncertainty %	Calculated impact
Delivery Van	0,00	0,001	226	1	30%	3,889E-05
Container Ship	0,00	0,001	20500	1	20%	0,0432342

USE	Eco-intensity (impacts/MJ)	Amount per wash (MJ)	Washes per func. unit	Uncertainty %	Calculated impact
Electricity, low voltage, domestic use NL	0,14	0,9	10	30%	1,2549847

END OF LIFE	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
PU incineration with electricity	1,07	0,000	1	30%	0,0002132
PET incineration w. e.	1,24	0,639	1	30%	0,7914843
PET trims incineration w. e.	1,24	0,036	1	30%	0,0445697
Silicone rubber incineration w. e.	0,72	0,022	1	30%	0,01558
Landfill	0,00	0,782	1	20%	0



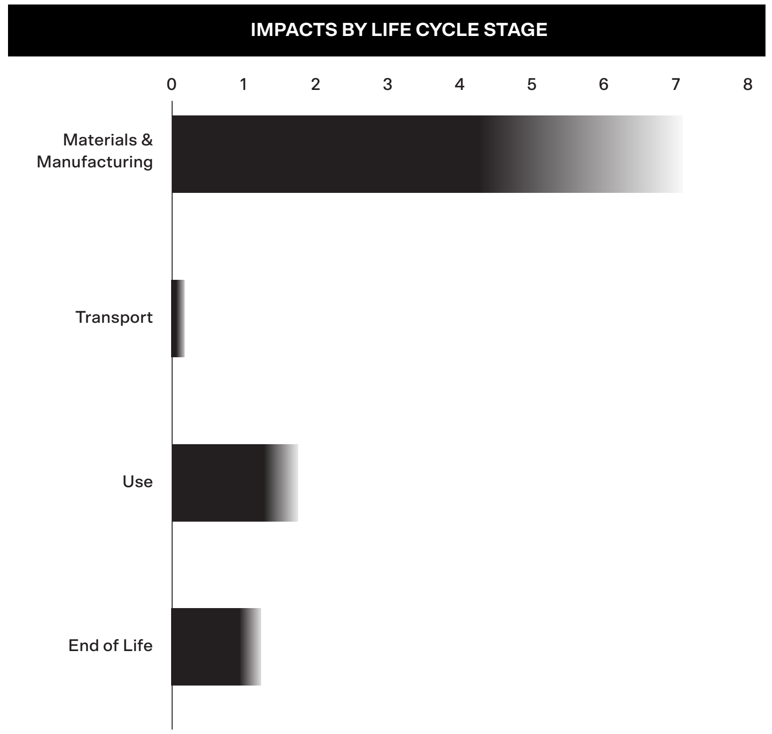


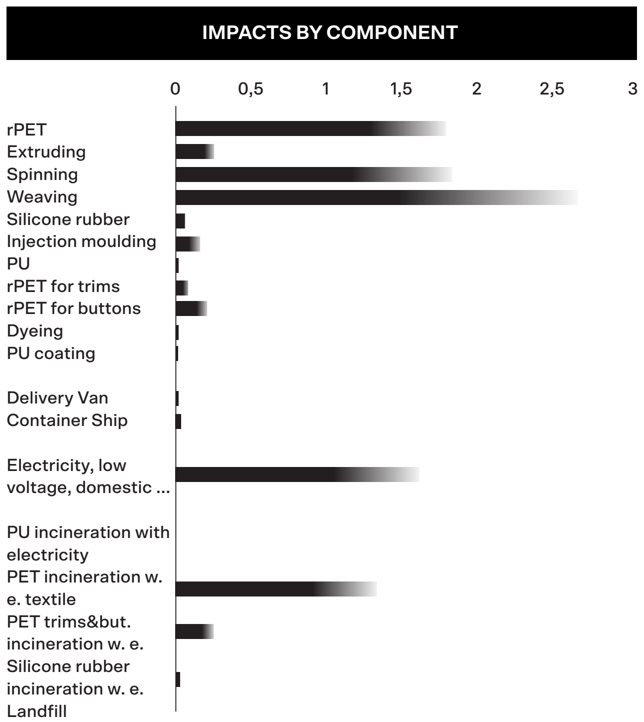
Figure 25: Current production LCA.

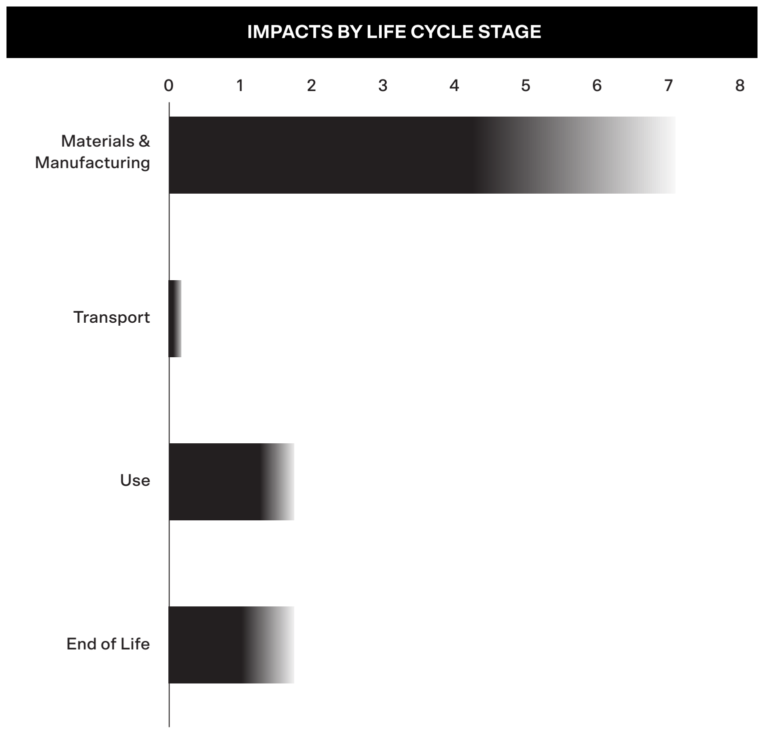
MANUFACTURING	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
rPET	2,13	0,639	1	30%	1,3645409
Extruding	0,36	0,639	1	10%	0,2318155
Spinning	2,17	0,639	1	30%	1,3902593
Weaving	3,19	0,639	1	30%	2,0372117
Silicone rubber	2,75	0,022	1	20%	0,0593404
Injection moulding	1,52	0,022	1	20%	0,0328137
PU	5,09	0,000	1	50%	0,0010173
rPET for trims	2,13	0,036	1	20%	0,0768395
rPET for buttons	2,13	0,085	1	30%	0,1814265
Dyeing	1,92	0,000		20%	0,0001916
PU coating	2,50	0,000	1	50%	0,0005
			1		

TRANSPORT	Eco-intensity (impacts/ton-km)	Mass per item (ton)	Dist. per item (km)	Items per func. unit	Uncertainty %	Calculated impact
Delivery Van	0,00	0,001	226	1	30%	4,311E-05
Container Ship	0,00	0,001	20500	1	20%	0,0432342

USE	Eco-intensity (impacts/MJ)	Amount per wash (MJ)	Washes per func. unit	Uncertainty %	Calculated impact
Electricity, low voltage, domestic use NL	0,14	0,9	10	30%	1,2549847

END OF LIFE	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
PU incineration with electricity	1,07	0,000	1	30%	0,0002132
PET incineration w. e. textile	1,24	0,639	1	30%	0,7914843
PET trims&but. incineration w. e.	1,24	0,121	1	30%	0,1498038
Silicone rubber incineration w. e.	0,72	0,022	1	30%	0,01558
Landfill	0,00	0,782	1	20%	0





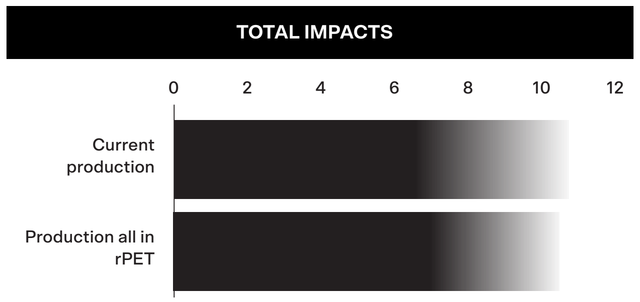


Figure 26: LCA on production with everything made out of rPET.

The impact unit in the eco-cost analysis (Figure 27 and Figure 28) is euro, and it is possible to see in the final chart that producing everything in rPET is slightly less expensive, yet the difference is not that huge to be meaningful. Further research needed to be conducted.

In an LCA many types of impact can be analysed, carbon footprint and eco-costs are just two of them (the ones that have been used in this study), to give the most complete overview on the environmental impact a product or service has. Depending on the necessities of the entity that is conducting the research, it is better to use one instead of another, and consequently align their activity.

Analysing these charts, the life cycle stage with the highest impact is always the Materials & Manufacturing one: this means that to have a big impact, change need to be done in this area. Maium though, has always been convinced of not changing anything in the processes related to the material choice, since they already have partnerships with other entities and do not want to revolutionise their business model. Plus, as they say, they have built the brand's identity around the use of rPET coming from used plastic bottles, and it would be too much of a switch to change right now. Another path needed to be considered.

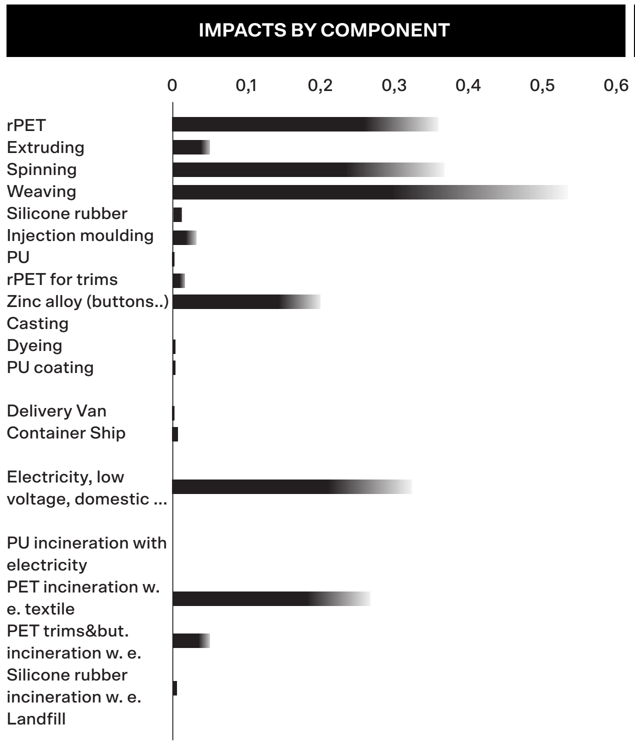
All the other comparisons can be found in Appendix A.

MANUFACTURING	Eco-intensity (€/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
rPET	0,45	0,639	1	30%	0,2856981
Extruding	0,13	0,639	1	10%	0,0824895
Spinning	0,44	0,639	1	30%	0,280895
Weaving	0,64	0,639	1	30%	0,4116085
Silicone rubber	0,97	0,022	1	20%	0,020967
Injection moulding	0,31	0,022	1	20%	0,0066298
PU	1,83	0,000	1	50%	0,0003659
rPET for trims	0,45	0,036	1	20%	0,0160881
Zinc alloy	1,93	0,085	1	30%	0,1638889
Casting	0,01	0,085	1	30%	0,0011212
Dyeing	0,39	0,000	1	20%	3,872E-05
PU coating	0,80	0,000	1	50%	0,00016

TRANSPORT	Eco-intensity (€/ton-km)	Mass per item (ton)	Dist. per item (km)	Items per func. unit	Uncertainty %	Calculated impact
Delivery Van	0,00	0,001	226	1	30%	1,839E-05
Container Ship	0,00	0,001	20500	1	20%	0,0262208

USE	Eco-intensity (€/MJ)	Amount per wash (MJ)	Items per func. unit	Uncertainty %	Calculated impact
Electricity, low voltage, domestic use NL	0,02	0,9	1	30%	0,190952

END OF LIFE	Eco-intensity (€/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
PU incineration with electricity	0,22	0,000	1	30%	4,307E-05
PET incineration w. e.	0,25	0,639	1	30%	0,1599155
PET trims incineration w. e.	0,25	0,036	1	30%	0,0090051
Silicone rubber incineration w. e.	0,15	0,022	1	30%	0,0031479
Landfill	0,00	0,782	1	20%	0,0010731



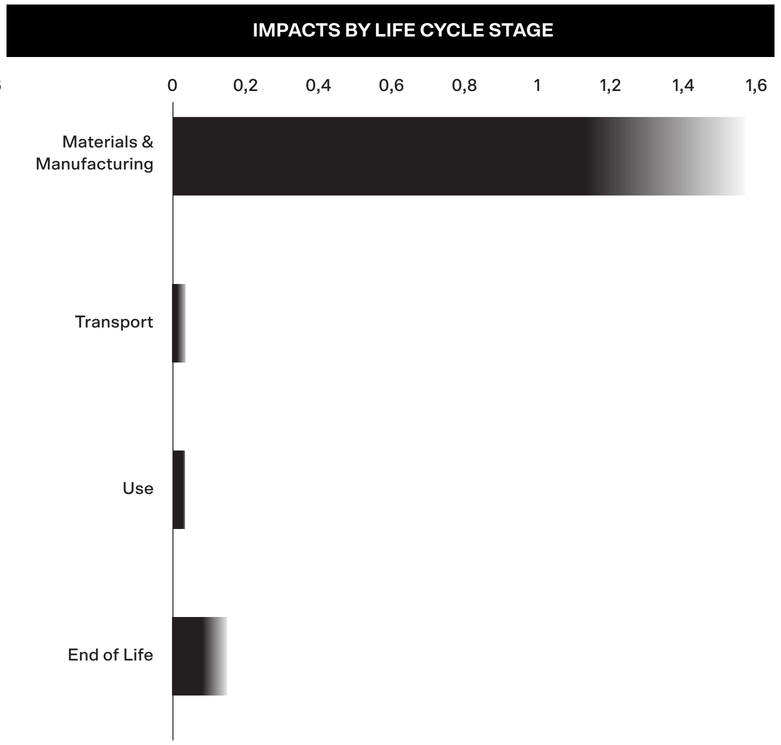


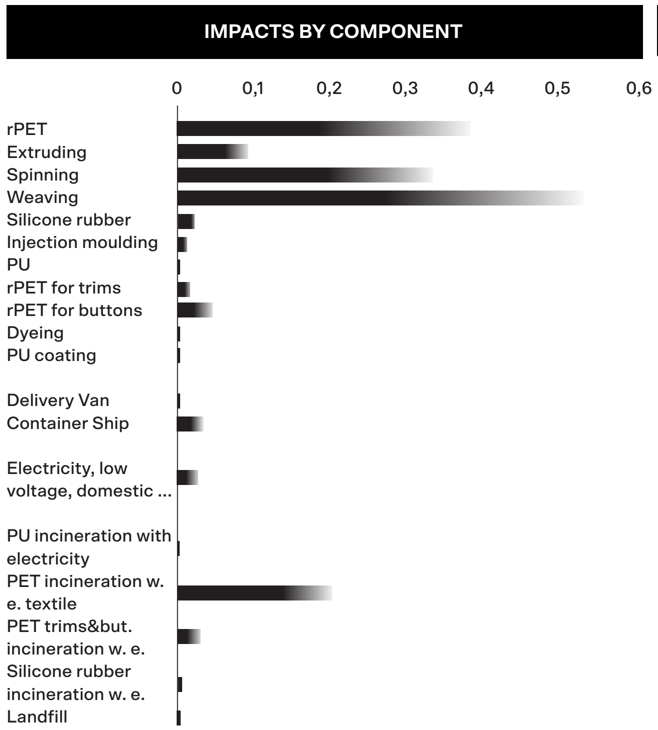
Figure 27: Current production eco-costs LCA.

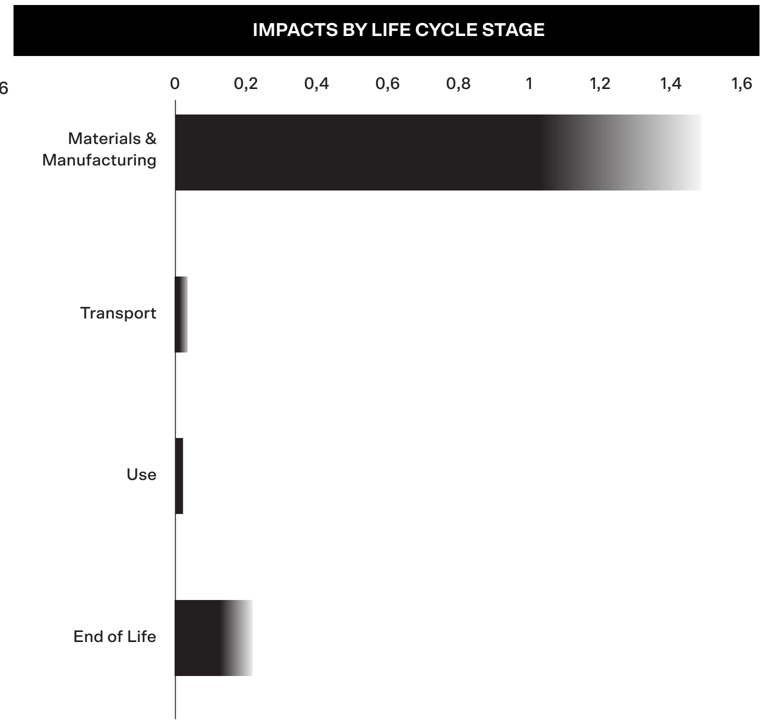
MANUFACTURING	Eco-intensity (€/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
rPET	0,45	0,639	1	30%	0,2856981
Extruding	0,13	0,639	1	10%	0,0824895
Spinning	0,44	0,639	1	30%	0,280895
Weaving	0,64	0,639	1	30%	0,4116085
Silicone rubber	0,97	0,022	1	20%	0,020967
Injection moulding	0,31	0,022	1	20%	0,0066298
PU	1,83	0,000	1	50%	0,0003659
rPET for trims	0,45	0,036	1	20%	0,0160881
rPET for buttons	0,45	0,085	1	30%	0,0379858
Dyeing	0,39	0,000	1	20%	3,872E-05
PU coating	0,80	0,000	1	50%	0,00016

TRANSPORT	Eco-intensity (€/ton-km)	Mass per item (ton)	Dist. per item (km)	Items per func. unit	Uncertainty %	Calculated impact
Delivery Van	0,00	0,001	226	1	30%	1,839E-05
Container Ship	0,00	0,001	20500	1	20%	0,0262208

USE	Eco-intensity (€/MJ)	Amount per wash (MJ)	Items per func. unit	Uncertainty %	Calculated impact
Electricity, low voltage, domestic use NL	0,02	0,9	1	30%	0,190952

END OF LIFE	Eco-intensity (€/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
PU incineration with electricity	0,22	0,000	1	30%	4,307E-05
PET incineration w. e.	0,25	0,639	1	30%	0,1599155
PET trims&but. incineration w. e.	0,25	0,121	1	30%	0,0302671
Silicone rubber incineration w. e.	0,15	0,022	1	30%	0,0031479
Landfill	0,00	0,782	1	20%	0,0010731





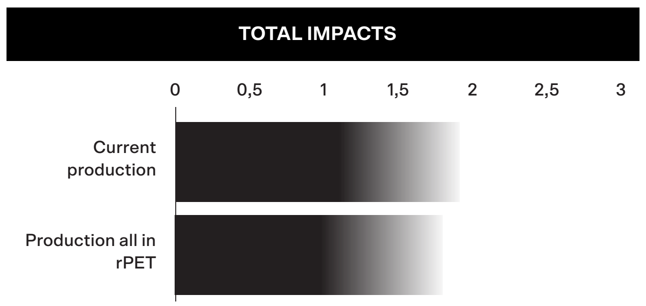


Figure 28: LCA eco-costs on production with everything made out of rPET.

FIRST ITERATION

Whole System Mapping

Once the first LCA scenario was generated, the first round of Whole System Mapping process has been conducted.

Prior to the brainstorming session, the first thing that has been done has been delineating what were the negative environmental impacts throughout each gate of the system boundaries, and what were the specifications of each gate.

In Figure 29, this layout can be seen: the black text represents the characteristics of each gate, and the red text represent the negative environmental impacts. The light blue one represents the main limitation.

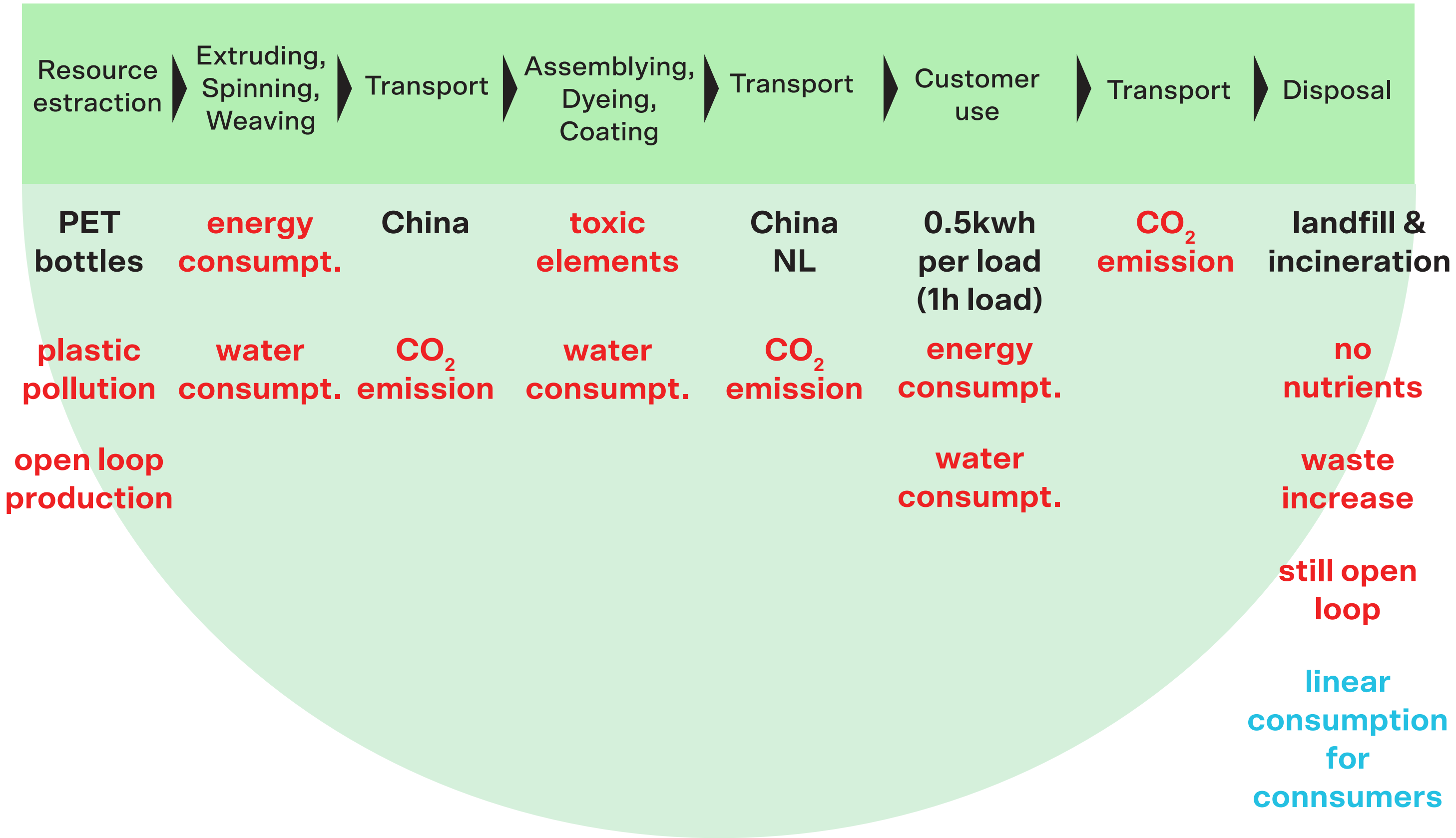


Figure 29: Characteristics and negativities of Maium's production.

After having drawn this picture together with the company, the next step was to explain what is involved in the redesign of a product or service in a circular model. This part of the preparation can be expressed as just a theoretical background given to the participants.

It allowed them to have the right inputs in the brainstorming sessions, to come up with more specific and less out of the blue ideas.

System Map
After the preliminary steps, always together with the company, the system map was constructed (Figure 30). What the product is used with and the connections between elements were added to the initial structure in which the life cycle stages are represented (Materials&Manufacturing, Transport, Use, End of Life) as well as user interactions.

It is necessary to say that in this first iteration the system map did not seem so intricate or complex as expected, especially since the user interactions with a raincoat were not numerous.

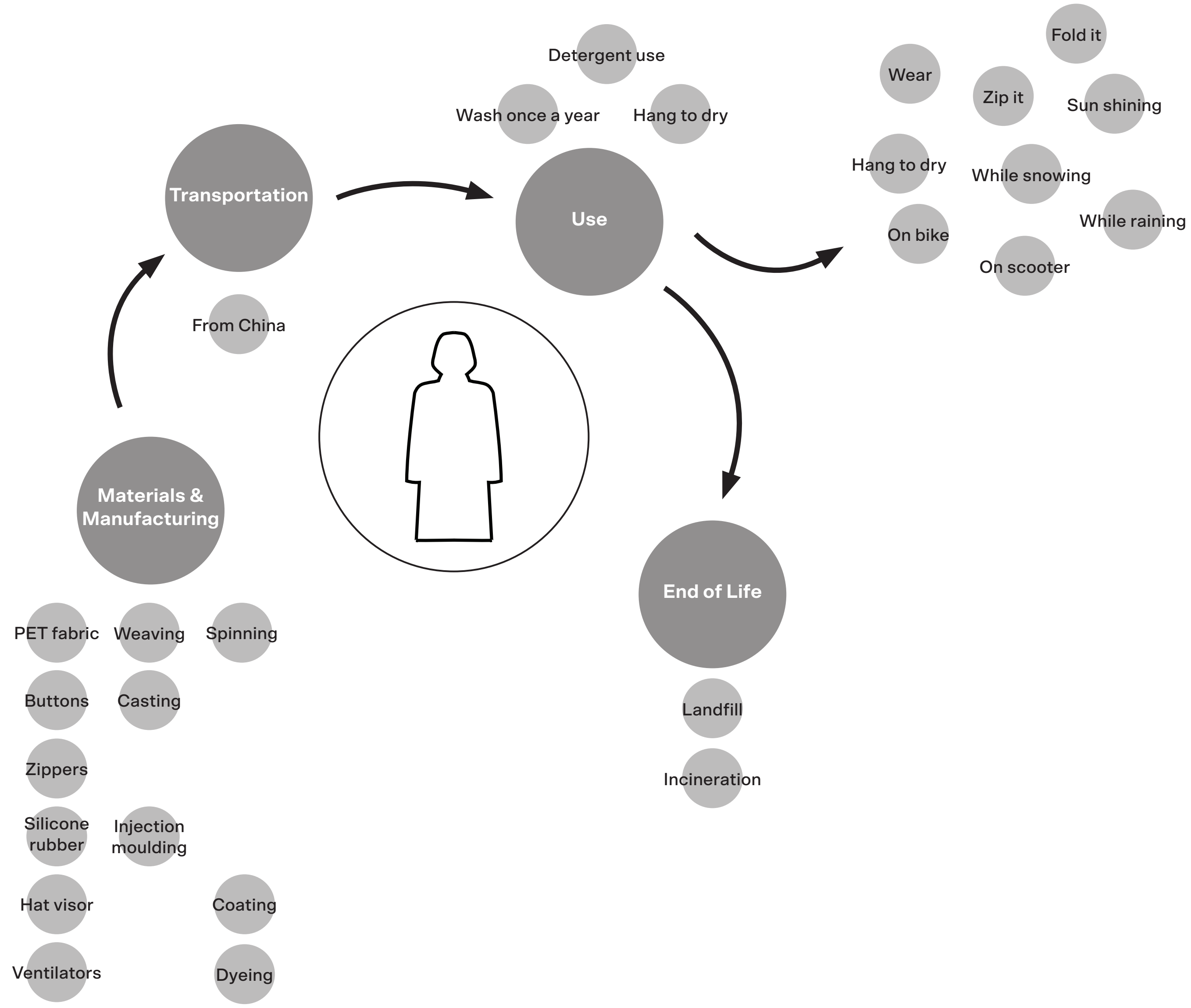


Figure 30: System Map setup.

Priorities
The priorities for the brainstorming were then set:

1. Minimise the environmental impact

2. Deployability

3. Cost efficiency

These three priorities have been chosen as they represent the three main areas Maium wanted to focus on.

Obviously, the environmental impact minimisation had a huge relevance in their choices, yet cost efficiency needed to be taken in serious consideration as well, and this does not keep the impact decrease from happening, but it certainly set boundaries on what can and cannot be done.

The reason for this is the fact that Maium is a small company that is now starting to set its roots in the market and become well-known in the Netherlands, yet it cannot afford to just focus on the sustainability of their production, as sustainability is something that for every company can get very expensive.

Yet, cost efficientcy has been set as the third priority, to emphasise the importance of environmental choices and deployability: the fashion industry has little to none attention in what happens next with clothing after they have been used. This priority for Maium meant to consider the possible applications of old garments once they have been disposed of, and be ready, to consider them on a design level.

Having discussed and put down the priorities, the brainstorming question has been formulated:

How can we minimise the environmental impact of the raincoats focusing on ease and speed of deployability, without increasing the costs?

Brainstorming
Two sets of brainstorming were done in two different moments with different participants: this was done for organisational reasons, as some people in the company could not be present for the first set.

Both of the brainstormings were quite free, and it was possible for the participants to drive the direction of the ideas they had: the first brainstorming was not used as a starting point for the second one, so that bias could be avoided.

Just at the end of the second brainstorming a comparison between the two was made, so that it was possible to see similarities and differences.

Figures 31 and 32 represent the two brainstorming sets: the dark grey circles represent the System Map, while the light grey ones are the brainstorming ideas connected to the System Map.

The circles have different sizes: the bigger circles are the ones that have been voted most, while the smaller ones are the ones with less or zero votes.

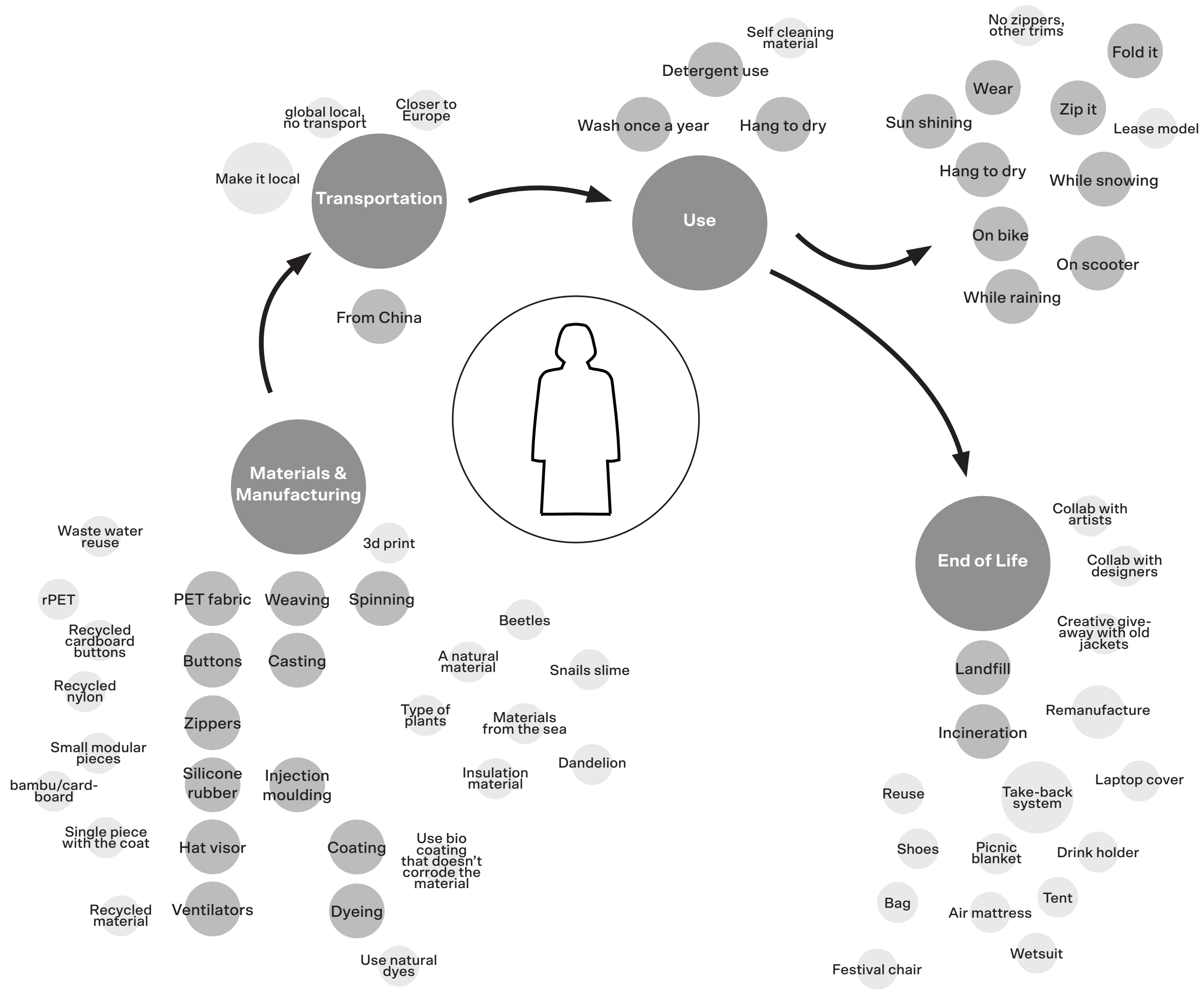


Figure 31: First brainstorming set.

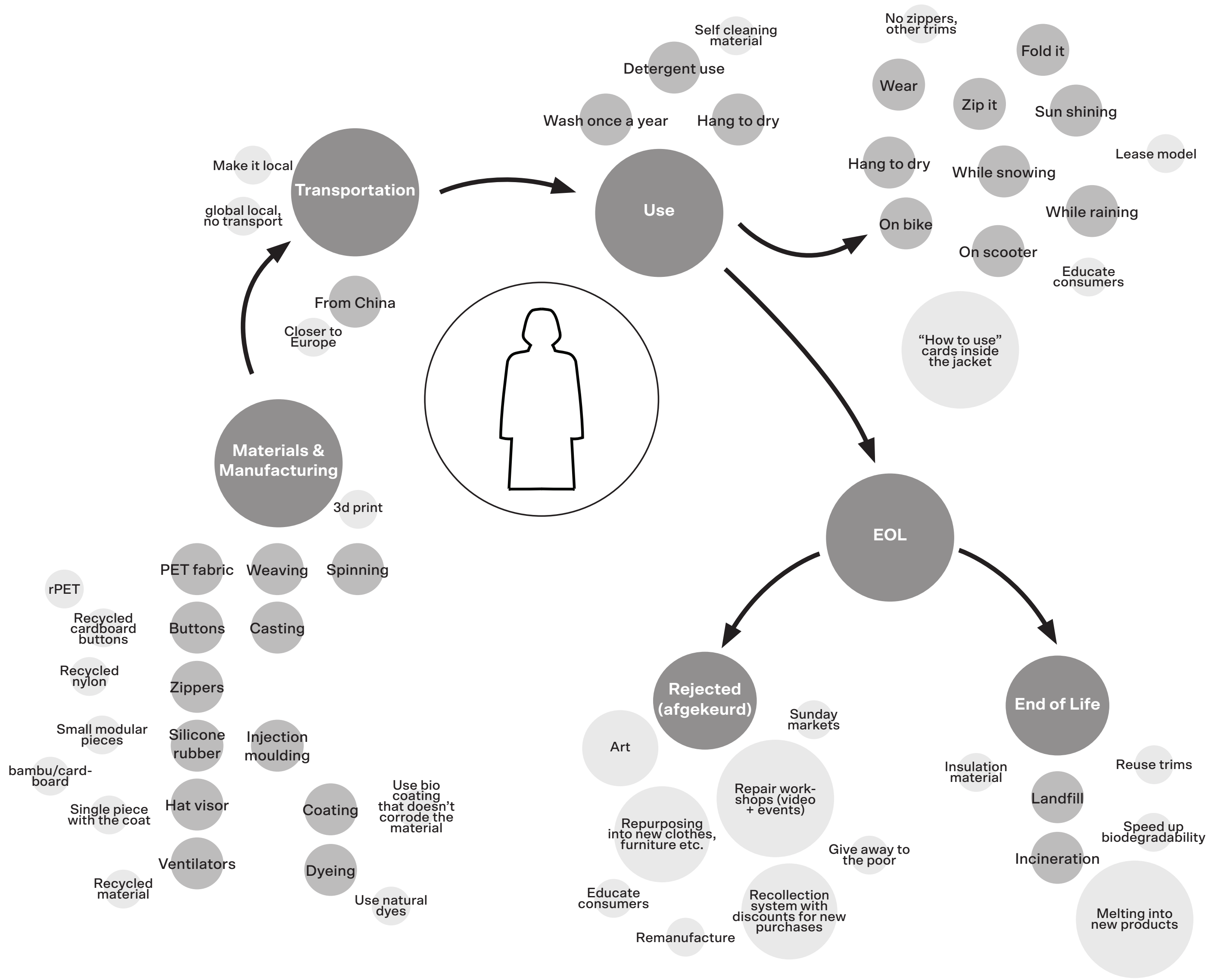


Figure 32: Second brainstorming set.

In this second brainstorming (Figure 32) it can be seen that the EOL stage has been divided in two sub-cycles, Rejected (afgekeurd in Dutch), and End of Life: this has been suggested by the company so as to better define, in their opinion, the difference between products that are not used anymore for some technical reason (broken parts for example) and products that have exhausted their lifetime.

Decide winner based on priorities
After satisfactory number of ideas was reached, we then proceeded with voting them in accordion to the priorities we had set before starting with the brainstorming. Dot-voting has been used: every participant had a total of three dots to vote the ideas with, and the winners have been put in a score board (Figure 33), so that calculations on which ones were the best and most worthy of pursuing could be made, according to the priorities' weight.

OBJECTIVE	Weight	Repair workshops	Recollection	How to use inside jackets	Repurposing
Minimise environmental impact	2	3	3	2	4
Deployability	3	1	2	3	2
Cost efficiency	4	5	2	4	2
TOTAL SCORE		**29**	20	**26**	24

Figure 33: Scoreboard of the first Whole System Mapping iteration.

The ideas initially were:

1. Create and host workshops to incentivise customers to repair their clothes once they broke (when they could), and give them tips for a better product care;

2. design a recollection system to foster recycling;

3. design a more detailed care label to add at the inside of the raincoats, with tips for a better product care and a QR code that linked to Maium's website;

4. design a repurposing system.

The options that scored best, and did not exclude one another, were the **repair workshops** and the **care label.**

The specifics of these ideas will be explored more in the next chapter.

5.6 SECOND ITERATION
Life Cycle Assessment

After this first iteration, a second one was conducted: the purpose of doing the same process again was to get more specific on the design possibilities, and hypothesize on a second LCA what the impact would be if Maium adopted the options that came up in the first Whole System Mapping iteration.

In order to do so, the scope of the second scenario has been changed into “compare the environmental impact of future production vs. current production”, and the functional unit: instead of ten years of use, 15 years of use has been chosen, because five years are the amount of time assumed to extend the lifetime of a raincoat.

The parameters taken into consideration were always carbon footprint and eco-costs.

Moreover, the hypothetical raincoats produced in the future, with the repair workshops, have been thought as completely made out of rPET, instead of having just the fabric in recycled polyester: this means that also the trims and buttons were thought as being made of that material. This was a suggestion of Maium, that was interested in exploring the possibility of such production for the future.

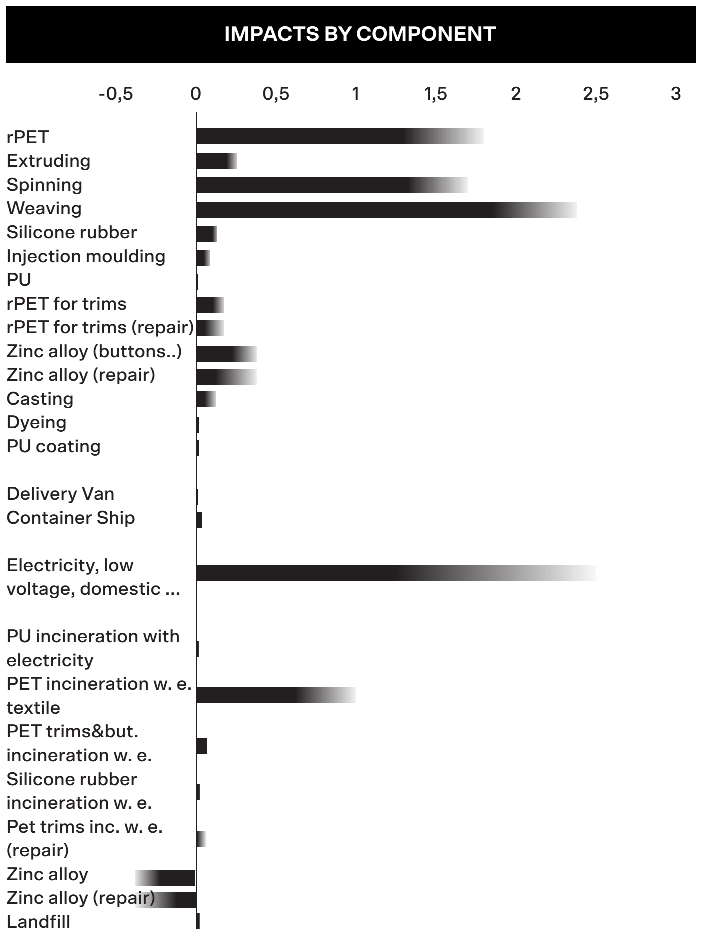
In Figures 34 and 35 it is possible to see the LCAs of the two options: the first one is for the production that includes repair in the calculations, and the second one is for the current production with the lifespan extended to 15 years.

MANUFACTURING	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
rPET	2,13	0,639	1	30%	1,3645409
Extruding	0,36	0,639	1	10%	0,2318155
Spinning	2,17	0,639	1	30%	1,3902593
Weaving	3,19	0,639	1	30%	2,0372117
Silicone rubber	2,75	0,022	1	20%	0,0593404
Injection moulding	1,52	0,022	1	20%	0,0328137
PU	5,09	0,000	1	50%	0,0010173
rPET for trims	2,13	0,036	1	20%	0,0768395
rPET for trims (repair)	2,13	0,036	1	40%	0,0768395
Zinc alloy	3,44	0,085	1	30%	0,2923058
Zinc alloy (repair)	3,44	0,085	1	40%	0,2923058
Casting	0,90	0,085	1	30%	0,0765
Dyeing	1,92	0,000	1	20%	0,0001916
PU coating	2,50	0,000	1	50%	0,0005

TRANSPORT	Eco-intensity (impacts/ton-km)	Mass per item (ton)	Dist. per item (km)	Items per func. unit	Uncertainty %	Calculated impact
Delivery Van	0,00	0,001	226	1	30%	4,49E-05
Container Ship	0,00	0,001	20500	1	20%	0,049923

USE	Eco-intensity (impacts/MJ)	Amount per wash (MJ)	Washes per func. unit	Uncertainty %	Calculated impact
Electricity, low voltage, domestic use NL	0,14	0,9	15	30%	1,8824771

END OF LIFE	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
PU incineration with electricity	1,07	0,000	1	30%	0,0002132
PET incineration w. e.	1,24	0,639	1	30%	0,7914843
PET trims incineration w. e.	1,24	0,036	1	30%	0,0445697
PET trims inc. w. e. (repair)	1,24	0,036	1	40%	0,0445697
Silicone rubber incineration w. e.	0,72	0,022	1	20%	0,01558
Zinc alloy recycling credits	-2,69	0,085	1	40%	-0,228409
Zinc alloy recycling creds (repair)	-2,69	0,085	1	50%	-0,228409
Landfill	0,00	0,782	1	20%	0



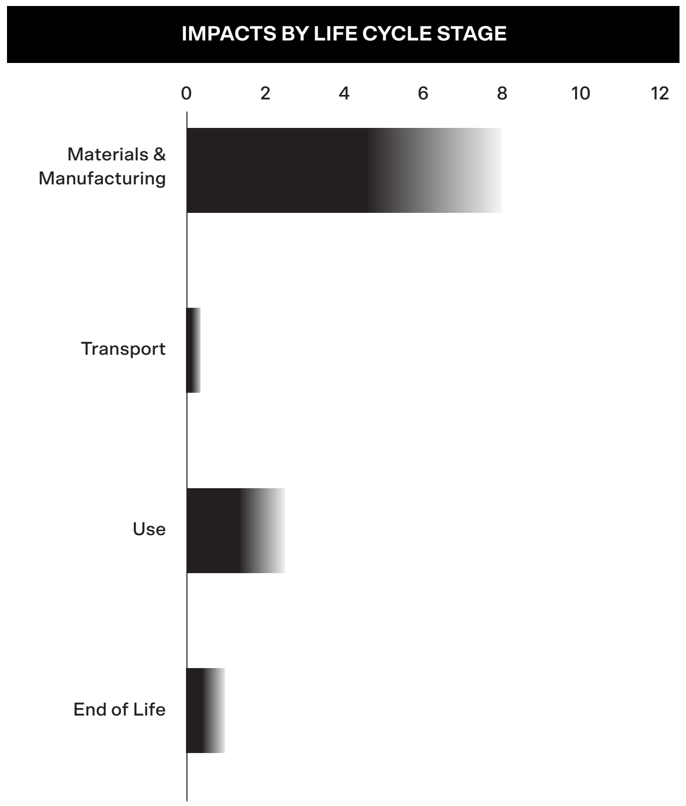


Figure 34: Production including repair.

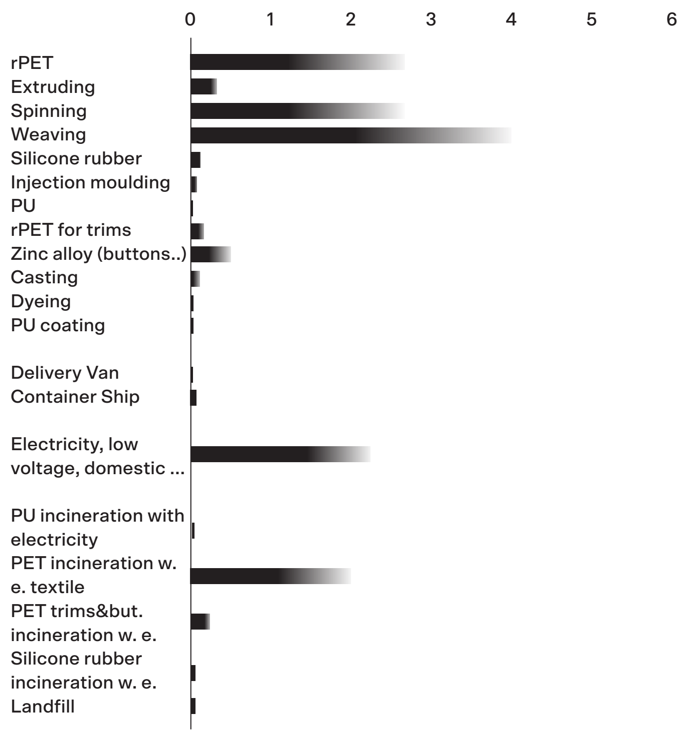
MANUFACTURING	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
rPET	2,13	0,639	1,5	30%	2,0468113
Extruding	0,36	0,639	1,5	10%	0,3477232
Spinning	2,17	0,639	1,5	30%	2,0853889
Weaving	3,19	0,639	1,5	30%	3,0558175
Silicone rubber	2,75	0,022	1,5	20%	0,0890107
Injection moulding	1,52	0,022	1,5	20%	0,0492205
PU	5,09	0,000	1,5	50%	0,0015259
rPET for trims	2,13	0,036	1,5	20%	0,1152592
Zinc alloy	3,44	0,085	1,5	30%	0,4384587
Casting	0,90	0,085	1,5	30%	0,11475
Dyeing	1,92	0,000	1,5	20%	0,0002874
PU coating	2,50	0,000	1,5	50%	0,00075

TRANSPORT	Eco-intensity (impacts/ton-km)	Mass per item (ton)	Dist. per item (km)	Items per func. unit	Uncertainty %	Calculated impact
Delivery Van	0,00	0,001	226	1,5	30%	6,467E-05
Container Ship	0,00	0,001	20500	1,5	20%	0,0648513

USE	Eco-intensity (impacts/MJ)	Amount per wash (MJ)	Washes per func. unit	Uncertainty %	Calculated impact
Electricity, low voltage, domestic use NL	0,14	0,9	15	30%	1,8824771

END OF LIFE	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func. unit	Uncertainty %	Calculated impact
PU incineration with electricity	1,07	0,000	1,5	30%	0,0003197
PET incineration w. e.	1,24	0,639	1,5	30%	1,4119322
PET trims incineration w. e.	1,24	0,036	1,5	30%	0,0668546
Silicone rubber incineration w. e.	0,72	0,022	1,5	30%	0,02337
Landfill	0,00	0,782	1,5	20%	0

IMPACTS BY COMPONENT



IMPACTS BY LIFE CYCLE STAGE

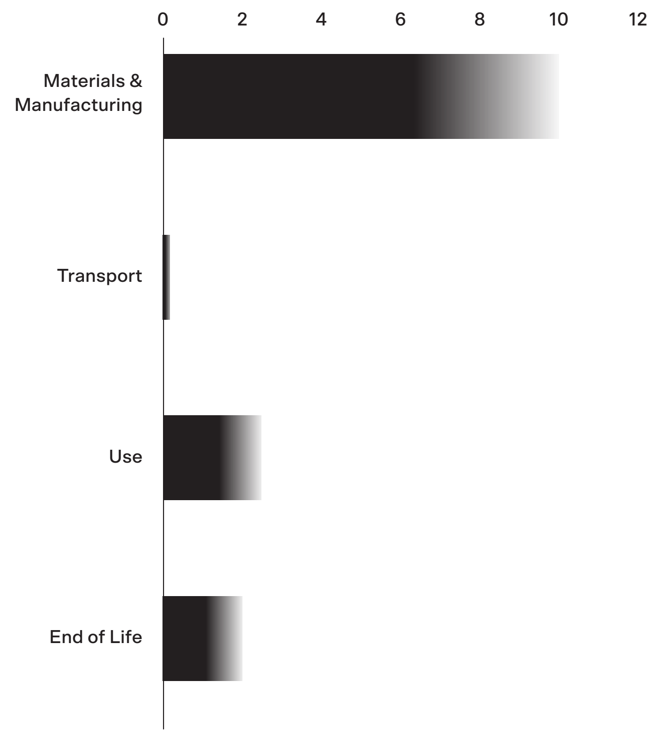
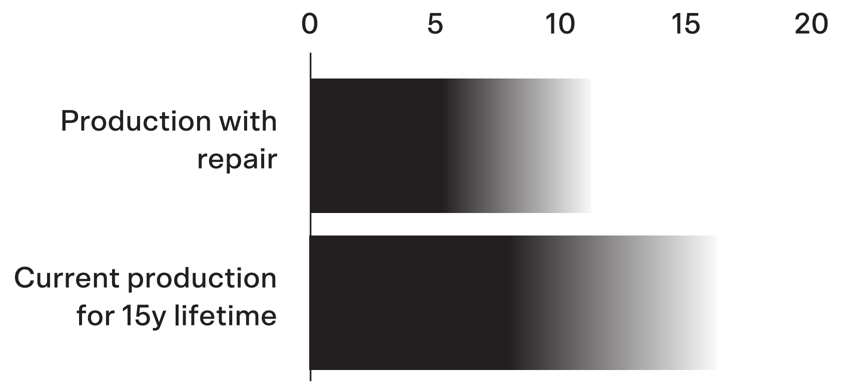


Figure 35: Current production with lifespan of 15 years.

TOTAL IMPACTS



TOTAL IMPACTS

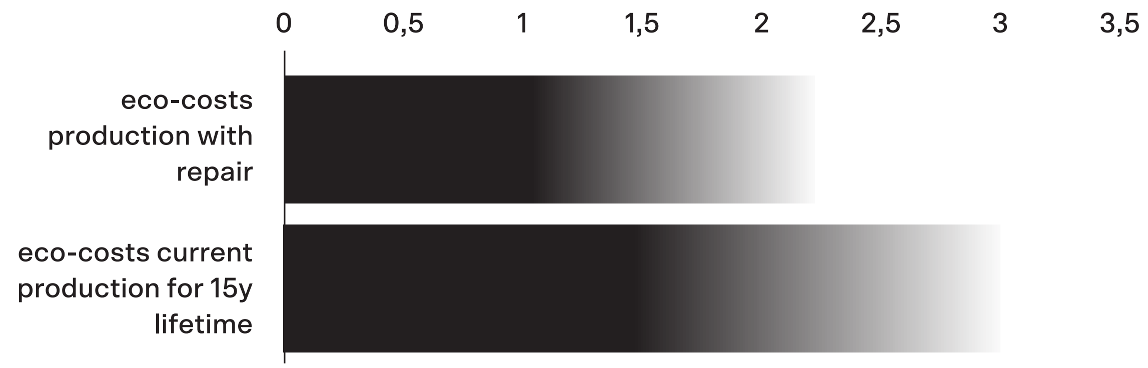


Figure 36: Total eco-costs impacts comparison between the two options.

As it can be seen, on a 15-year timeframe, the production that included repair workshops appeared to be much less impactful than the current production, generating 10 kg of CO_2 equivalent against 15.

Also the eco-cost difference was quite significant and in favour of the repair workshops system (Figure 36).

This is partly due to the change operated in the timeframe: indeed, approximately the difference between the two links to the difference of 10 to 15 years. Yet, it confirms that implementing the repair system could be a more sustainable to apply to Maium's activity.

For what concerns material choice, by the time the second scenario was being conducted, Maium expressed the will of considering just rPET as main material, and not the alternatives that were investigated in the first scenario: changing material would mean for them to change their whole supply chain, partnerships and abandon the recycling of plastic bottles into fabric as their Unique Selling Point (USP).

SECOND ITERATION
Whole System Mapping

After having conducted the second LCA, it was time for the second WSM to take place: this time the setting of the method has been slightly different, so as to better formulate hypotheses for the design solution.

Keeping the same priorities as the first iteration, the brainstorming question this time has been changed to:

What are the advantages and disadvantages, opportunities and barriers of the design solution?

Before starting the actual brainstorming, a set of preliminary considerations has been thought of together with the participants: these questions had the objective of having the company think about the overall context in which the possible design solution might be applied to, and think about how to position Maium in that specific context that would come out after the brainstorming.

During the second iteration an answer to the brainstorming question has tried to be given, here it is possible to find the flow of thoughts we had together with Maium.

“The advantages of the solution are that it is not expensive to set up (partnerships can be discussed, but videomaking, repair materials and information provision on the website are almost free), it’s environmentally friendly and includes customers in the process, strengthens the bond between user and brand, educates users to a more conscious consumption, hands out knowledge and skill to learn, extends lifetime of jackets. little effort, good result.”

“The disadvantages are that the recollection system is quite intricate, there is possible need of partnership with government or retailers, otherwise fewer people are going to be incentivised by just doing something good for the environment. Need bait to get their cooperation. People are lazy and used to consumeristic approach to fashion, costs of collecting and costs of setting up physical repair workshops (people who teach? stand? renting of space?...).”

“The opportunities are many, as long as investing money is not a problem, like amplifying the network and awareness people have towards Maium, could become one of the first to implement this type of approach in the Netherlands, include many people in the community, lower environmental impact of jackets.”
“The barriers are many too: investing of money, legislation and technology difficulty to completely recycle, difficulty in getting people to follow your good example, collecting system is intricate, the shift to a more circular model is hard, in the current linear model.”

What can someone do after having repaired the repairable items?

- Recycle broken items
- Resell at higher price than just used
- Keep wearing same jacket until EOL
- Leasing system

What happens when the fabric needs repair?

- Remanufacture
- Downgrade
- Give back the whole thing
- Higher discount if irrepairable?
- Use remaining fabric for something else
- Give to the poor
- Redesign depending on what defect there is
- Personalised patches

How is it possible to repair the jackets?

- Change buttons
- Change zippers
- Mend fabric
- Recolour
- Add water repellent
- Put patches

How might the recollection system work?

- People bring their used clothes back to retail stores
  - Users get discounts
  - No collection costs
  - % to pay to retailers
- Partner up with government
  - Collection costs
  - Capillarity reach
  - No partnership costs
- 2nd hand markets collection points
  - No partnership costs
  - People need to know the existence of this
  - No recollection costs

The second brainstorming itself has been set up as the first one (Figure 37): the system map has been drawn (in dark grey) and ideas have been written down (in light grey).

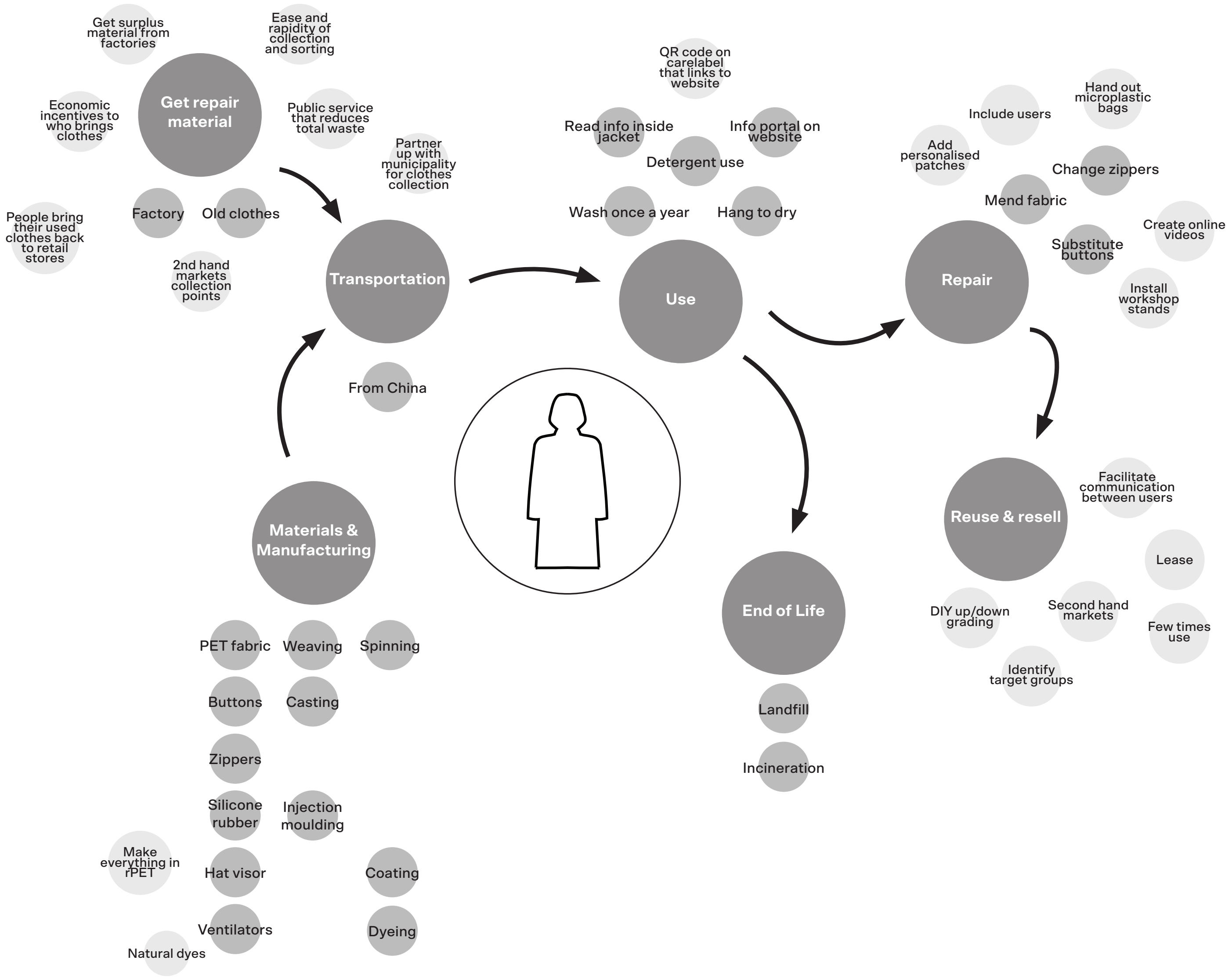


Figure 37: Second iteration brainstorming.

As for the first iteration, a voting session was made and the results were inserted in the scoring board (Figure 38), where it has been possible to calculate the scores of the winning ideas.

From this point on, the design solution had enough data to be created, and will be explored in the next chapter.

OBJECTIVE	Weight	Government partnerships	Retailers partnerships	2nd hand markets	Mail directly to Maium *
Minimise environmental impact	2	2	3	2	3
Deployability	3	3	3	2	3
Cost efficiency	4	2	2	4	3
TOTAL SCORE		21	23	26	27

* Intended as users that send used clothes directly to Maium, which discounts the shipping costs (and gives something more) on the next purchase.

Figure 38: Second iteration scoring board.

5.7 THIRD ITERATION
Presidio Sustainability Booster

This third iteration has been conducted to incorporate a business model analysis in a sustainability-oriented approach to the first two sets of LCA-WSM. To do this, the Presidio Sustainability Booster has been used: it consisted of interviewing the company following the direction defined by each card of the Booster.

Considering that Maium has been defined as a type of audience with characteristics of both traditional entrepreneurs and Social entrepreneurs working in developed countries, the areas of investigation have been chosen to cover almost all the Business Model Canvas, but eliminating the cards that seemed redundant for their business model. The main areas of interest have been Value propositions, Customer relationships, Channels, Key partners and activities (Figure 39).

Value proposition
The larger value proposition beyond the immediate customer need that Maium could meet can be described as this: Maium blends techwear and fashion with innovative design, creating the best option for biking during rainstorms while being comfortable, and makes it possible to take care of the environment with its sustainable practices. This because Maium has a great attention to sustainability and sustainability related issues, such as plastic and fashion waste recycling and the environmental impact they have.

"We've been applying LCAs and Whole system mapping methods to see the environmental impact (carbon footprint, eco-costs and water usage) of the production/post-production of

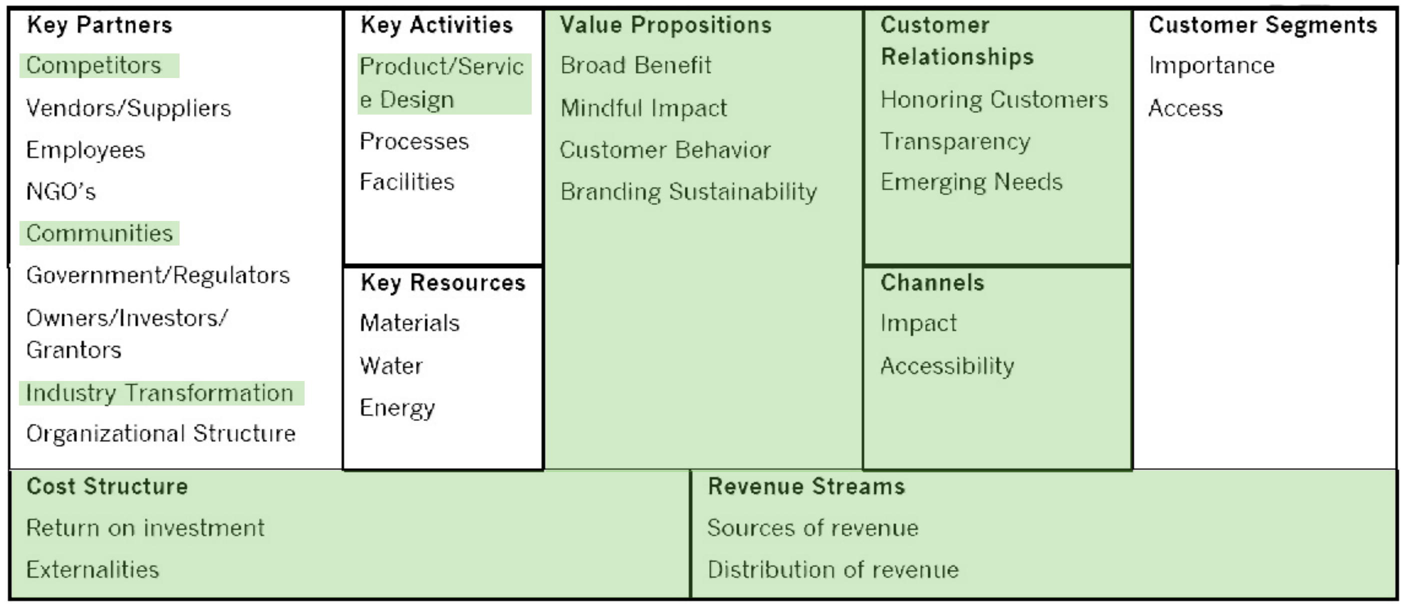


Figure 39: Areas of investigation for the Presidio Sustainability Booster.

our raincoats. With this we can make comparisons against our competitors, and also have absolute comparisons.
The main issues regarding sustainability in our brand are related to plastic recycling, closed loop production, reforestation and biodiversity preservation, and fashion disposal: these are, besides the product itself (made in rPET), key to our brand."

Yet, they are aware of the problems and limitations of their operations: the waste and recycling on synthetic fibres is not completely possible yet. The economic model does not help in terms of customer inclusion, since they are seen as mere consumers.

"Our product (including repair tutorials, ed.) *can help customers be more sustainable by educating them on practices that increase the lifetime of the jackets (more care, less water use, more information) and on possible alternatives to the linear consumption."*

Customer relationships
In relation to the customers, Maium expresses its intent of including them and showing them empathy, appreciation and education. Moreover, they value transparency and openness as one fundamental aspect of a company's work: just by being crystal clear, consumers can learn.

"We can make customers participate as much as possible in the process: give them information, teach them how to do stuff, give them a platform where to communicate with us (blog), award them with some discounts when they do something good, and give them visibility on our platforms."

Channels
Maium is now quite aware of the impacts generated in the production: this has been possible thanks to the Life Cycle Assessments, because before that they did not have profound knowledge on what happened in the production process. To make Maium more accessible they have come up with an idea that will be presented later on.

Key partners
What makes Maium stand out of the crowd right now is the fact that they produce their raincoats in rPET, and the collaboration they have with Eden Reforestation Projects. This might not be enough though, and they are thinking of extending their partnerships with bigger brands and government organisations as well.

"We could differentiate us even more by being exhaustively clear on our mission, and specifically the steps that are needed and taken so as to fulfill our goals: make even more clear and preponderant the work we're doing with Eden Reforestation Project. Push towards an exhaustive research on our processes (we're already doing fast track lcas, but maybe also try and see more in depth what our opportunities are). Last thing, we could create an effective disposal system, in collaboration with the government and the industry."

Their current partners (owners, investors, banks) do have a sustainable mindset, but that is not even close to their profit mindset.
They are very aware of their community and want to add value to it:

"Our community is composed by individuals that care about the

environment, that cycle, and that have a fashion sensitivity: we can add value to it by putting them more in the centre of our operation, and not having them as just marginal actors that passively consume our products. We need to understand their needs, without compromising the sustainability of our practices, instead making them participate in new activities that could benefit them, our business and the environment."

They want to change the industry by leading as an example, but without preaching.

Key activities
The opportunities to include a service to their product are vast, and this research is a way to find one. The Presidio Sustainability Booster itself is a tool to find chances of implementation of such ideas. Maium is open to include services to their products, as long as they do not create more waste or have higher environmental impacts. Unfortunately technology is a big obstacle to successfully and seamlessly recycling synthetic fibres, but this means that other ways can be persecuted. User inclusion is one that Maium values greatly, and intends to implement.

Figures 40 and 41 show examples of the set of questions and answers of the iteration. For the whole set of the Presidio Sustainability Booster, see in Appendix B.

VALUE PROPOSITION – Broad Benefit

- **What could be the larger value proposition beyond the immediate customer need we could meet?**
- How might our product or service further enhance the quality of life (e.g. health, safety, accessibility, education) of our customers beyond its immediate benefit? How might we refine the business model to contribute even more to their ability to thrive?
- Are there opportunities for our product/service to contribute to the solution of larger social or environmental problems beyond its primary purpose?
- In what way does promoting these multiple benefits improve our brand?

- Our products and services could educate consumers to become more aware of the environmental issues that characterise the Fashion industry, and to become more proactive in the everyday choices and activities they can carry out in order to prevent or limit the aforementioned issues. Moreover, there's a great attention towards the choice of materials, so that they are as less toxic (for humans and environment) as possible.
- Partnering up with Eden Reforestation Projects makes it possible to take care of trees and biodiversity of specific environments, not to count the jobs created by this reforestation service - most of the time reforestations happen in poor and exploited areas of the world, and the people who work in the projects can find a way to sustain themselves (under fair working conditions of course).
- It improves the brand by creating awareness and sharing knowledge: by being educated, customers create a special bond with the brand, as they start seeing it as standard-bearer for these types of topics.
- Maium blends techwear and fashion with innovative design, creating the best option for biking during rainstorms while being comfortable, and makes it possible to take care of the environment with its sustainable practices.

Figure 40: Broad Benefit card example for the Value Proposition.

CUSTOMER RELATIONSHIPS - Transparency

- **What information would customers want to develop a trusting, honest relationship with us?**
- (Openness) Is there anything about our business model that might cause concerns amongst some of our customers (e.g. ingredients, labor issues, lobbying)? Is there anything about our practices or our associations that would embarrass us if it were made public? If so, how can we change our model to eliminate these concerns?
- (Consistency) In what ways can we 'walk our talk,' demonstrate our commitment to our values and mission? Do we do what we say and say what we mean all the time?
- (Follow through) How can we be sure we deliver on all our promises? What regular practices do we need to implement to assure we continuously share critical information?

- (Openness) probably the fact that all the production is made in China does not help in the perception of sustainability (even if sustainable requirements are met, OEKO-TEX100 and GRS). The model can be changed just if the partners are changed to some closer to the NL (but it's not going to happen probably). So being extremely clear and transparent in all the production process's steps (production, working conditions etc), could definitely help.
- (Consistency) making our achievements clear and easy to understand for everyone, share our milestones and goals achieved (i.e. how many trees have been planted in a month/year etc)
- (Follow through) use the blog to express all our info and activities + desired further steps
- They would definitely want info on the production line (where things are being made, what are the working conditions, where and how the materials are collected etc.), and info on our goals, the steps that are needed to get there, and updates on our achievements (how much we have lowered the environmental impact of the jackets, how many trees we planted etc.)

Figure 41: Transparency card example for the Customer relationships.

6

FEEDBACK ON METHODS

Maium has been asked to provide feedback on the methods and tools used to get to the design solution, highlighing positive aspects as well as pain points. Also expectations and unexpected outcomes have been valued as relevant for the feedback. A short summary on the perspective of the researcher has also been included, so as to best reflect on the methods.

6.1 SUMMARY

Life Cycle Assessment
Maium has been enthusiastic about this method from the beginning, and extremely eager to know how to conduct an analysis of this type: it has been satisfying to see so much interest and proactivity, but most of all seeing that this type of work has been valued as very important and necessary in order to achieve a higher level of awareness on the environmental impacts of a company.

At first, they seemed to think the method was quite complex and not extremely clear, but once I showed them how it works, the results and the conclusions that can be formulated starting from them, everything made sense.
They also expressed their will to continue applying this method even after the end of this study, so that they can have a broader view when making design decisions on their production.

Whole system Mapping
This method has been a little less satisfying to apply because there needs to be some sort of willingness in participating. During the brainstorming sessions, responsiveness to the method was there, but not all participants were proactive.

The company later confirmed that it indeed was felt by some as an activity too far away from their expertise and character, especially from people who don't usually work with creativity in their daily tasks.

The method has been valued as relevant for the project, and helpful to delineate the whole system of their production in a way that isn't just linked to raw data and facts, yet not everyone was feeling completely immersed in the type of activities the method requires.

Presidio Sustainability Booster
This method has been the most criticized. Not because of the method itself, but more for the fact that the people involved (Design and financial departments of Maium) were since the beginning a bit skeptical on the value of a business model canvas in general.

They thought that it is indeed very important to think about all the aspects of a company in order to maximise its possibilities on the market. However, the sustainability booster is too much of a didactic approach, where the reality of things cannot always be defined by a set of pre-written questions applicable to all situations.

Working with these three methods has been helpful to get a broad view on the problem and solution definition, and to compensate the insufficiencies of some tools with others.

For example, LCAs have been extremely beneficial in defining what the environmental impact of the different lifecycle stages is and in getting an overview on what possible alternatives in this area might be.

Unfortunately, it has been less specific in what to do with the waste in the industry, which is one of the major issues that this research wants to focus on. In this case, Whole System Mapping has done what LCA could not: starting from the emission investigation and impact per lifecycle definition, it has been possible to merge these together with a design solution that could eventually reduce the impacts of the raincoats' production by operating on the activities related to waste and user involvement.

The process has been divided into three iterations exactly for this reason: work transversally between LCA and WSM, so that the end point of one iteration of one tool could be the starting point of the other. Also the Presidio Sustainability Booster has been used to get to a more complete final solution, by making participant think about how to improve the business direction with a more sustainable orientation.

The LCAs suggested a major redesign in the Materials & Manufacturing processes, which would have meant to redesign the whole supply chain and change Maium's identity: this is not unacceptable by the brand, but it requires time and resources that right now they do not want to invest. In this case, WSM has brought a fresh perspective that could integrate a part of the LCA research into the final design proposal.

7

DESIGN SOLUTION

In this chapter the design solution will be described, focusing on the reasons for which it has been thought the way it is, how it is possible to apply it to market's and Maium's reality and the analysis and interpretation of the outcome.

7.1 CARE LABEL

To get to the final solution two iterations of LCA and WSM were needed, plus a third in which the Presidio Sustainability Booster has been applied.

As it has been described in chapter 5, the first iteration gave an overall idea of the direction to take, the second was needed to analyse the potential impacts and get more in detail of such a direction, and the third gave additional insights to the design in relation to the business model.

Care label
The first element of the design solution would be to add, inside every raincoat, a care label that gives more information to consumers than the ones that are generally used nowadays.

The main scope of this idea is to encourage people to take extra care of the clothing so that, besides raising awareness with small tips and pieces of information, the lifetime of that product (and hopefully of others as well) can be extended. Of course, it is not just this that can make a big difference in terms of impact, nor in terms of life extension, yet it has been thought that change needs to be built brick by brick, where every little help counts.

On the care label (Figure 42) the information that will appear would be:

- **Standard indication for washing**;

- **Info about the product**: what material is used, where does it come from, how good it is for the fashion industry/environment;

- **Tree planting information**: Maium plants a tree for every purchase in at risk environments (making sure biodiversity is respected), but it is not properly advertised. Adding it to the care label could make people more aware on their actions and build trust with Maium.

- **A QR code** that links to the website, where all the previous information is more thoroughly explained.

This part of the solution is the easiest to apply to Maium, because the material used to make it is so little that it doesn't make any difference on the environmental impact of the raincoats.

Indeed, in the LCAs no difference has been detected in terms of environmental impact both for what concerns the Carbon Footprint and the eco-costs.

Moreover, the processes that would make it possible are already being used for the current care label, and it would not influence the production in any way, considering that it is such a small detail (that has quite a big impact). The actual change in the design would be in the size of the care label and the graphics on it.

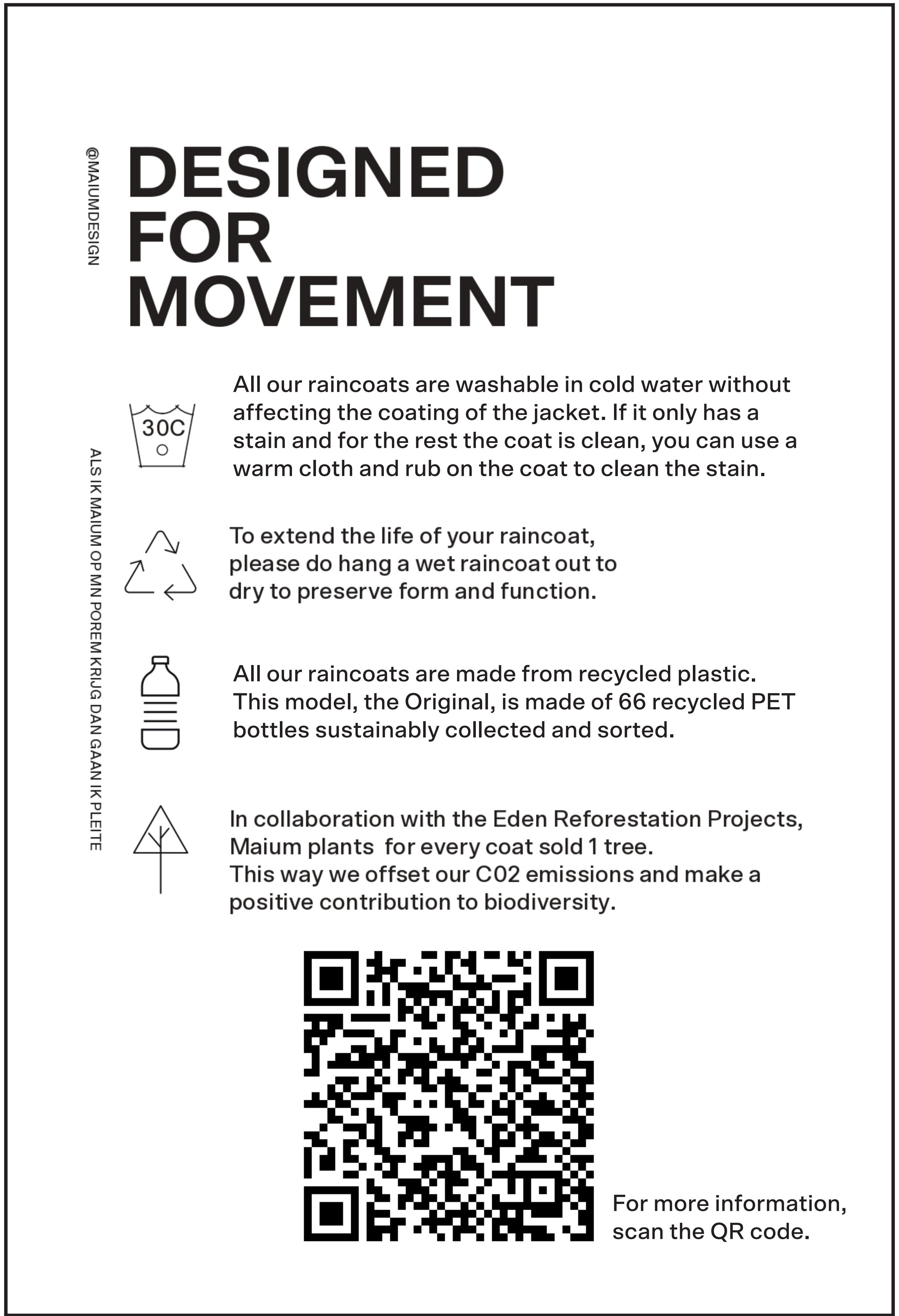


Figure 42: New care label prototype.

7.2 TUTORIALS AND WORKSHOPS

The second element of the solution is the repair tutorials and workshops system. This system is integrated in Maium's activity and website by just adding a few practices that influence their current production in a minor way.

The prototype of Maium's integrated website can be found at the link https://wordpress.com/view/maiumworkshop.wordpress.com.

The digital design solution consists of three areas that can be found on the website, under the new page "Repair". These are: "Repair tutorials", "The industry", and "Other guides and lessons" (Figure 43).

Repair tutorials
The first type of tutorials provided by Maium relates to the basic maintenance and repair techinques of a raincoat. The insights come in the form of tutorial videos, in which the users can learn repair techniques such as fixing the buttons of the raincoat, reapplying water repellency to it, or fix the zippers etc.

All the videos are first presented with a list of tools required to complete the repair and the level of difficulty and time necessary to make the repair.

User inclusion is always a priority, so that it is possible, for who wants to, to share new information or upload videos with new techniques for repair.
This would incentivise users to learn how to take care of their garment, without necessarily changing it or buying a new one.

The industry
This second section is a form of educational content in which Maium just shares articles in which more information on the fashioon industry is provided. The articles can range from what fast and slow fashion are, where the materials that Maium uses come from, what fair working conditions mean in practice etc.

This section specifically can be included to the newly implemented blog Maium has: in this Maium shares information about the company and their way of operating. The industry would also include more general information for users to access and get knowledgeable about.

It is by creating knowledge, and letting people know about the world that surrounds us, that new solutions can be found. All this needs to be done in the most transparent way possible. It can become a way to increase communication not only from firm to users, but also from suppliers to the company as well.

Other guides and lessons
The last section comprehends both educational videos and guides: the videos follow the same structure of the repair tutorials, but the difference is that the content in these videos is not basic knowledge anymore. The intent is to transfer new knowledge to users, not necessarily related to repair techniques, but to new skills in general. For example, a sewing or knitting course divided in many lectures can be provided, or how to iron clothes depending on which material they are composed of...

The guides are articles that provide useful information to users on how to approach their clothing.

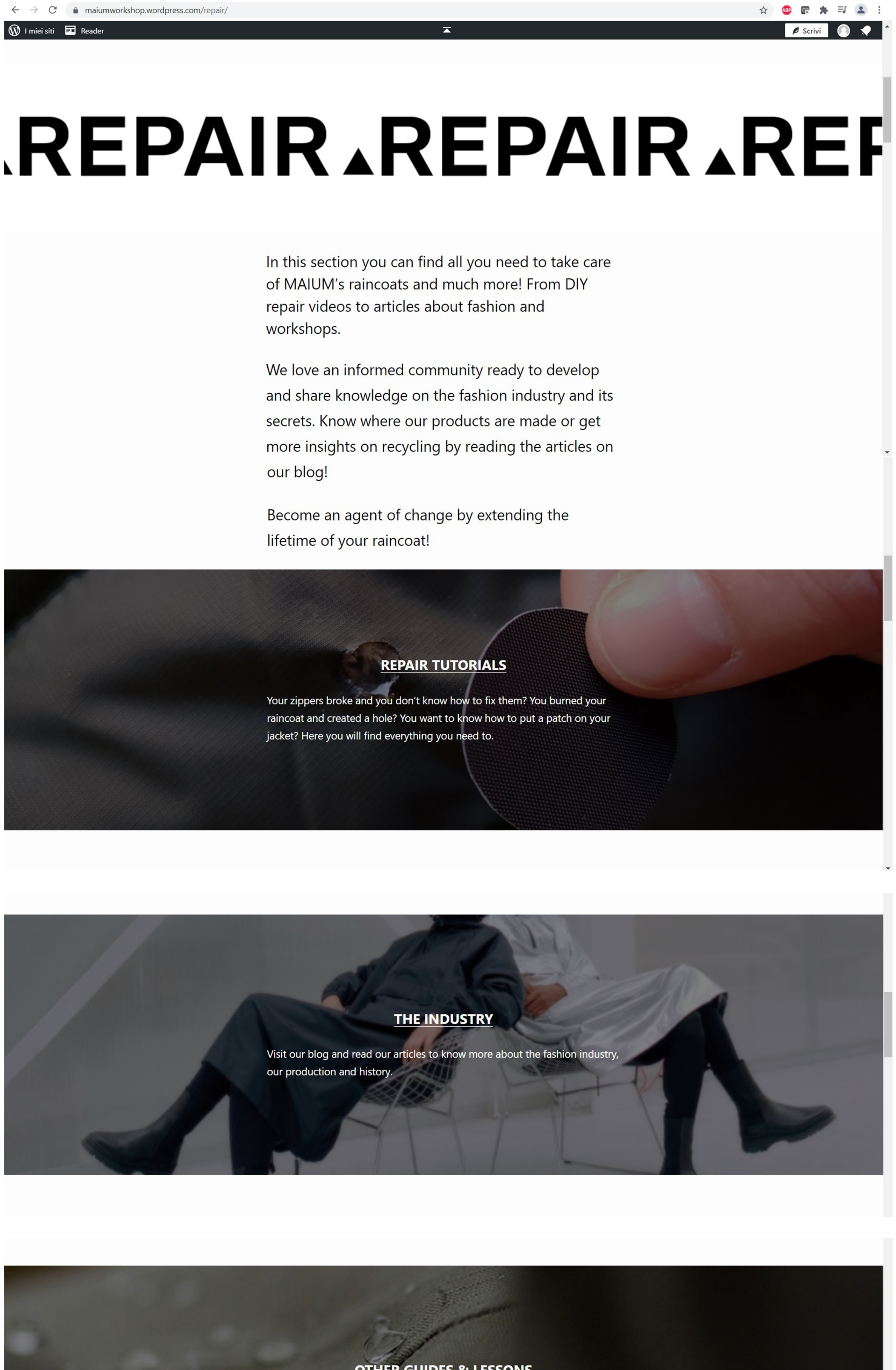
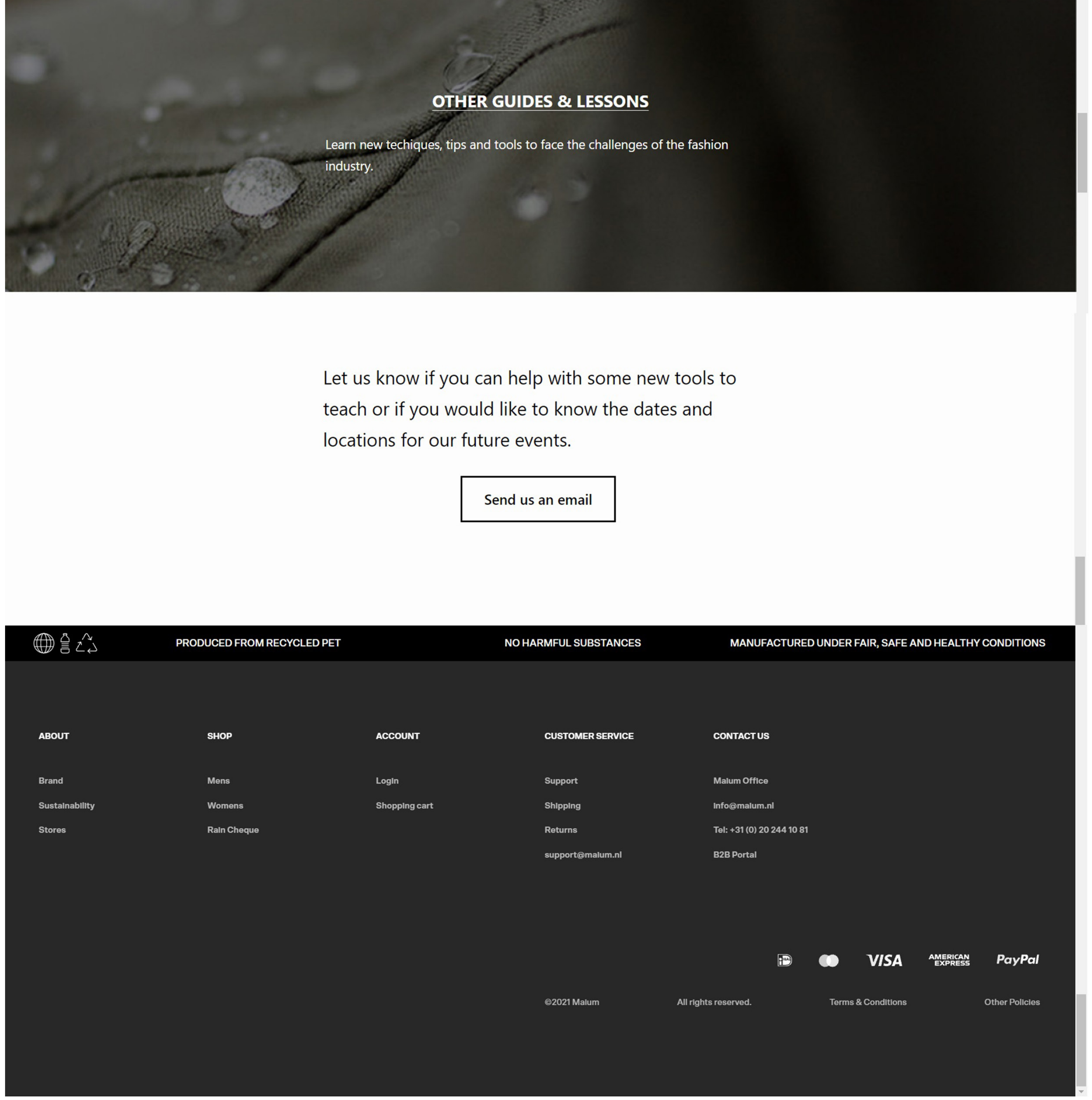


Figure 43: Maium's "Repair" webpage prototype.

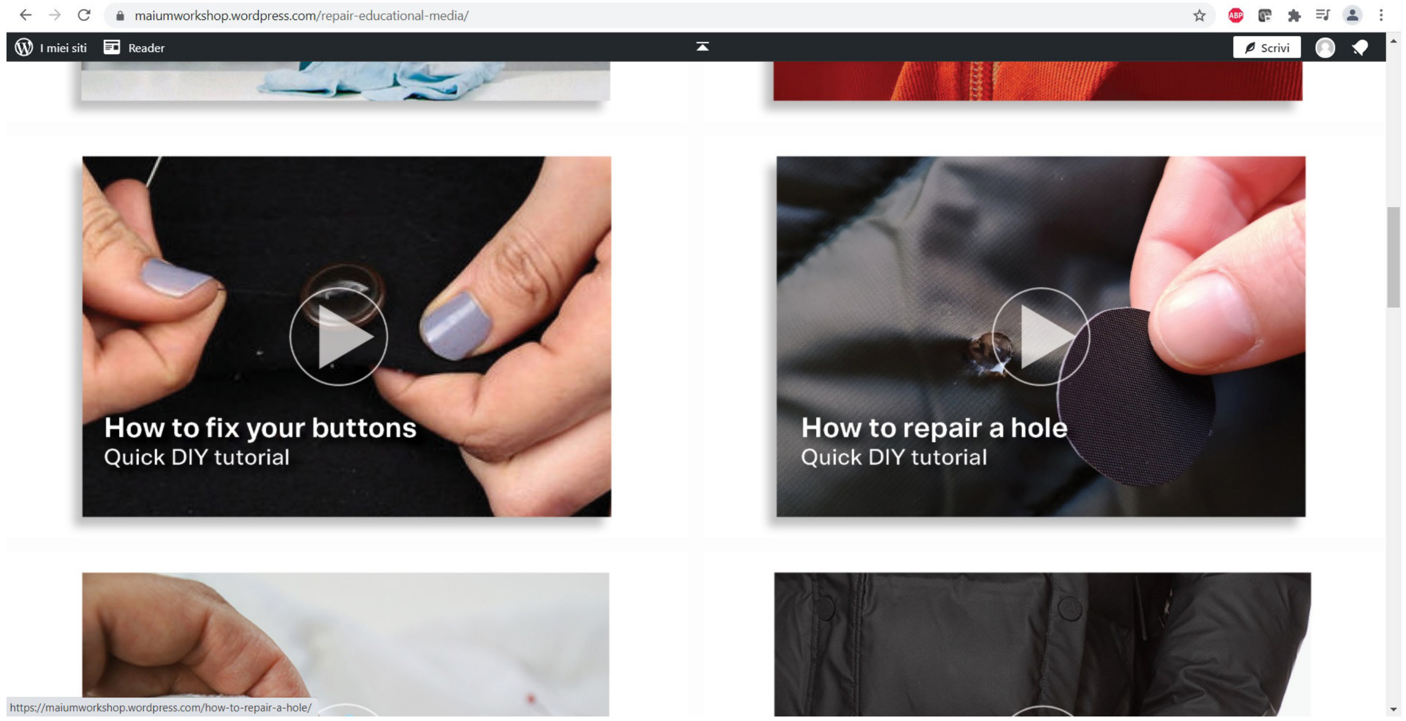


These can vary from articles on learning what washing machine symbols mean, or which is the best way to remove a specific stain, on a specific material, without using the washing machine etc.

The reason behind this, is to have users not only learn what they need in a precise moment in time, but to get them interested and proactive in learning new skills and transfer knowledge that otherwise could be lost.

Workshops
Apart from the implementations to the website, Maium could offer the same type of service in person: during their pop-up stores or events, they can collect old clothes and teach users who ask for it (paying a fee) how to repair them.

If clothes are too damaged to be repaired, Maium can collect them and provide customers with discounts on the next purchases: this is thought for increasing user trust and engagement to Maium, and also ease the recollection of old garments, so that they can be recycled.



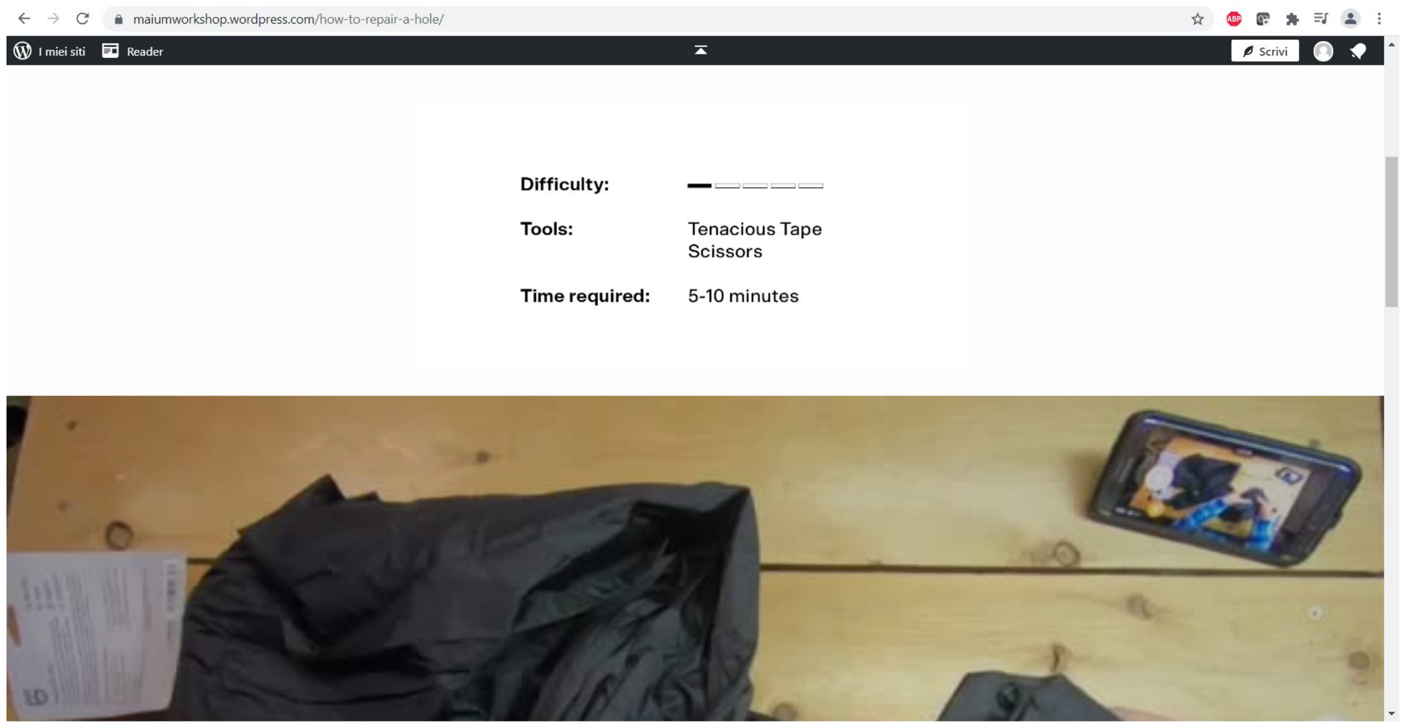
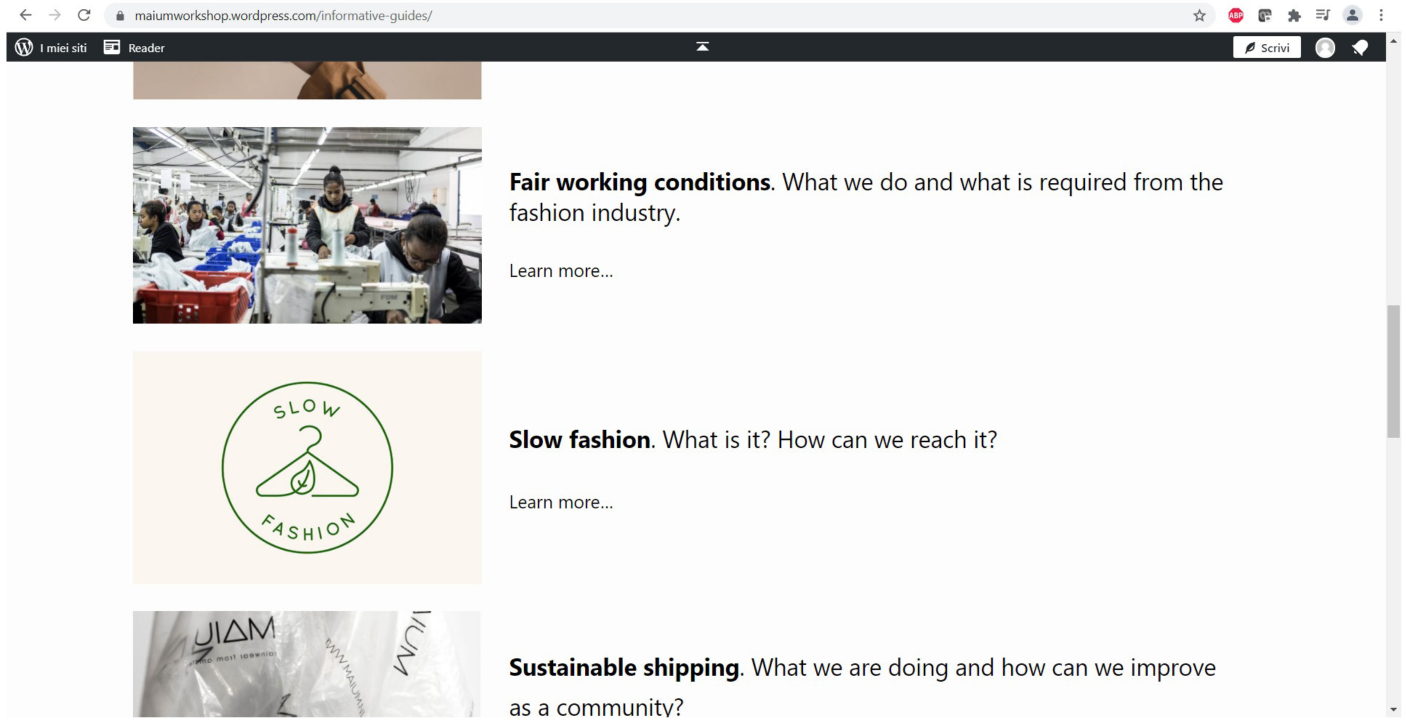


Figure 44: Maium's "Repair tutorials" webpage prototype.

Figure 45: Maium's "Repair tutorials" webpage prototype. Example of videos tutorial.



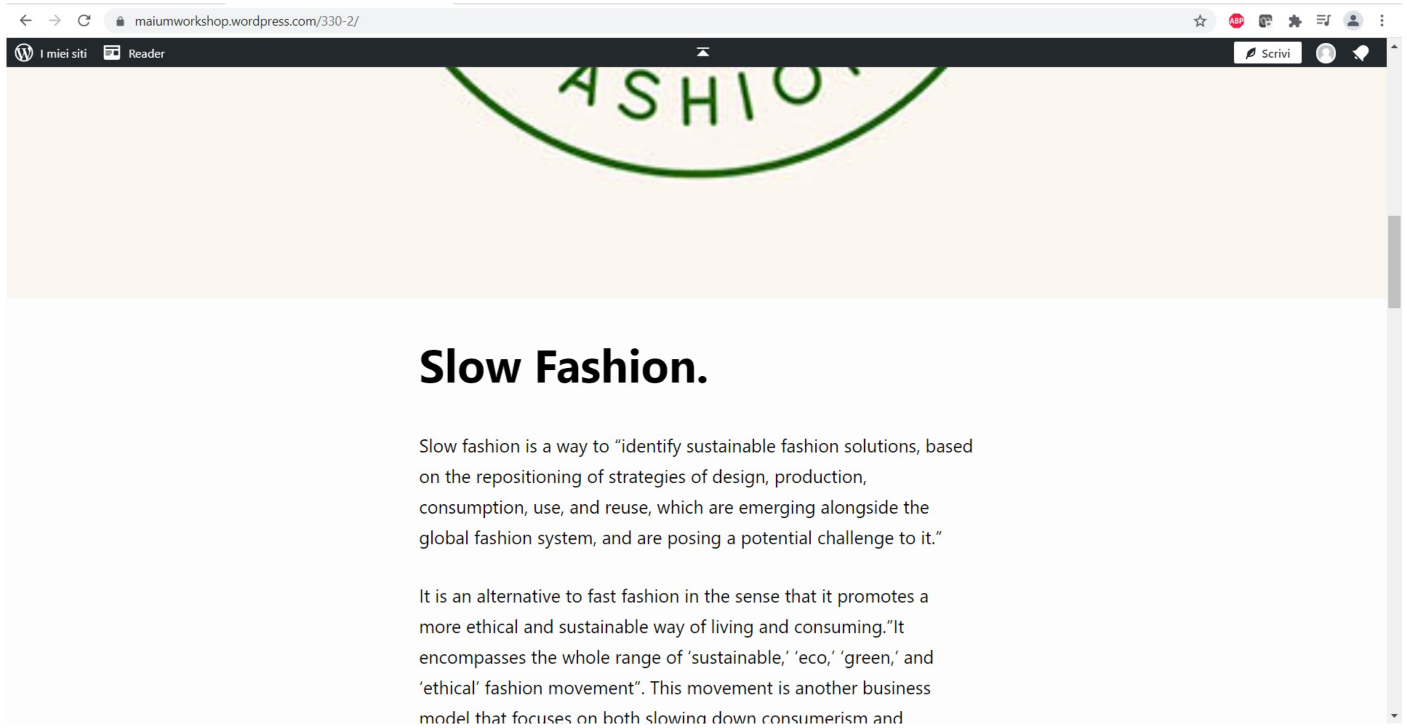
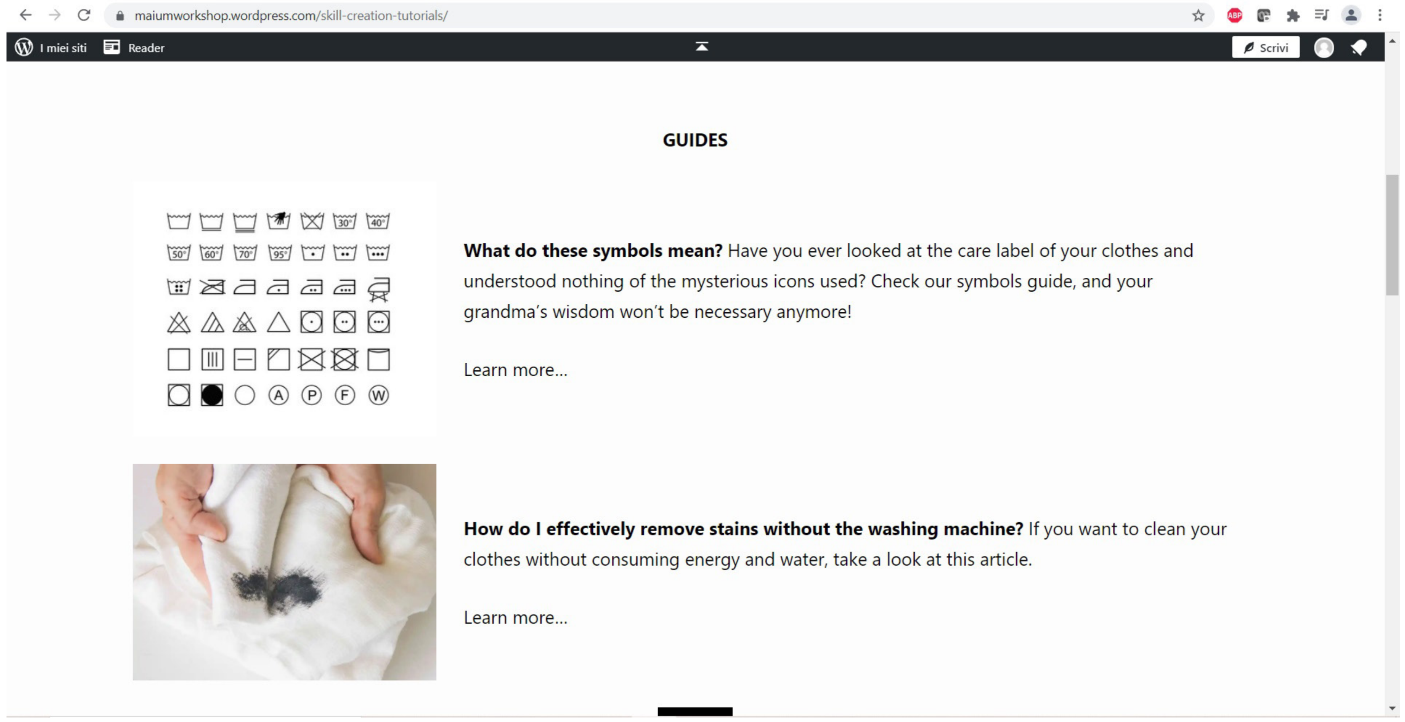


Figure 46: Maium's "The industry" webpage prototype.

Figure 47: Maium's "The industry" webpage prototype. Example of articles provided.



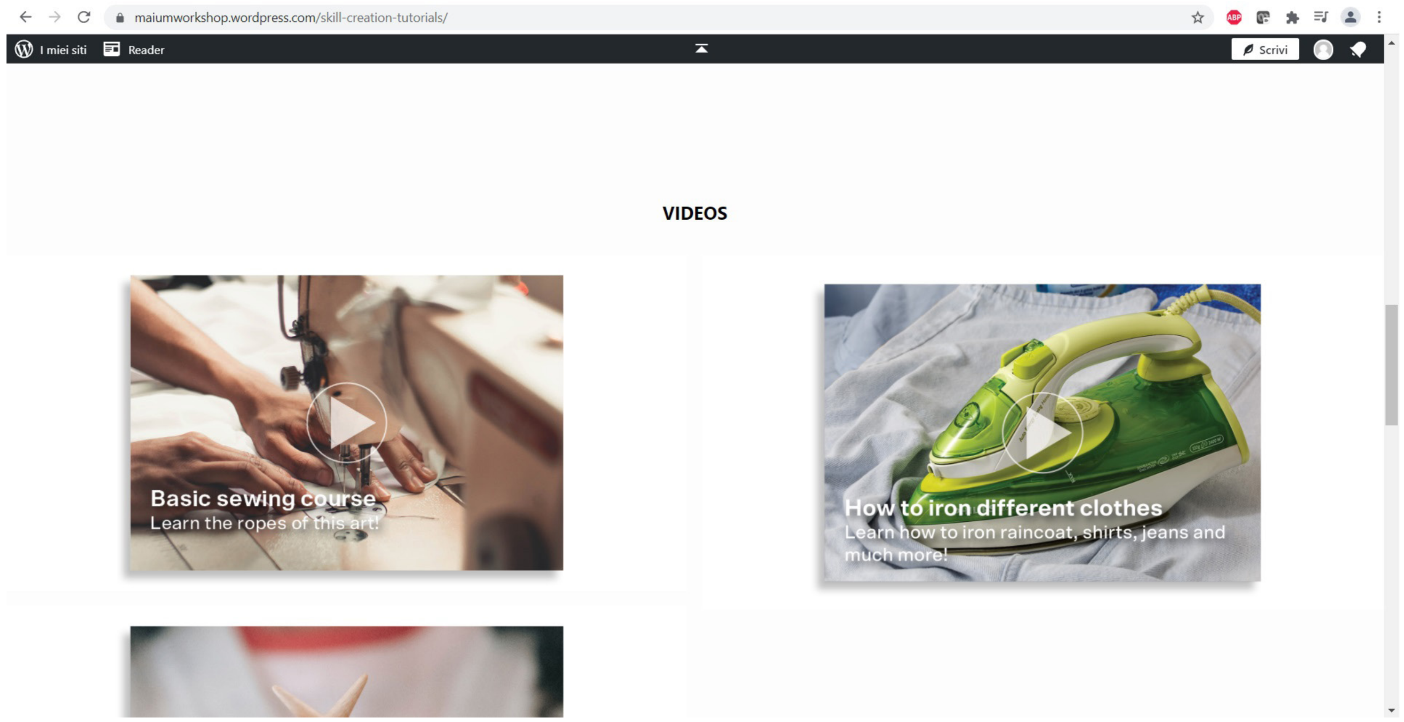
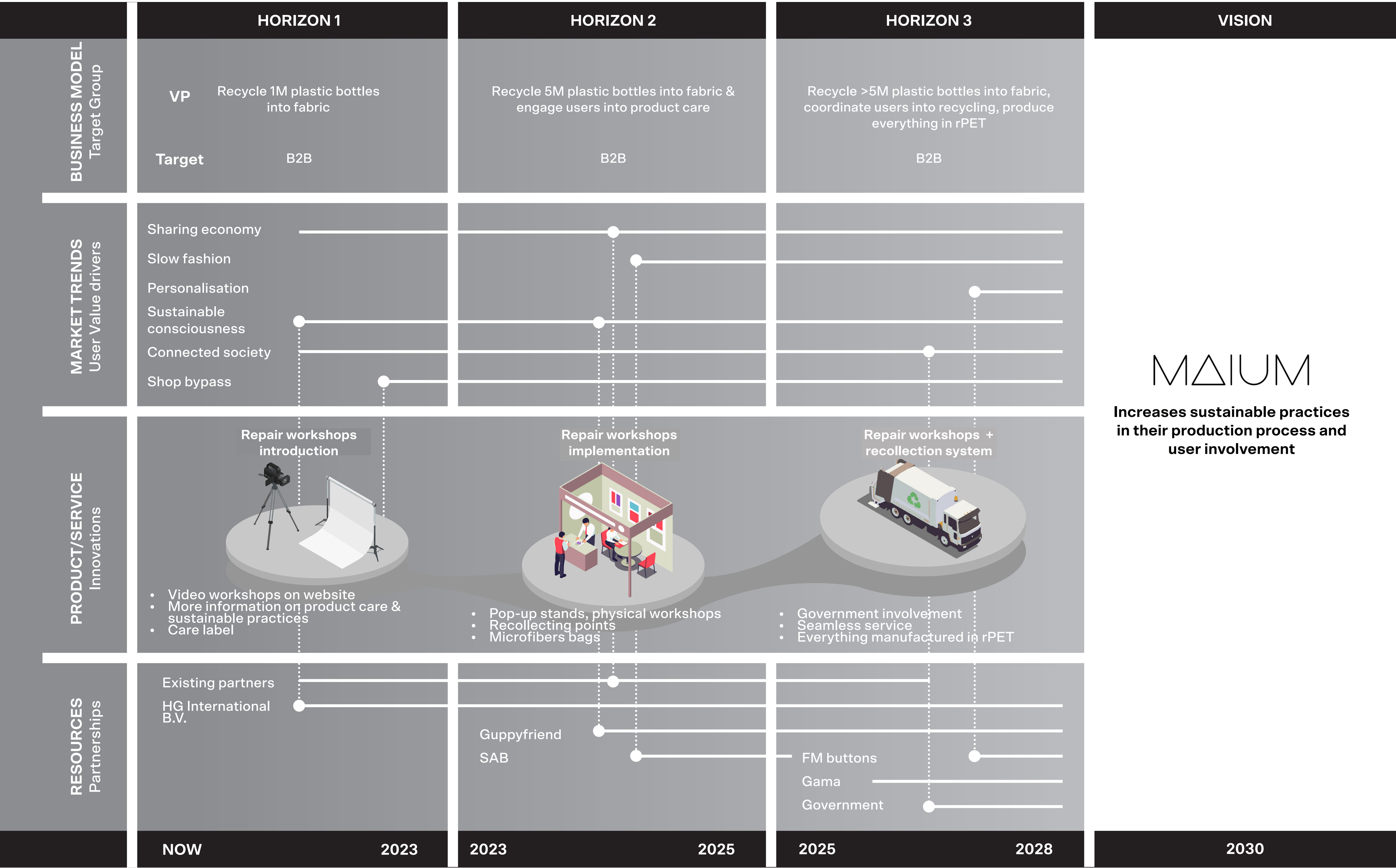


Figure 48: Maium's "Other guides and lessons" webpage prototype. Example of guides.

Figure 49: Maium's "Other guides and lessons" webpage prototype. Example of videos.

7.3 ROADMAP

Figure 50: Roadmap to reach objectives.



In order to best consider the application of these workshops in Maium's activity, a roadmap has been created (Figure50). This is a visualisation of the steps needed to reach the vision Maium has of increasing the adoption of sustainable practices in their production process and involvement of users.

The X axis in the roadmap represent time, and three horizons can be seen: each one of them has a time frame of two/three years, and it eventually ends with the vision for the year 2030. On the Y axis, the roadmap is divided in four parts, which consist of:

- **Business model, target group**: in this section the value proposition for each horizon is expressed, followed by the target, which always remains Business to Business (B2B);

- **Market trends, user value drivers**: here some of the main fashion industry and social trends are expressed and represented by white horizontal lines that start at a specific point in time (i.e., "sharing economy" is something that is already present and will be for all the time of the roadmap, while "slow fashion" does not happen until the second horizon);

- **Product/service, innovations**: in this section the actual application of various workshops and activities is shown. For each horizon it is possible to see what is going to be implemented.

- **Resources, partnerships**: here a list of the recommended partners is presented. These have been chosen depending on their business activity, location and links to the trends.

There are some white dots and vertical dotted lines, which represent the intersection points between the trends, Maium activities, and partnerships.

For example, in the first horizon "sustainable consciousness" goes hand in hand with the existing partners. It would be increased by the application of the first set of workshops and the partnership with HG International B.V., a Dutch company specialised in sustainable product care for textiles.

In the second horizon, "sustainable consciousness" could be increased with the partnership with Guppyfriend, a German company that produces microfibers bags for washing machines, as well as SAB. These developments could increase the position Maium has towards a slower production model (SAB recycles and remanufactures products).

Together with the workshops, Maium needs to provide customers with spare materials and components: this can easily be done adding a products page to Maium's webpage, Figure 51.

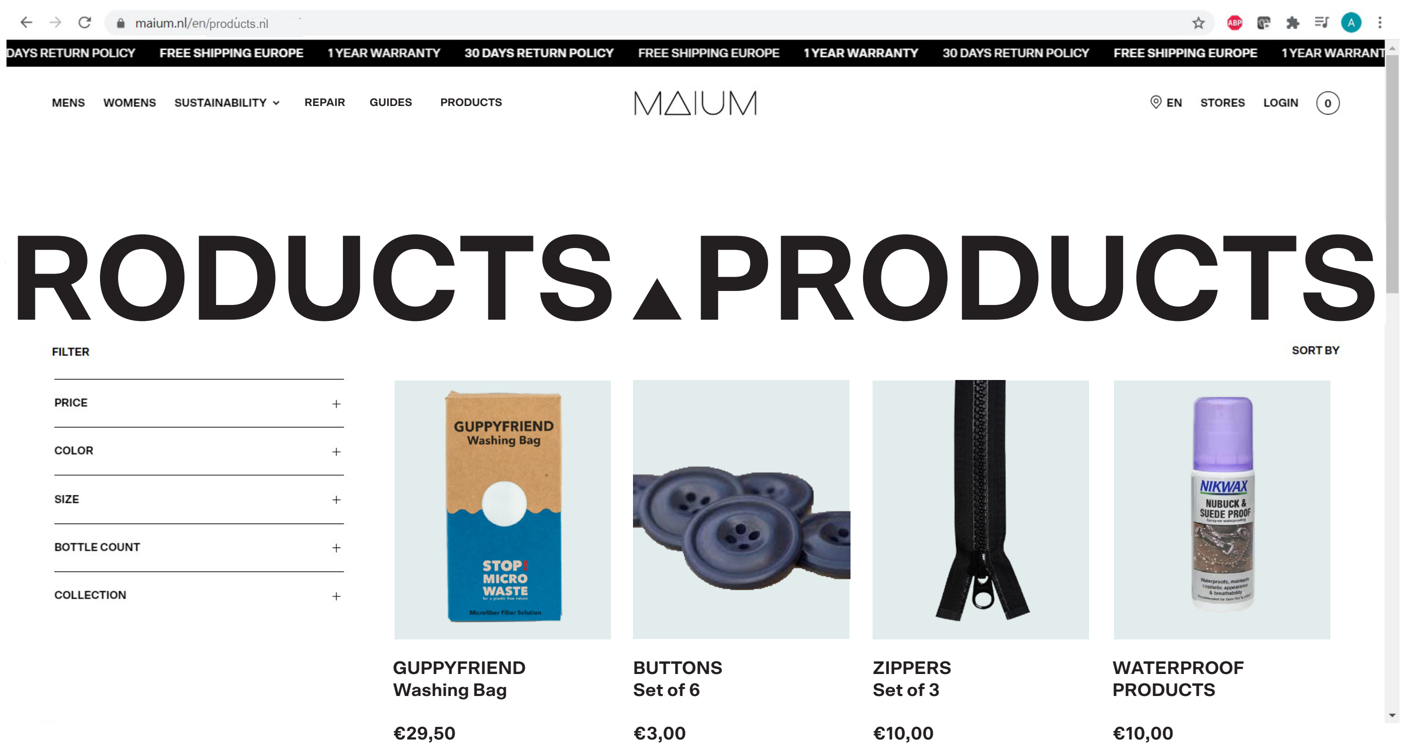


Figure 51: "Products" page on Maium's website.

8 CONCLUSIONS

In this chapter the sub-questions formulated at the beginning of the research will be given an answer. Recommendations will be also part of the final reflection, with a distinction between design recommendation and recommendations on the methods and tools used in the research.

- ***How can sustainability tools and method best be applied to Maium's practice and business model?***

The tools and methods applied to Maium's practice find the best application if the company has the resources and is determined to change their actions, where change is required. This has happened especially with LCA, which has been found to be the best tool to apply in a company like Maium.

Surely the application of all of the three methods used in the research have proven to be beneficial to Maium's activity: first of all because the company did not have any other sustainability tools and methods in its daily operations, but secondly also because Maium has expressed interest and decision in pursuing their goal of making the company greener.

The fact that they have started learning more specifically what happens in the production line in China has been the stepping stone to all the other (future) ideas and activities to improve the company. In this regard, to generate even more knowledge and self-awareness it would be necessary for Maium to have a thorough communication with its suppliers, which are sort of missing actors in this research. In order to best apply the methods, especially LCAs, it is fundamental that all the information on the production process is retrieved and calculated.

Just by doing this, the definition and level of detail of its environmental impact can be specific and lead to concrete and (maybe) unexpected insights. Moreover, the incremented knowledge on Maium's activity could lead to more seamlessly envision what needs to change in its current production and proactively act towards a solution.

- ***Which barriers are hindering a more sustainable approach to the production and post-production phases in the lifecycle of fashion products?***

The first, and biggest, barrier to the adoption of a more sustainable approach to fashion production is intrinsic in the system itself. The linear economic model that the fashion industry has been used to work with for ever hinders, just by existing, a more circular, thus sustainable, model. There needs to be a shift towards circularity that needs to be supported by the bigger companies, the ones that have the greatest impact on the world's production.

This leads to the second obstacle: right now, it is very difficult, and extremely expensive, to recycle synthetic fibres into new fibres. For this, a technological advancement is necessary, and this will happen together with the growth of the circular model.

Another barrier is the reluctancy of suppliers, especially those working in far away countries, to provide crystal clear information to their customers. When this obstacle will be surpassed, a huge amount of problems will have the chance to be solved quite easily (i.e. fair working conditions): but until then, little can be made.

- ***How can consumers in the Dutch fashion system be included in design for sustainability processes, increasing their role as agents of change?***

Consumers can be included in design for sustainability processes by sharing with them as much information as possible, in relation to the production processes, to the working conditions in the manufacturing factories, to alternative ways of consumption.

More specifically, and applied to Maium, they can learn how to take care of their products and thus extend their lifespan, and push collaboration between different entities that could ease the recollection of old clothes that could be recycled.

For the future, Maium could also think of a way in which to include consumers in the collection process of used clothes or textile waste: having a seamless recollection system could improve the sustainability of the fashion system and save costs and transport to actuate them.

- ***What strategy does Maium need to follow in order to improve and implement sustainable practices in its production process?***

The strategy that Maium should follow to improve sustainable practices in its production process is to include users in the end lifecycle stages of the products. It can do this by implementing a repair workshops system, together with providing as much information as possible, and being as transparent as possible: this reconnects to Maium practices, and the ones of their partners.

In orderd to do so, it needs to establish new partnerships which can clearly communicate their needs and objectives, and work together to provide consumers with everything they need. At the same time, if possible invest in new technologies that might facilitate recycling of textiles and work also with governmental organisations to effectively collect and sort textile waste.

In conclusion, the design solution that has been thought of has the intent of extending the lifespan of the raincoats, by operating on product care and empowering consumers by raising awareness on sustainable practices they can adopt as agents of change.

This has been done for different reasons: intervening on the materials and manufacturing processes was not possible, since Maium had been clear that that area was going to remain unchanged as they are just now starting to position themselves well on the market. Changing the whole supply chain would require too many resources and time for them right now.

Moreover, recycling rPET clothes into new garments is not that easy, nor cheap, especially when considering clothing that has waterproofing layers on the textile. Further technology improvements are needed in order to recycle these types of garments.

Finally, including users in parts of the process where they can operate (recollection, redesign, remanufacture...) means taking a little step towards a production that is not defined by extreme consumerism and high levels of waste creation: this for the fact that users would not be seen anymore as just consumers, but proper co-creators and collaborators of the system. The life extension of the clothes that would derive from it, would hinder the explosion of surplus production that characterises today's fashion system.

User Benefits
The design solution provided by this research would benefit the end users in different ways.

Including them in the informative process would definitely increase the overall level of awareness of the problems and possibilities the fashion industry has to offer. Providing them with as much information as possible on different subjects, from different economic models to fair working conditions in third world countries to recycling systems, could increase their interest and attract more attention on these issues.

Teaching them how to personally take care of their clothes means on one way extending the lifecycle of clothes, but at the same time generate knowledge that can be transmitted to others as well. this makes them more independent and puts them in a position of knowing what they are doing, instead of having someone else do it for them.

The design solution would finally have them as integrating part of the process, and change the conception that users are just consumers.

Environmental impact
By implementing the design solution it's possible for Maium to limit its environmental impact, due to the fact that clothes last longer and the waste is diminished.
Moreover, it can be a stepping stone for future options that might be even less impactful. For instance, having the whole collection in rPET could lower even more the impact Maium has on the environment.

All of this without having considerable costs: it needs to be reminded that the production costs of the video tutorials are limited in comparison to the benefit that they would bring. Moreover, the workshops and recollection through discounts on next purchases, could attract more customers and create a biggere community.

8.1 RECOMMENDATIONS
Design recommendations

It is extremely important to study the possibilities of collaborating with governments to allow a take back system that is not expensive for users nor for companies: it is possible to find a common ground where the institutions can facilitate the recollection of old garments, for them to be recycled and put again in the market. It is true that there already are collection points throughout the cities, where people can put their used garments and devolve them to charity.

This system, though, does not provide a proper sorting or recycling service following the collection. This needs dedication and resource investment from all the parties involved, but it's fundamental in order to change and ease the recycling process. If this is reached, there will be much more options that will lead to sustainable practices in the fashion industry.

For Maium specifically: creating the webpages necessary to implement the whole design solution is a start. If more time was available, more concrete alternatives and changes in the supply chain could be applied : for example, switching to partners that not only are closer to the Netherlands, but who also operate in recycling synthetic fibres and who provide recycled components, or that truly insist towards a sustainable production model. Perfectioning the whole production process in this sense is what could really bring them to a leading position in the market. More detailed and in depth LCAs can be conducted so as to research possible solutions in this area specifically.

The research conducted in these months has been beneficial on many levels, but if it can be brought to a deeper level of definition, proper changes can be envisioned and implemented. For example, increasing the level of detail of data would lead to more precise comparisons between options and thus design solutions. If Maium is undecided between two options, they can compare them on different levels, such as evaluating the environmental impacts or the eco-costs, or the water usage... Depending on Maium's necessities, it can move their decisional process a step further with the methods that have been taught in these months.

8.1 RECOMMENDATIONS
Recommendations on methods

Life Cycle Assessment
Life Cycle Assessment has been found as the best tool to apply to Maium, since the outcomes it provides are quantifiable and allow to make comparisons between different options. This method benefitted of the best feedback from Maium. The versatility of the tool is its core strength, as with it many different aspects of the creation of a product or a service can be analysed.

Moreover, the fact that it can be conducted on different levels of definition makes it easy to apply, depending on the necessities of the research. More detailed the data, more precise and effective the calculations and analyses. This is the desirable way of conducting the research to get the maximum out of it. But at the same time, if detailed information are not present, Life Cycle Assessments can still provide useful information.

A tool like this is difficult to improve, or to implement possible improvements: yet, in this research a more detailed specification of time in the calculations could have been extremely useful. It is hard to define how long a material produced in a specific way might last, but if the time factor could be included in the databases it would highly increase the level of definition of an analysis.

Whole System Mapping
Whole System Mapping is a useful tool. What has been noticed, though, is less proactiveness in participating to the brainstorming sessions and less interest in the outcome. And this could hinder reaching unexpected outcomes.

The suggestion is to use this method in an environment that greatly values design and creative practices when operating towards possible solutions.

Participants need to be emotionally involved and ready to act in a way that does not lead to facts, but to concepts and intuitions. Creativity is one of the most relevant aspects included in this tool: it helps connecting patterns of thought to actions. The more advanced and experienced this ability is, the more unexpected outcomes may be reached.

One suggestion to possibly improve this tool would be to have preparatory “creativity sessions”: exercises, tutorials, and sharing experiences might help getting participants in the right mood and flow of thought. If someone is already creative, this might be intended as a sort of warm up, yet if someone is not familiar with a less traditional and more creative approach, the sessions could at least get this person on the same line of approach to a problem.

Presidio Sustainability Booster
The Presidio Sustainability Booster is a tool that might be useful to have as an addition to the classic Business Model Canvas. That being said, though, in Maium’s opinion it is unlikely that a company would analyse their business activity step by step in a sustainability-oriented way, when it has already started. It does not consider the small facets of a business, that might not be included in the Presidio analysis.

More in detail, it is their opinion that the Presidio Sustainability Booster acts as a set of predefined questions and considerations that has the aspiration of being an exact tool that if someone uses for their business, they will surely succeed.

To give one example, it does not consider

positions in which companies might need to compromise (for financial or moral reasons) to reach success. This tool incentivises conversation between the actors of a business in order to better define the direction of the business itself, so the best suggestion would be to be extremely careful when tailoring the questions to the participants, and to be as broad as possible when considering an issue.

It could be helpful to set examples that incentivise conversation and thought, which include moral and less concrete aspects to the facts and data.

Conclusion
It has been interesting to see the different outcomes that came from these tools and methods.

LCA presented a direction that would have led towards a redesign in the Materials and Manufacturing lifecycle of the products: if this was to be followed, Maium should have changed the material and processing composition of their garments, which means also making major changes in the supply chain and business model of the company. Since this was not an option, it has been extremely useful to iterate a couple of times the Whole System Mapping tool.

With this, the direction switched towards the End of Life cycle: the inclusion of consumers in the use and recovery stages of the product’s life has been defined as an important feature to add to Maium’s activity. The change of focus has been made possible by the tool itself, which enables product developers to think on what hidden possibilities can be leveraged.

Moreover, in the second iteration, LCA has not been the greatest tool: it has been difficult to define specifically what the changes in impact would be, how much the lifetime of a raincoat would be extended for, and how much new material would be needed. It has given general indications, yet nothing specific.

In this case, the second iteration with WSM has been useful once again, enabling product developers to ask questions related to the design solution, and think about possible new outcomes.

In this second iteration, also the Presidio Sustainability Booster has brought some insights while designing the solution: it has helped thinking on what direction would be the best from both financial and sustainable standpoint. As previously said tough, it has been thought of as too didactic and less observant of the multifaceted reality of a business.

9

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10

APPENDIX

A LIFE CYCLE ASSESSMENT Carbon Footprint

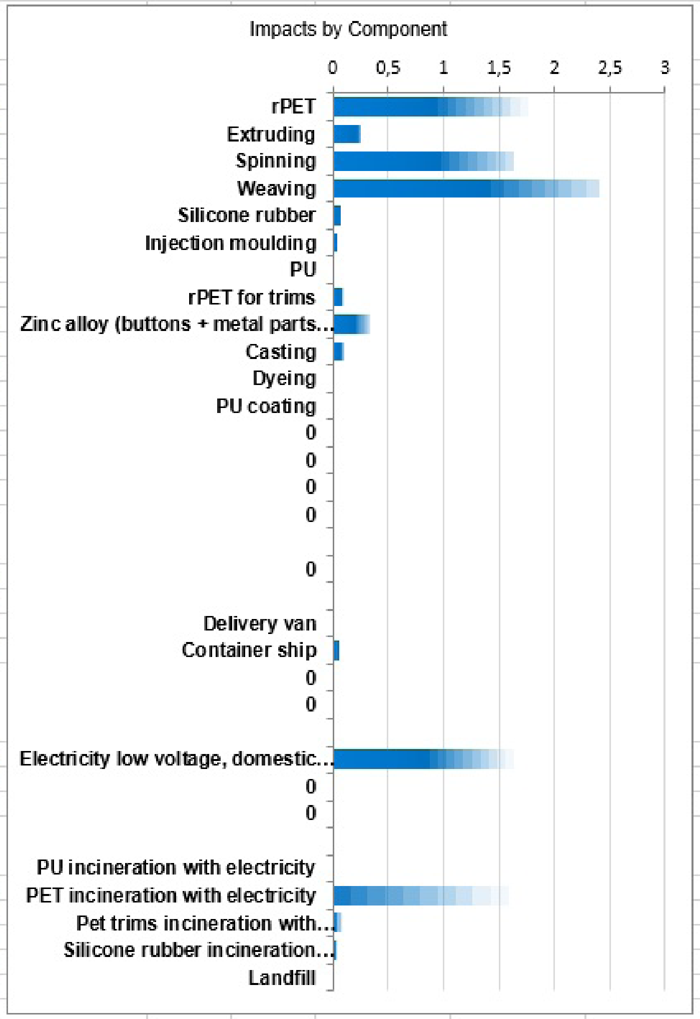
Desig	Main material Recycled PET					
(Nam	rPET					

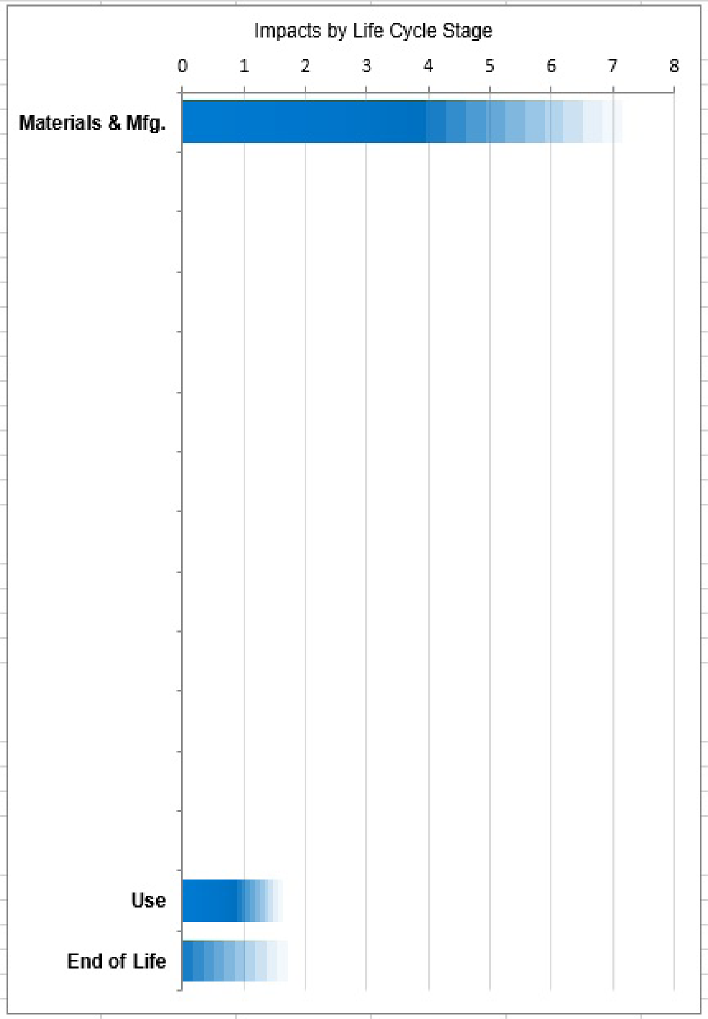
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	2,13	0,639	1,00	30%	Not sure whether	1,364541
Extruding	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
PET incineration with electricity	1,24	0,639	1,00	100%		0,791484
Pet trims incineration with electricity	1,24	0,036	1,00	100%		0,04457
Silicone rubber incineration with electricity	0,72	0,022	1,00	100%		0,01558
Landfill	0,00	0,782	1,00	70%		0





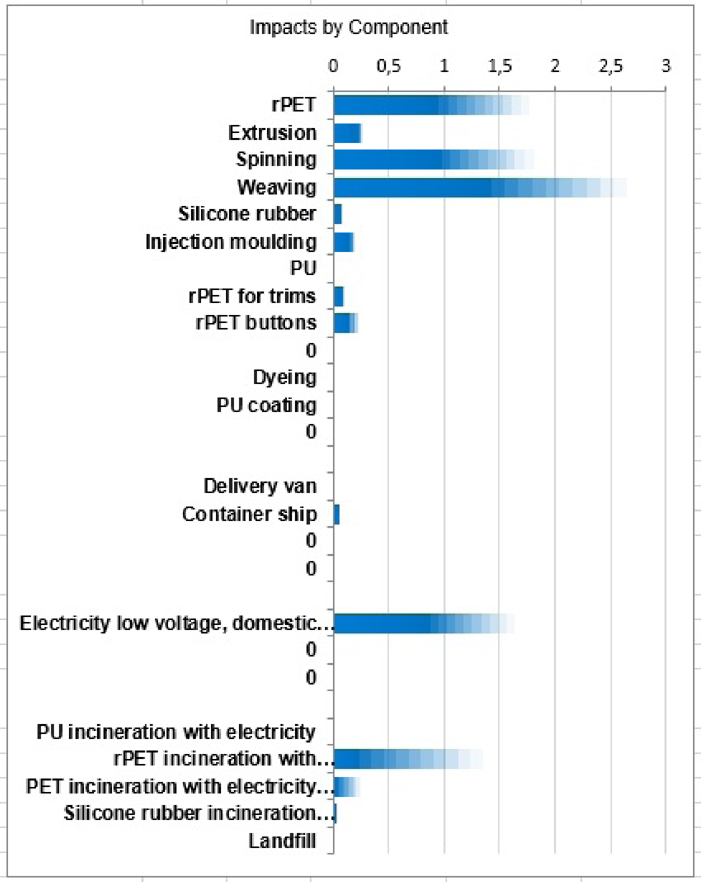
Desig everything rPET
(Nam everything rPET

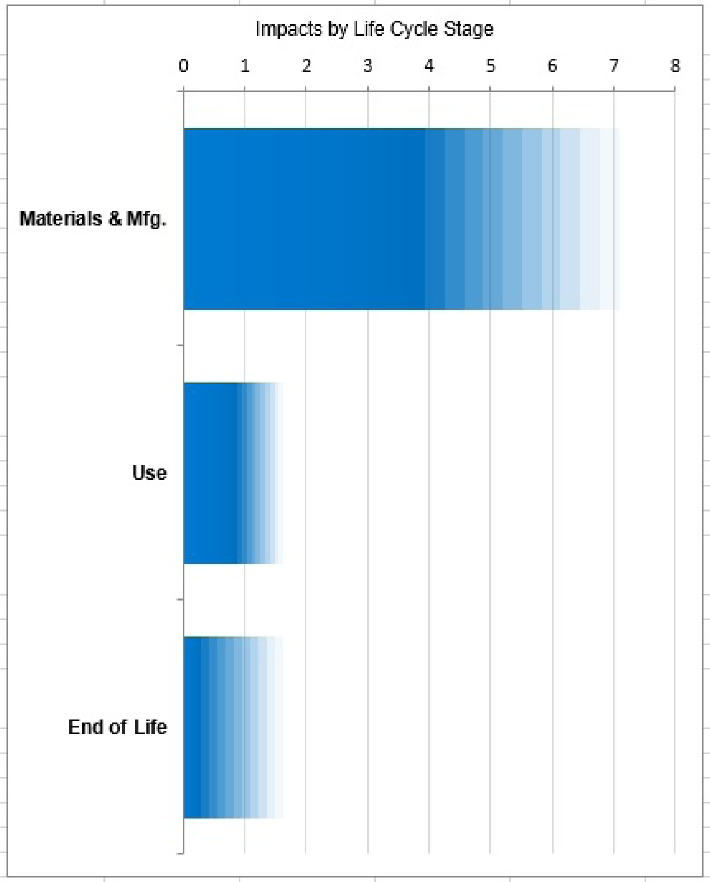
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	2,13	0,639	1,00	30%	Not sure whether	1,364541
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,107	1,00	20%		0,161942
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
rPET buttons	2,13	0,085	1,00	30%	Assumption on th	0,181427
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the en	1,254985
						0
						0

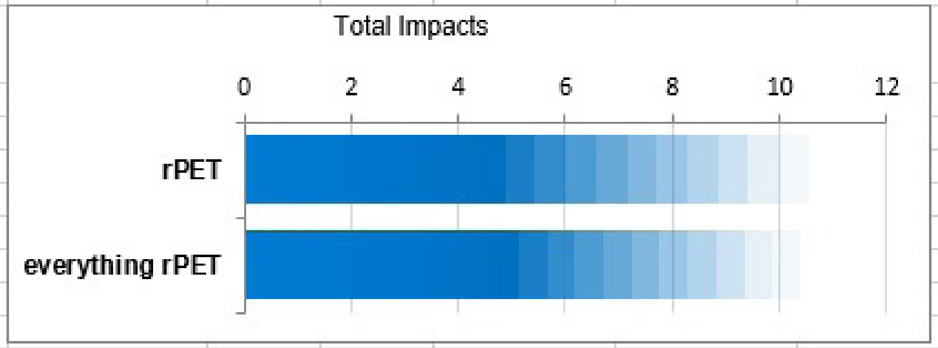
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	70%	(Use this column t	0
rPET incineration with electricity textile	1,24	0,639	1,00	70%	assumption of pro	0,791484
PET incineration with electricity buttons and trims	1,24	0,121	1,00	70%		0,149804
Silicone rubber incineration with electricity	0,72	0,022	1,00	70%		0,01558
Landfill	0,00	0,782	1,00	30%		0





Comparison

rPET
everything rPET



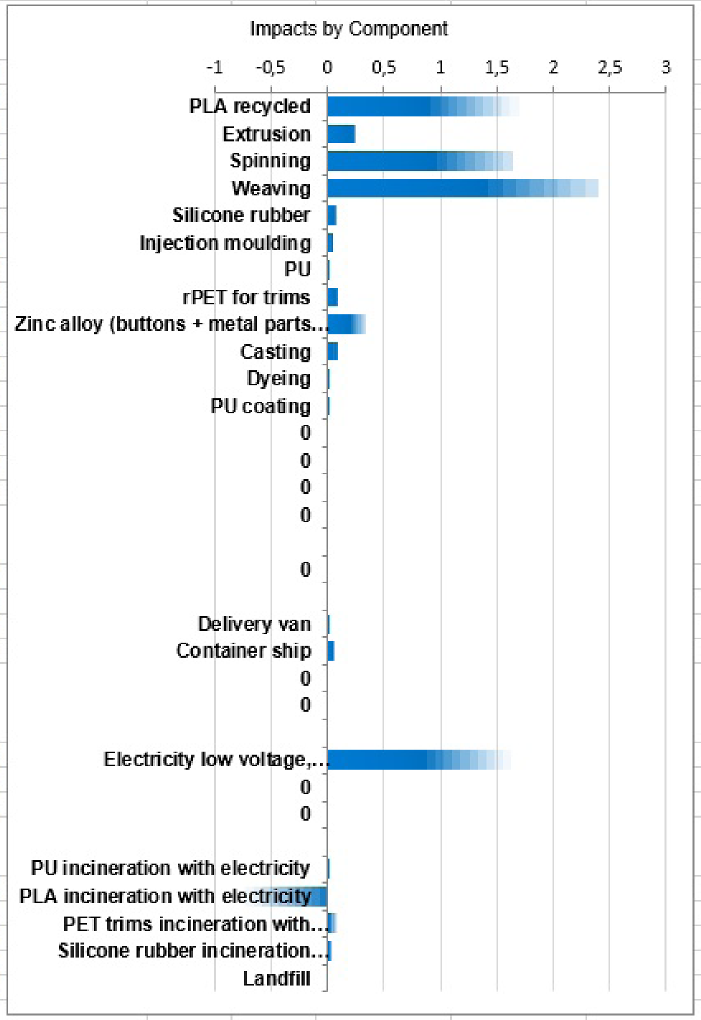
Desig Main material Recycled PLA
(Nam rPLA

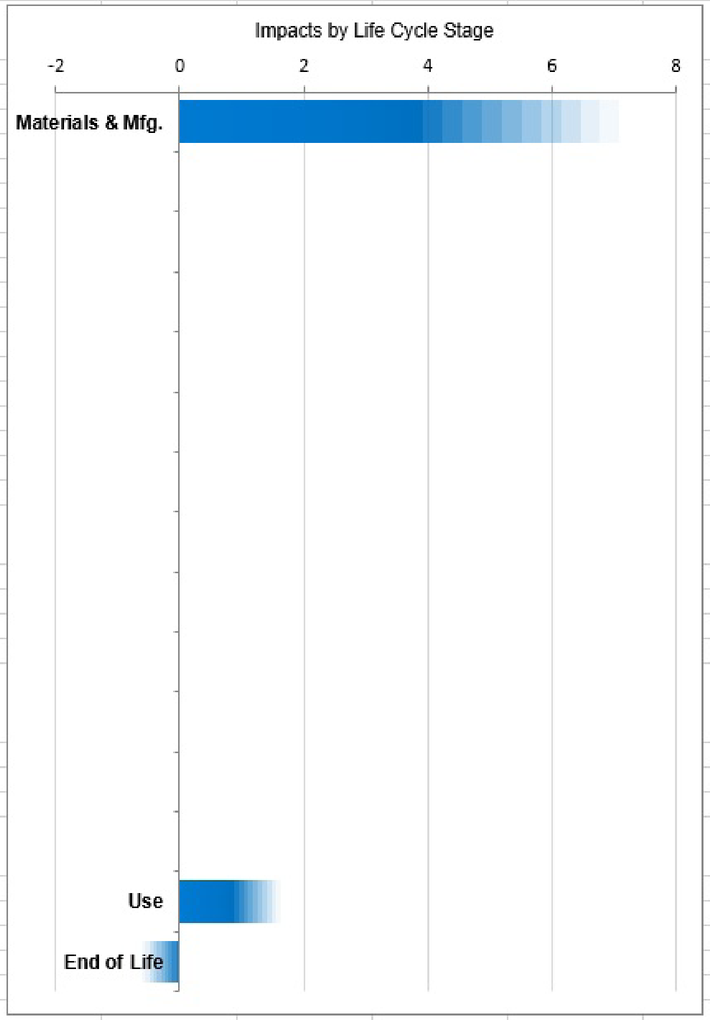
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PLA recycled	2,04	0,639	1,00	30%	Not sure whether	1,30604
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%	Not sure about m	0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
PLA incineration with electricity	-0,57	0,639	1,00	100%		-0,364771
PET trims incineration with electricity	1,24	0,036	1,00	100%		0,04457
Silicone rubber incineration with electricity	0,72	0,022	1,00	100%		0,01558
Landfill	0,00	0,782	1,00	30%		0





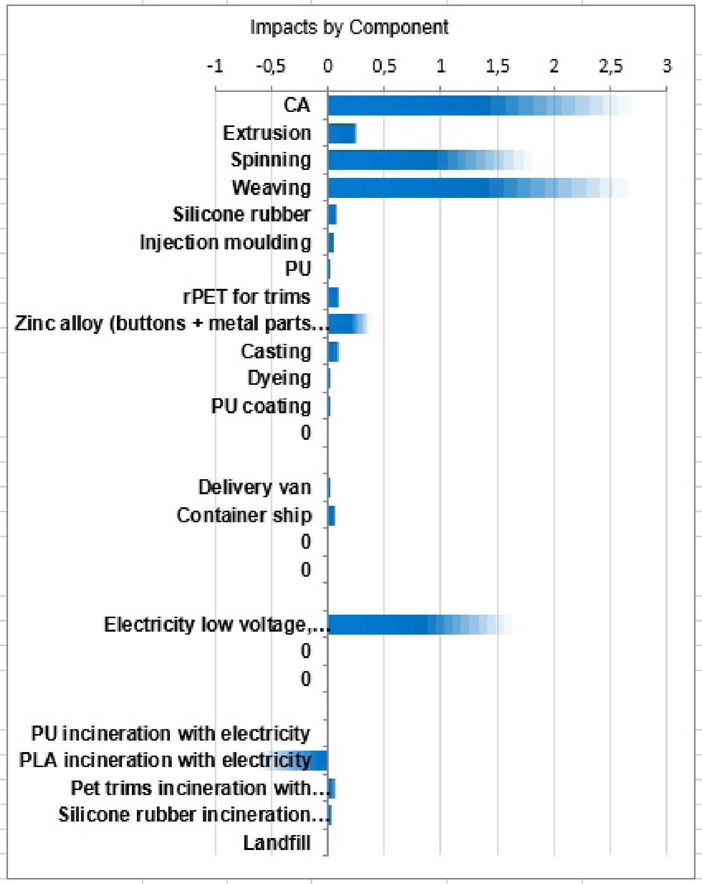
Desig	Main material Cellulose Acetate					
(Nam	CA					

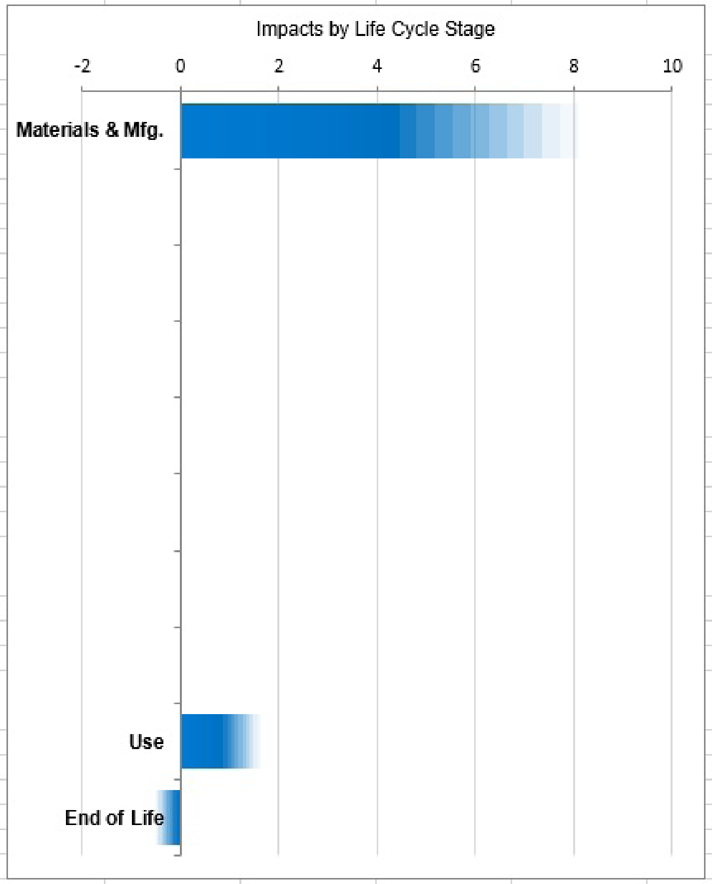
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
CA	3,23	0,639	1,00	30%	Not sure whether	2,064742
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

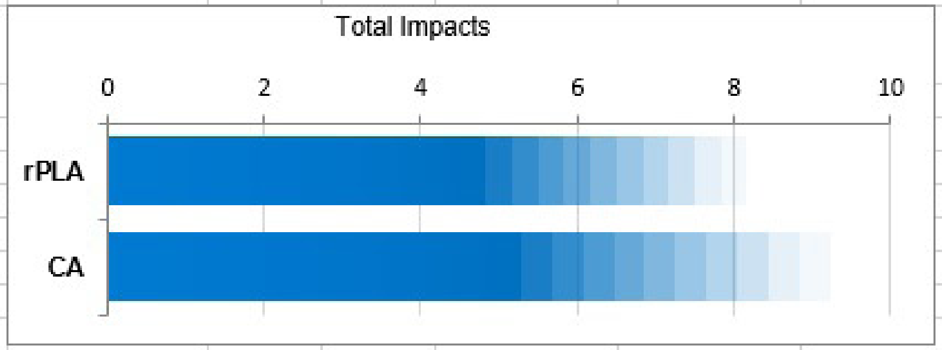
End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	70%	(Use this column t	0
PLA incineration with electricity	-0,57	0,639	1,00	70%	assumption of prc	-0,364771
Pet trims incineration with electricity	1,24	0,036	1,00	70%		0,04457
Silicone rubber incineration with electricity	0,72	0,022	1,00	70%		0,01558
Landfill	0,00	0,782	1,00	30%		0





Comparison

	rPLA
	CA



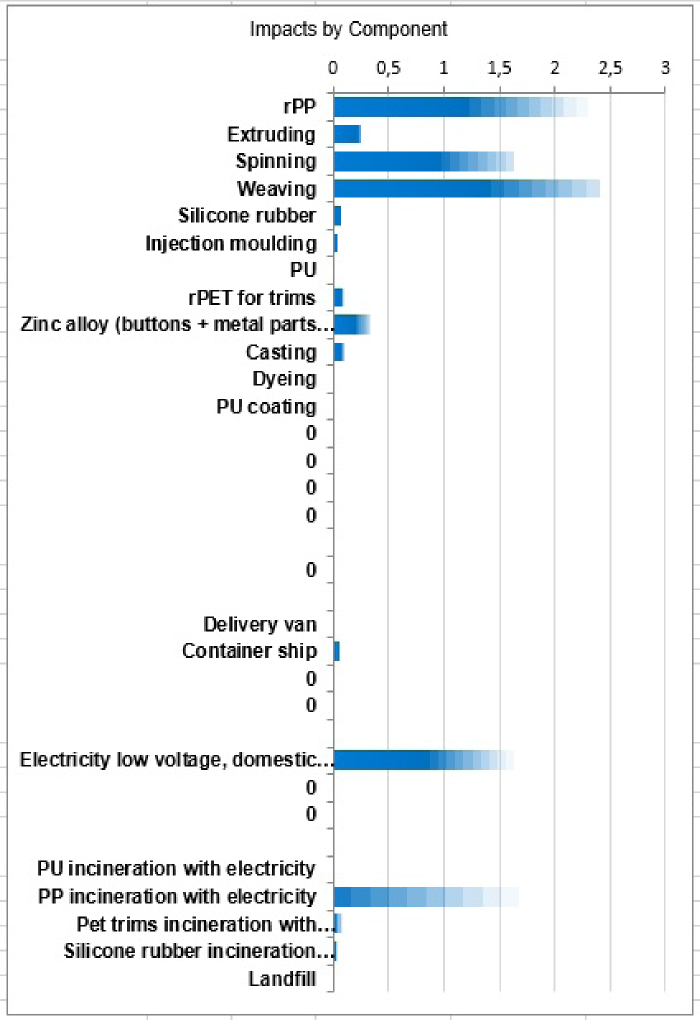
Desig Main material rPP
(Nam rPP

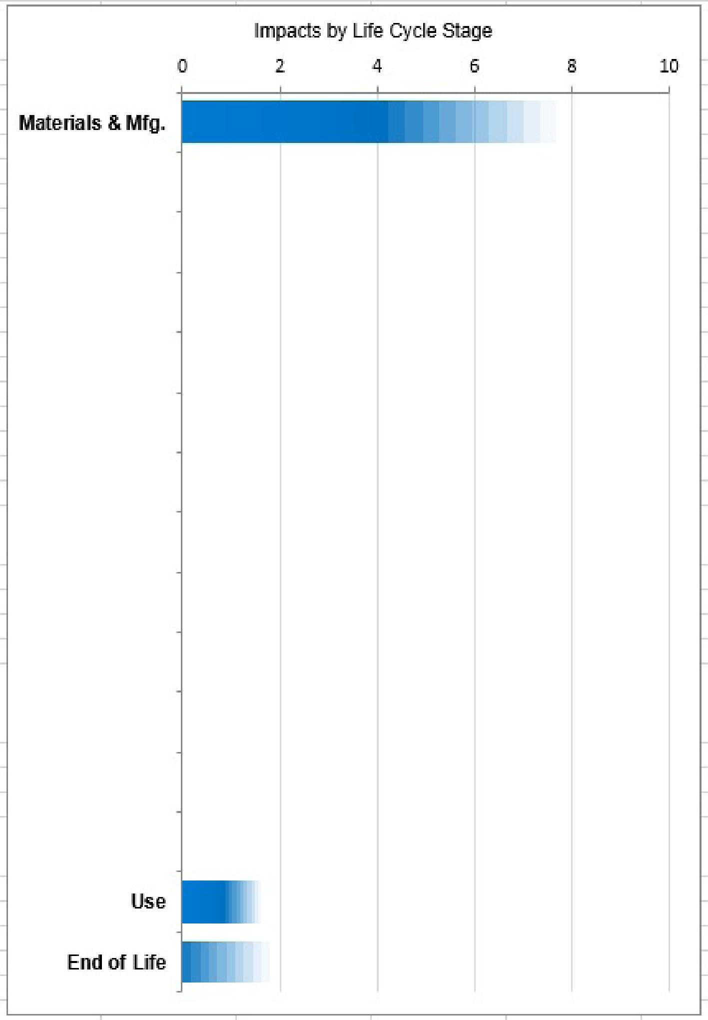
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPP	2,76	0,639	1,00	30%	Not sure whether	1,767165
Extruding	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
PP incineration with electricity	1,31	0,639	1,00	100%		0,839662
Pet trims incineration with electricity	1,24	0,036	1,00	100%		0,04457
Silicone rubber incineration with electricity	0,72	0,022	1,00	100%		0,01558
Landfill	0,00	0,782	1,00	70%		0





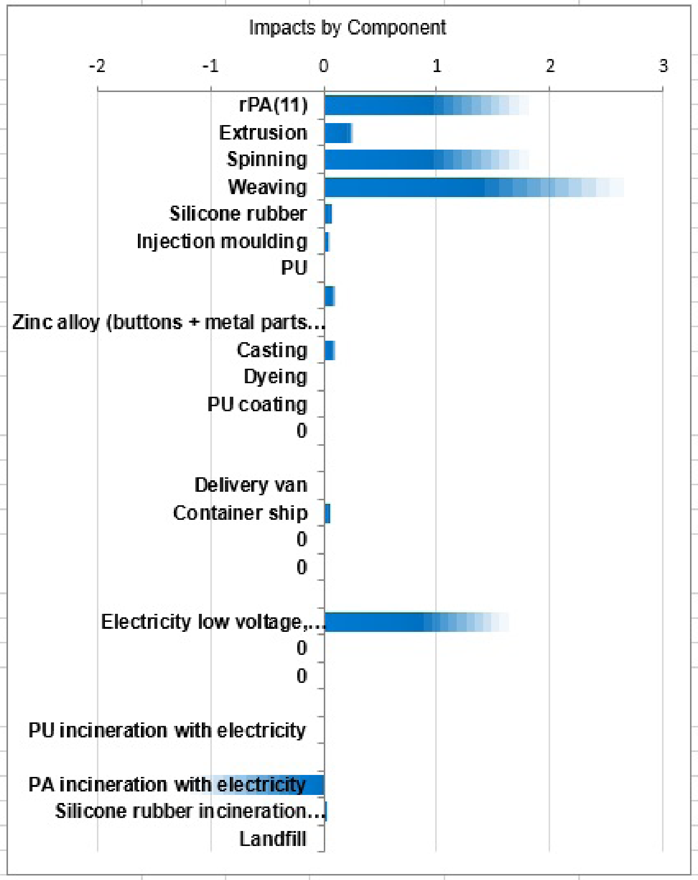
Desig Main material rPA(11)
(Nam rPA(11)

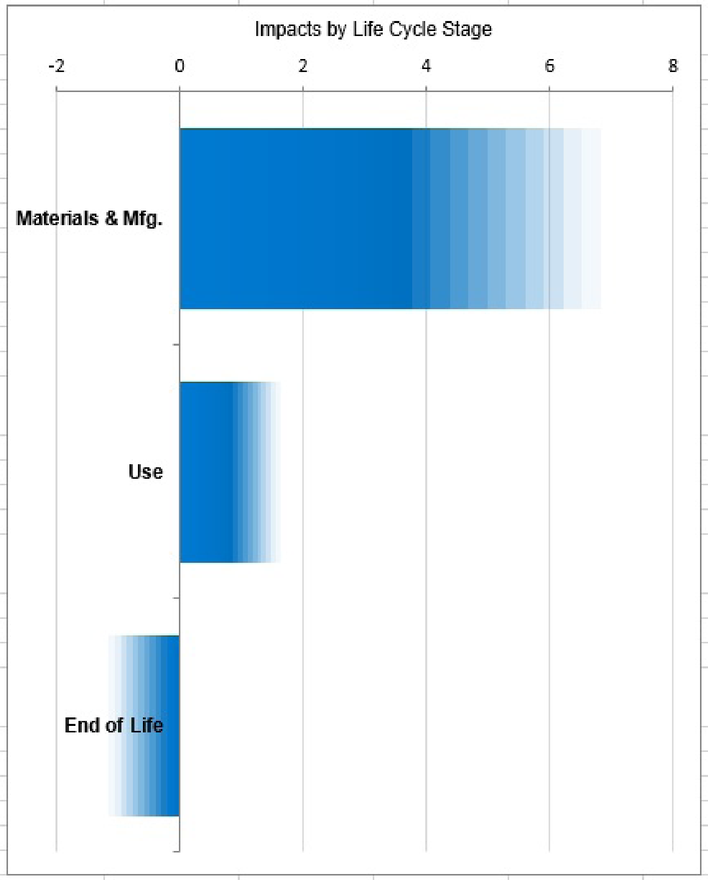
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPA(11)	2,17	0,639	1,00	30%	Not sure whether	1,39035
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	30%		0,076839
Zinc alloy (buttons + metal parts of zippers)	0,00	0,085	1,00	30%	Assumption on th	0
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

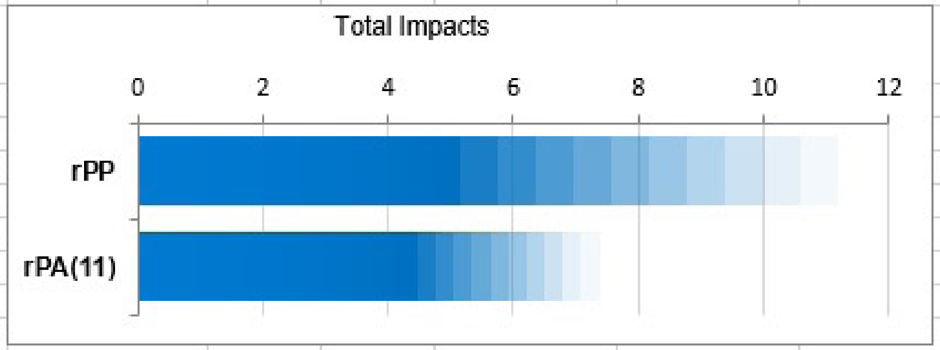
End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	70%	(Use this column t	0
Pet trims incineration with electricity	1,24	0,036	1,00	20%		
PA incineration with electricity	-1,08	0,639	1,00	70%		-0,688247
Silicone rubber incineration with electricity	0,72	0,022	1,00	70%		0,01558
Landfill	0,00	0,782	1,00	30%		0





Comparison

rPP	
rPA(11)	



Desig	Main material Recycled PET
(Nam	rPET

Manufacturing

	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	2,13	0,639	1,00	30%	Not sure whether	1,364541
Extruding	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport

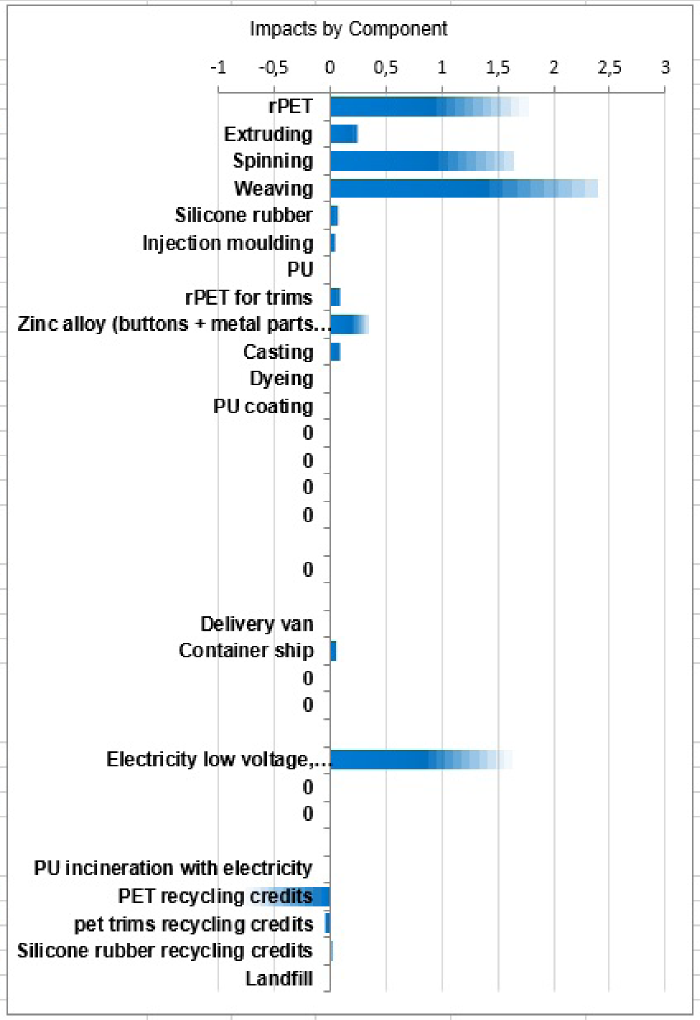
	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

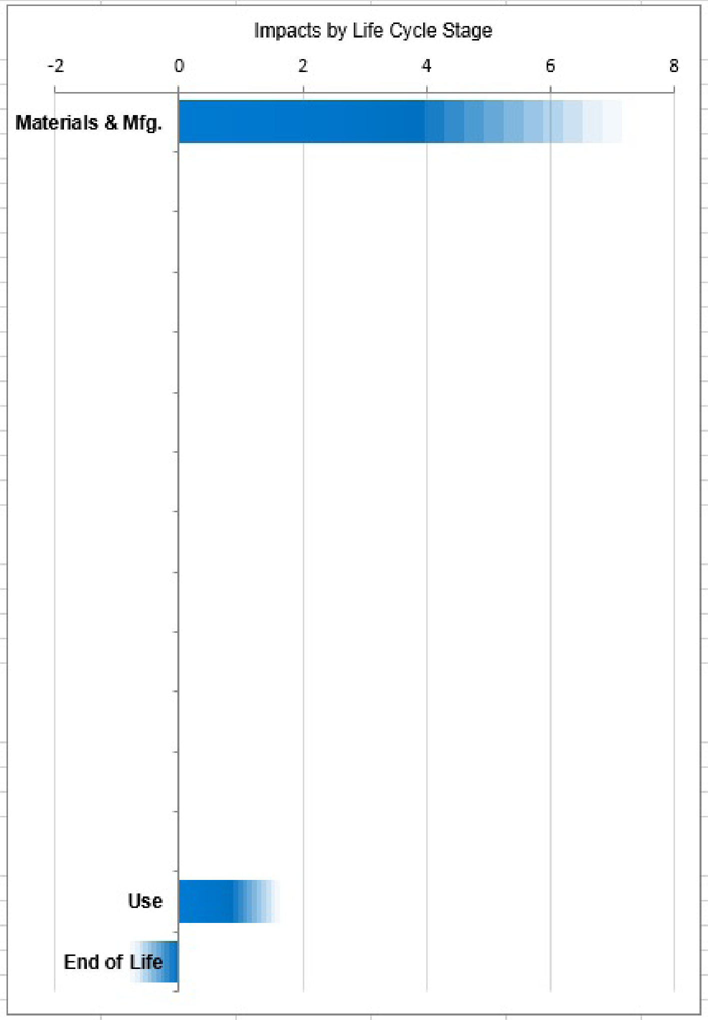
Use

	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life

	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
PET recycling credits	-0,66	0,639	1,00	80%		-0,418861
pet trims recycling credits	-0,66	0,036	1,00	80%		-0,023587
Silicone rubber recycling credits	0,14	0,022	1,00	80%	instead of silicone	0,003124
Landfill	0,00	0,782	1,00	80%		0





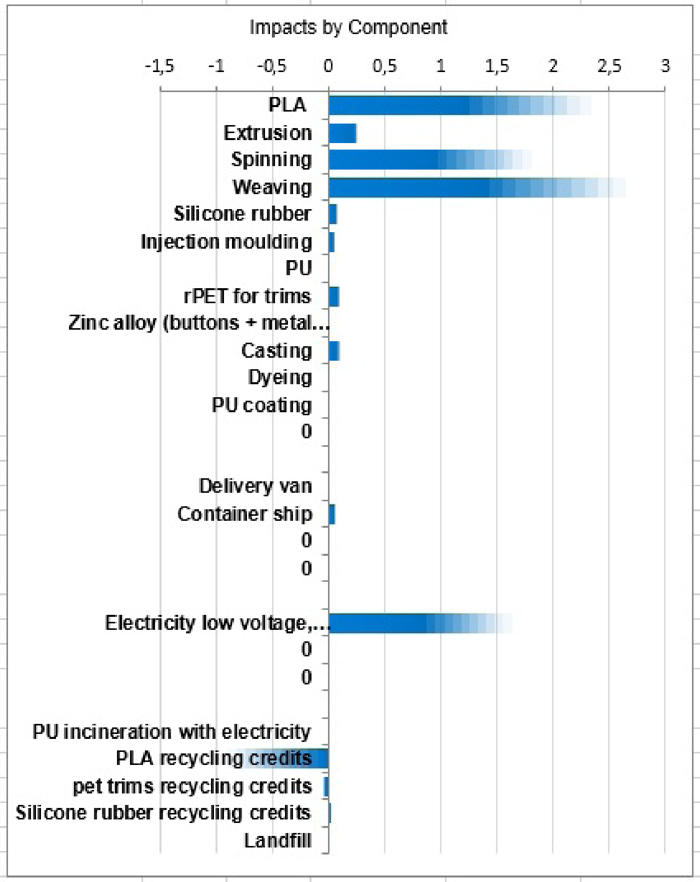
Desig Main material PLA
(Nam PLA

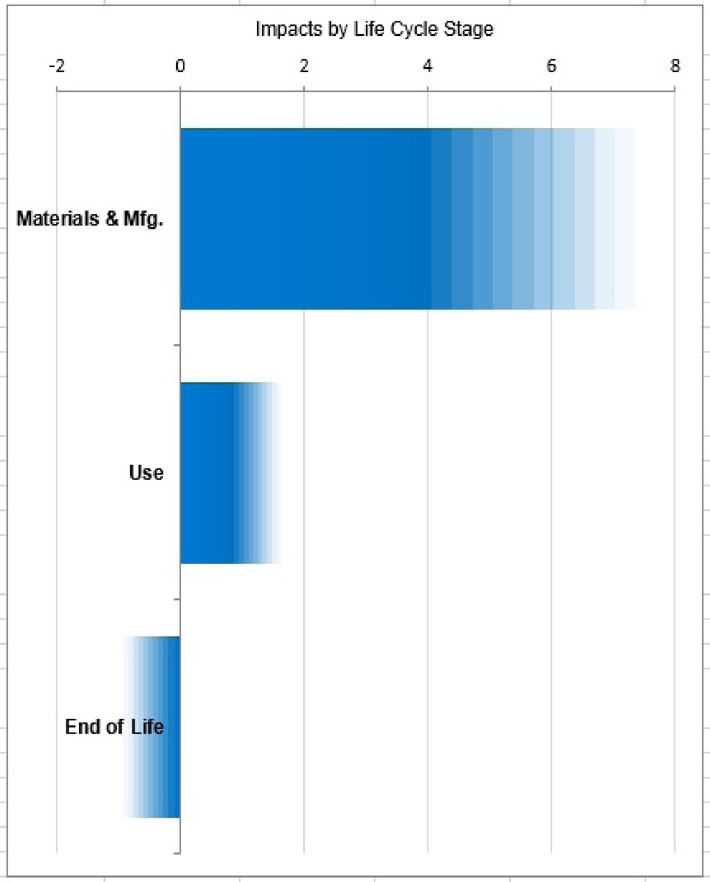
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PLA	2,82	0,639	1,00	30%	Not sure whether	1,802179
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	0,00	0,085	1,00	30%	Assumption on th	0
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

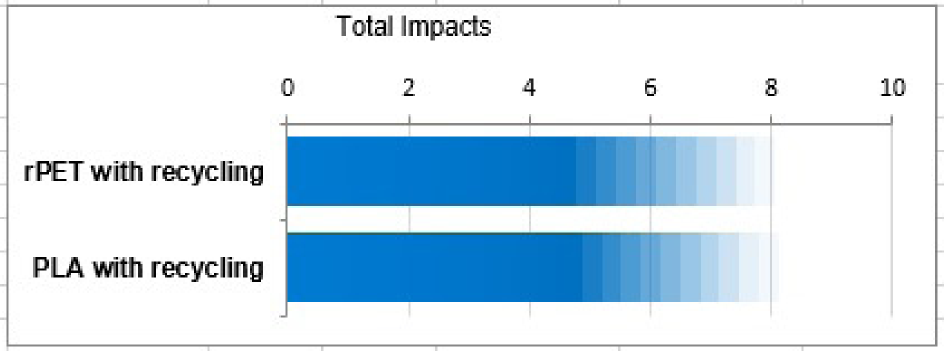
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	100%	(Use this column t	0
PLA recycling credits	-0,78	0,639	1,00	80%	assumption of prc	-0,496139
pet trims recycling credits	-0,66	0,036	1,00	80%		-0,023587
Silicone rubber recycling credits	0,14	0,022	1,00	80%		0,003124
Landfill	0,00	0,782	1,00	80%		0





Comparison

rPET with recycling
PLA with recycling



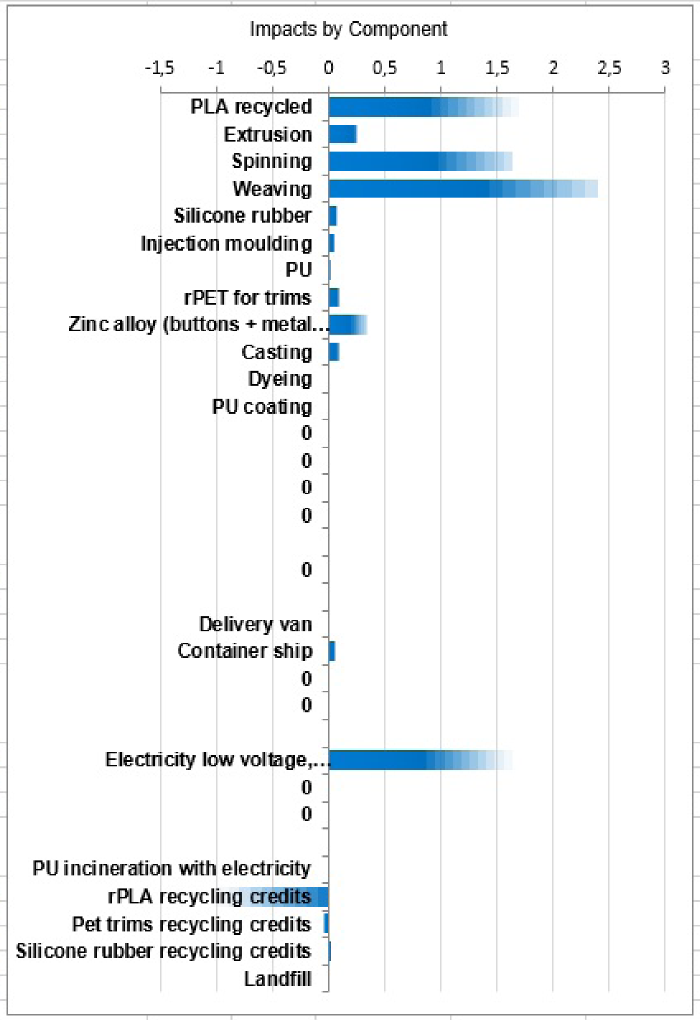
Desig Main material Recycled PLA
(Nam rPLA

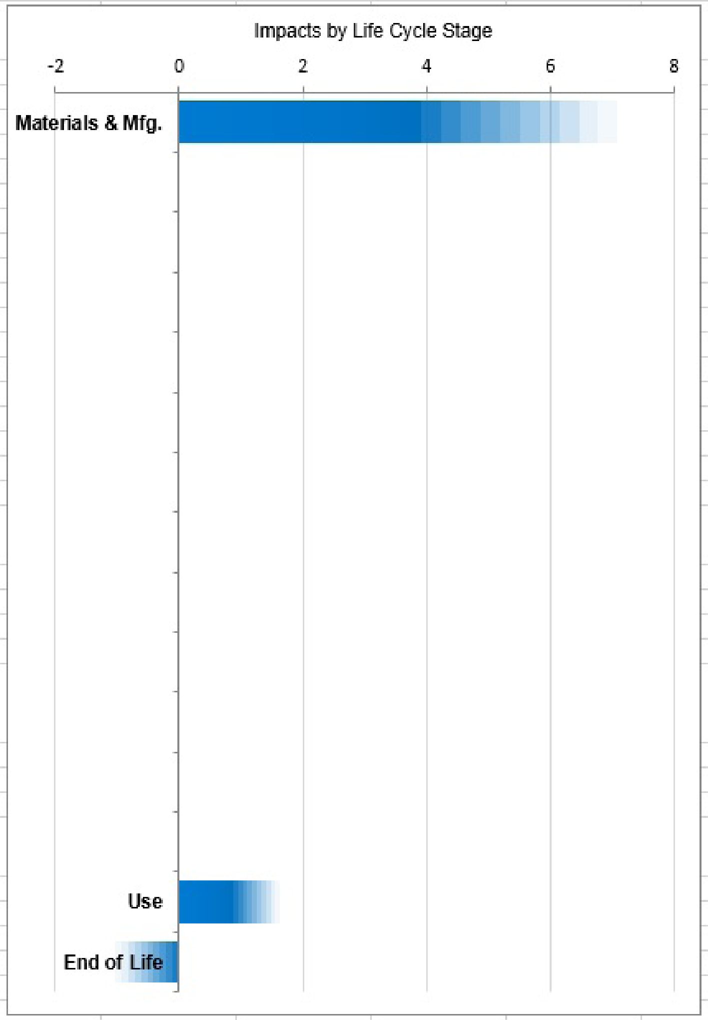
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PLA recycled	2,04	0,639	1,00	30%	Not sure whether	1,30604
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%	Not sure about m	0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
rPLA recycling credits	-0,78	0,639	1,00	100%		-0,496139
Pet trims recycling credits	-0,66	0,036	1,00	100%		-0,023587
Silicone rubber recycling credits	0,14	0,022	1,00	100%		0,003124
Landfill	0,00	0,782	1,00	30%		0





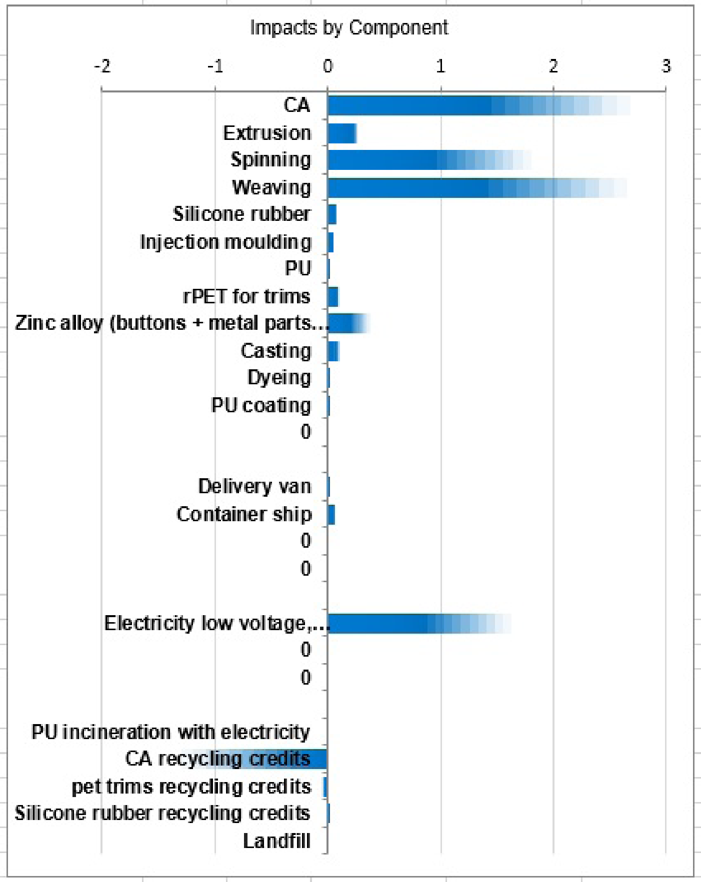
Desig	Main material Cellulose Acetate
(Nam	CA

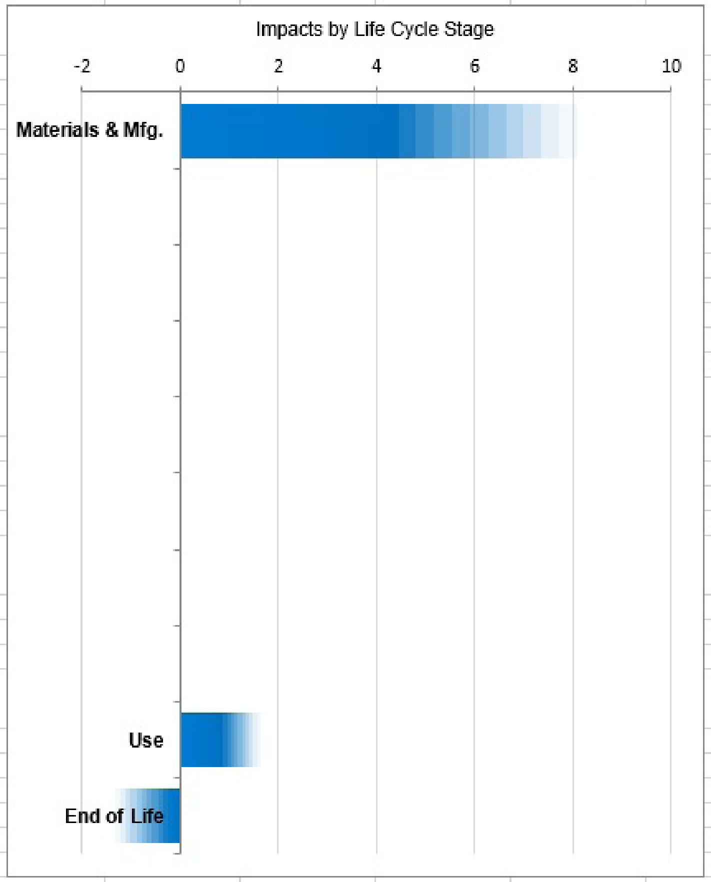
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
CA	3,23	0,639	1,00	30%	Not sure whether	2,064742
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

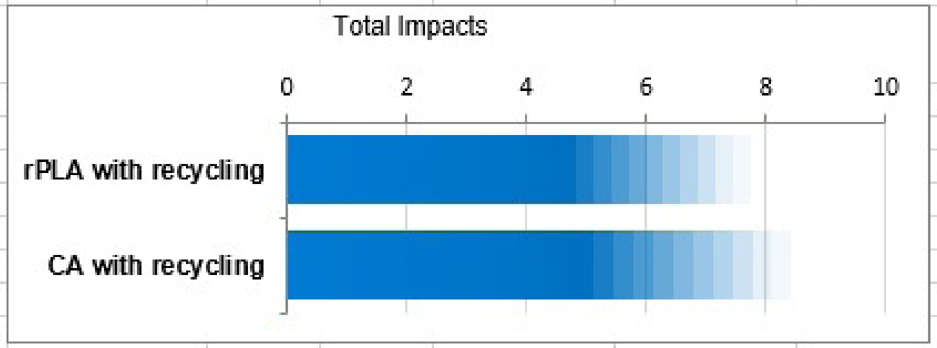
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	70%	(Use this column t	0
CA recycling credits	-1,19	0,639	1,00	70%	assumption of prc	-0,762143
pet trims recycling credits	-0,66	0,036	1,00	70%		-0,023587
Silicone rubber recycling credits	0,14	0,022	1,00	70%		0,003124
Landfill	0,00	0,782	1,00	30%		0





Comparison

rPLA with recycling
CA with recycling



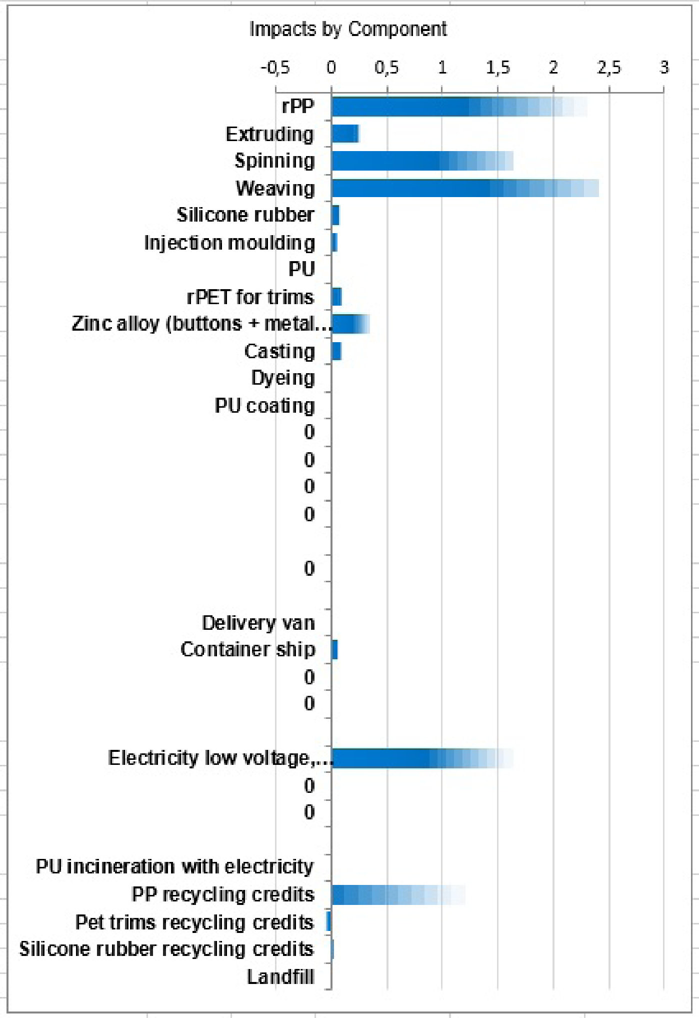
Desig	Main material rPP
(Nam	rPP

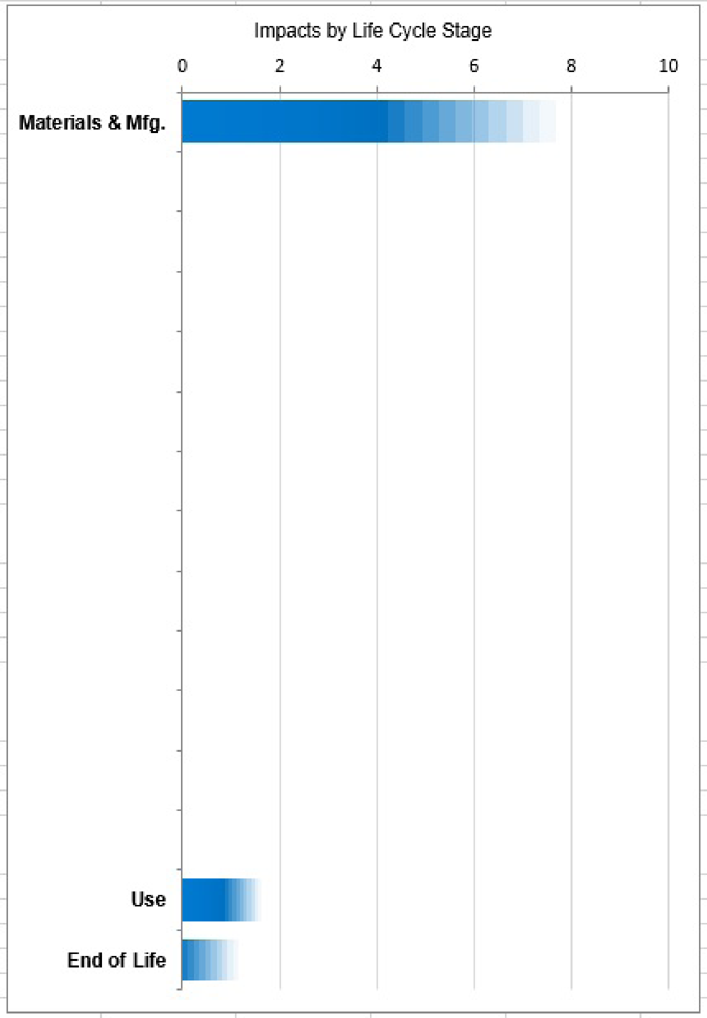
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPP	2,76	0,639	1,00	30%	Not sure whether	1,767165
Extruding	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
PP recycling credits	0,94	0,639	1,00	100%		0,601544
Pet trims recycling credits	-0,66	0,036	1,00	100%		-0,023587
Silicone rubber recycling credits	0,14	0,022	1,00	100%		0,003124
Landfill	0,00	0,782	1,00	70%		0





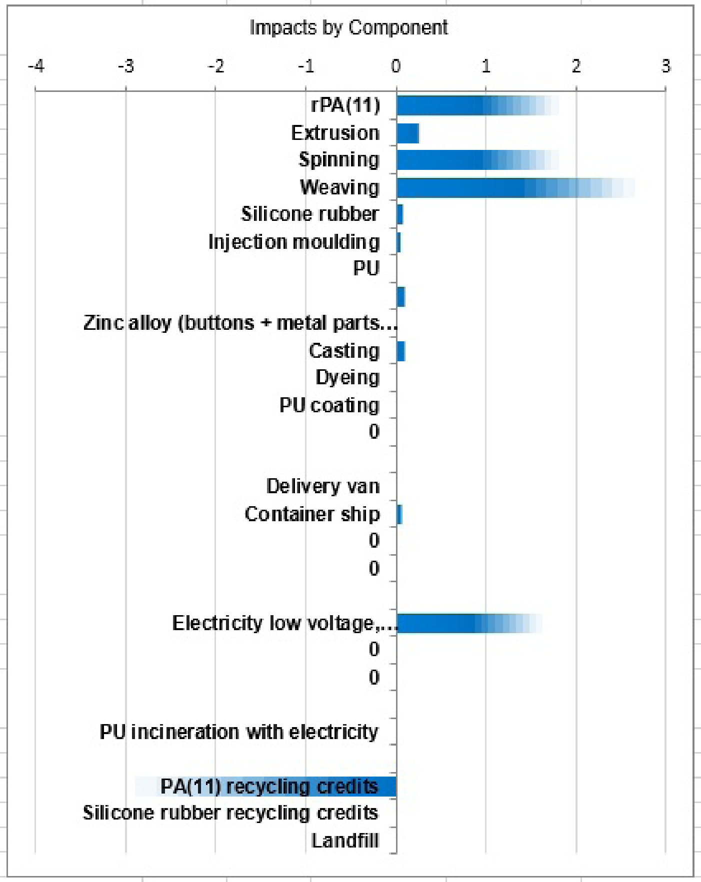
Desig Main material rPA(11)
(Nam rPA(11)

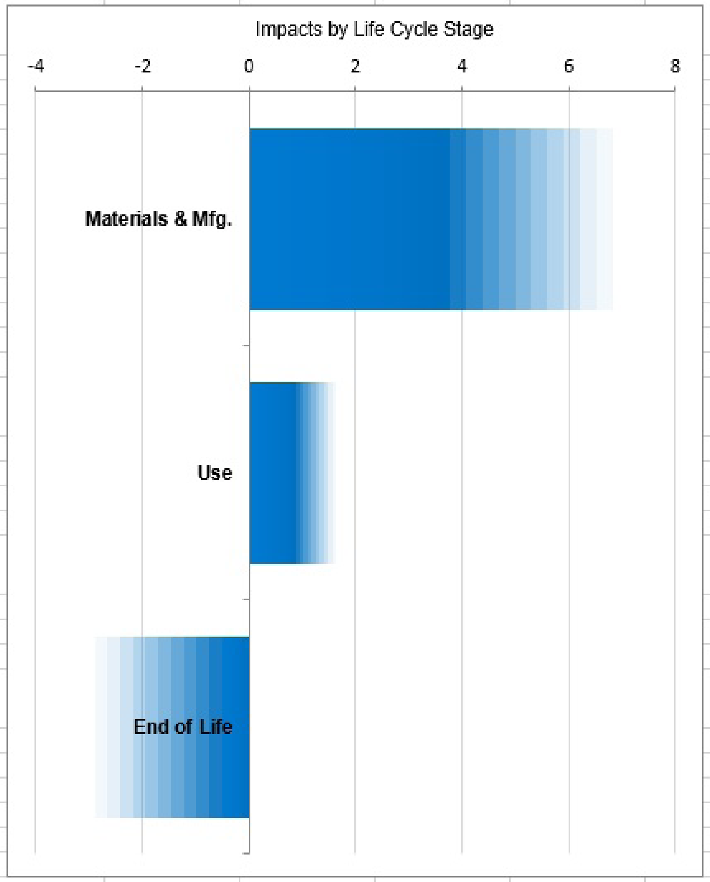
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPA(11)	2,17	0,639	1,00	30%	Not sure whether	1,39035
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	30%		0,076839
Zinc alloy (buttons + metal parts of zippers)	0,00	0,085	1,00	30%	Assumption on th	0
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

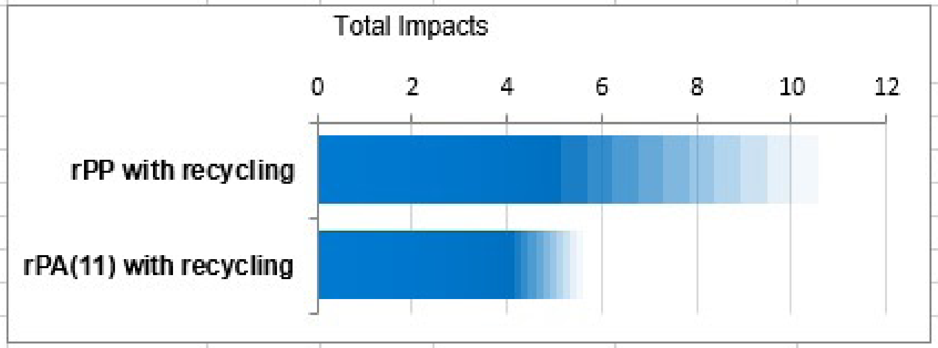
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	70%	(Use this column f	0
pet trims recycling credits	-0,66	0,036	1,00	30%		
PA(11) recycling credits	-2,67	0,639	1,00	70%		-1,706762
Silicone rubber recycling credits	0,14	0,022	1,00	70%		0,003124
Landfill	0,00	0,782	1,00	30%		0





Comparison

rPP with recycling
rPA(11) with recycling



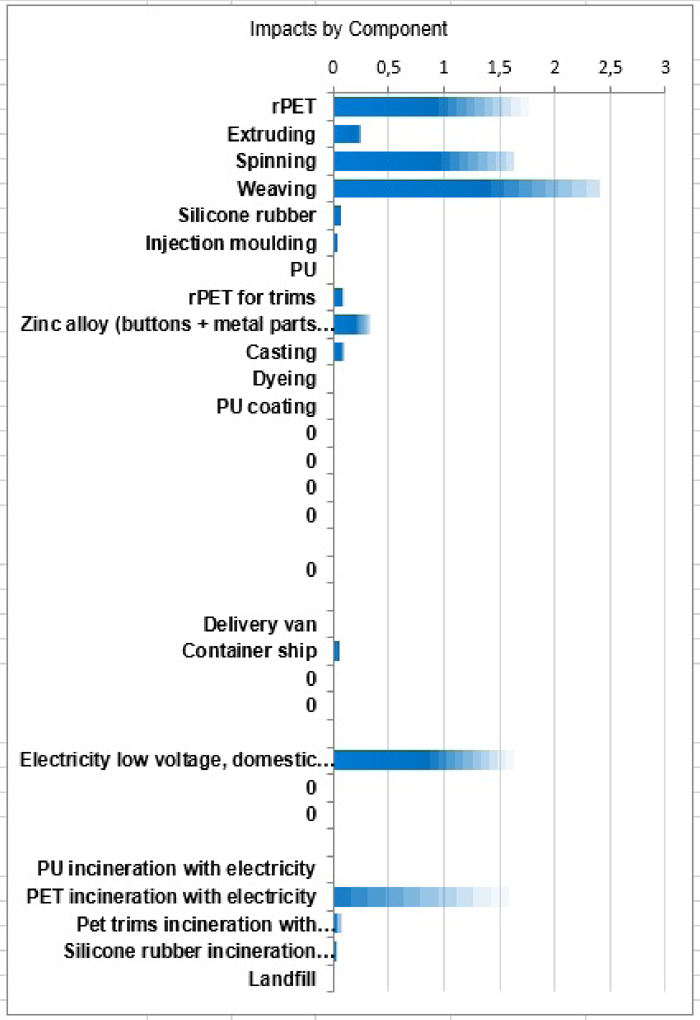
Desig Main material Recycled PET
(Nam rPET

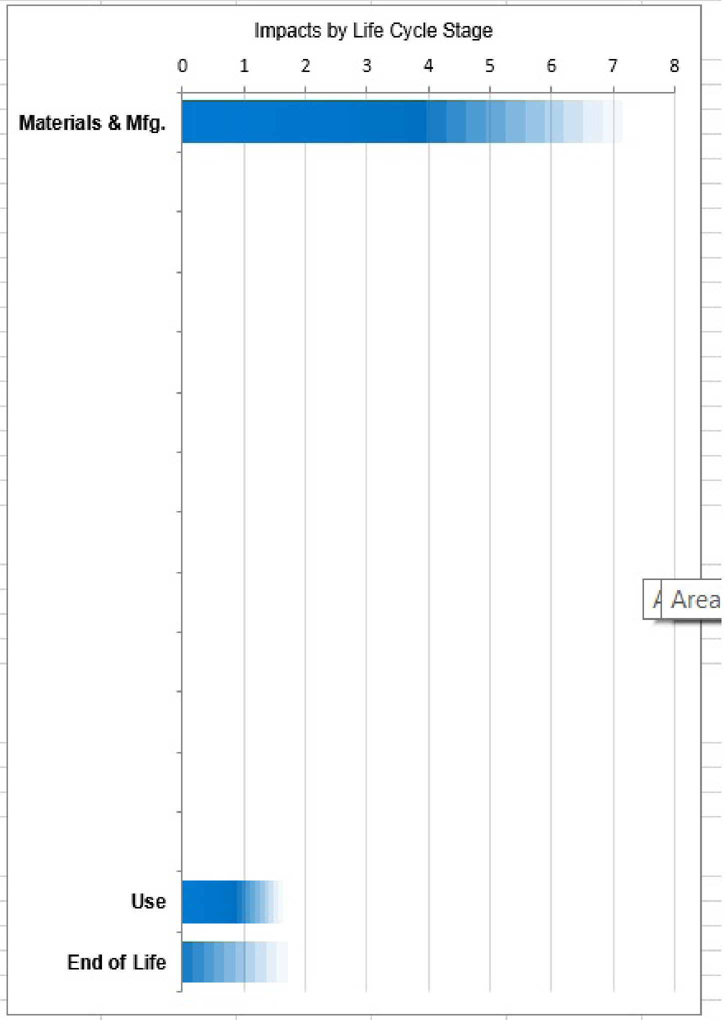
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	2,13	0,639	1,00	30%	Not sure whether	1,364541
Extruding	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
PET incineration with electricity	1,24	0,639	1,00	100%		0,791484
Pet trims incineration with electricity	1,24	0,036	1,00	100%		0,04457
Silicone rubber incineration with electricity	0,72	0,022	1,00	100%		0,01558
Landfill	0,00	0,782	1,00	70%		0





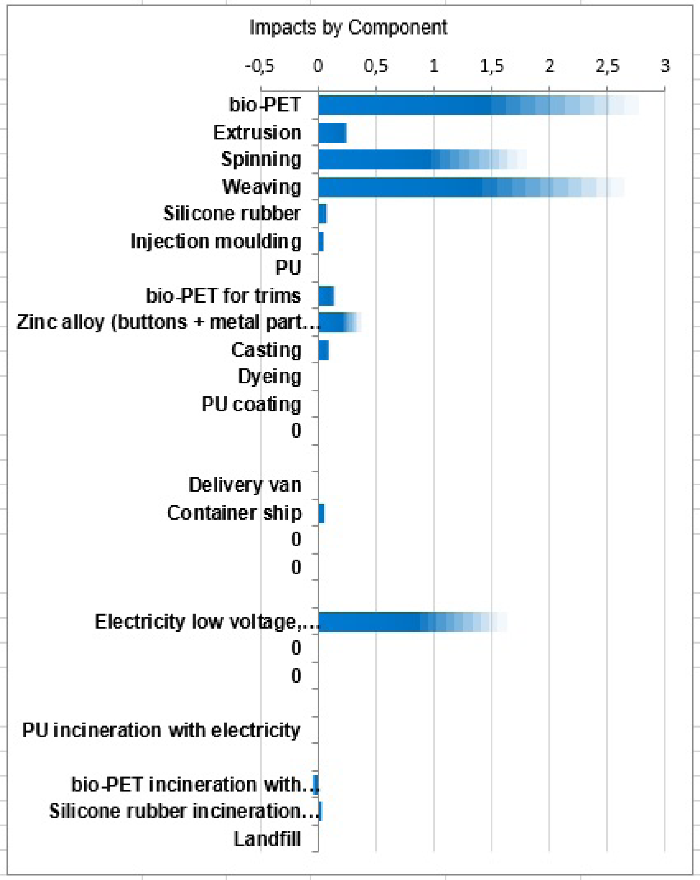
Desig	Main material bio-PET
(Nam	bio-PET

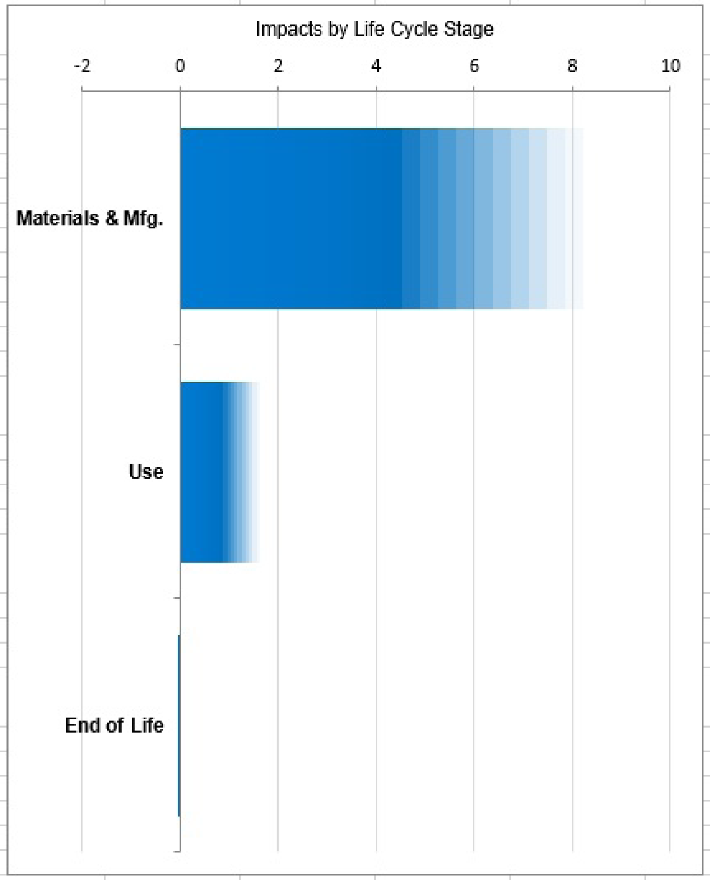
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
bio-PET	3,34	0,639	1,00	30%	Not sure whether	2,133566
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
bio-PET for trims	3,34	0,036	1,00	20%	Not sure whether	0,120145
Zinc alloy (buttons + metal part of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

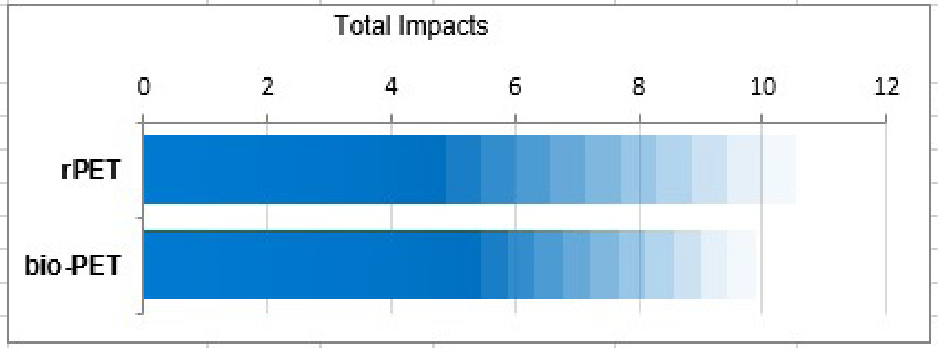
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	70%	(Use this column t	0
bio-PET incineration with electricity	-0,70	0,036	1,00	70%		-0,025192
Silicone rubber incineration with electricity	0,72	0,022	1,00	70%		0,01558
Landfill	0,00	0,782	1,00	30%		0





Comparison

	rPET
	bio-PET



Desig	Main material Recycled PET						
(Nam	rPET						

Manufacturing

	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	2,13	0,639	1,00	30%	Not sure whether	1,364541
Extruding	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport

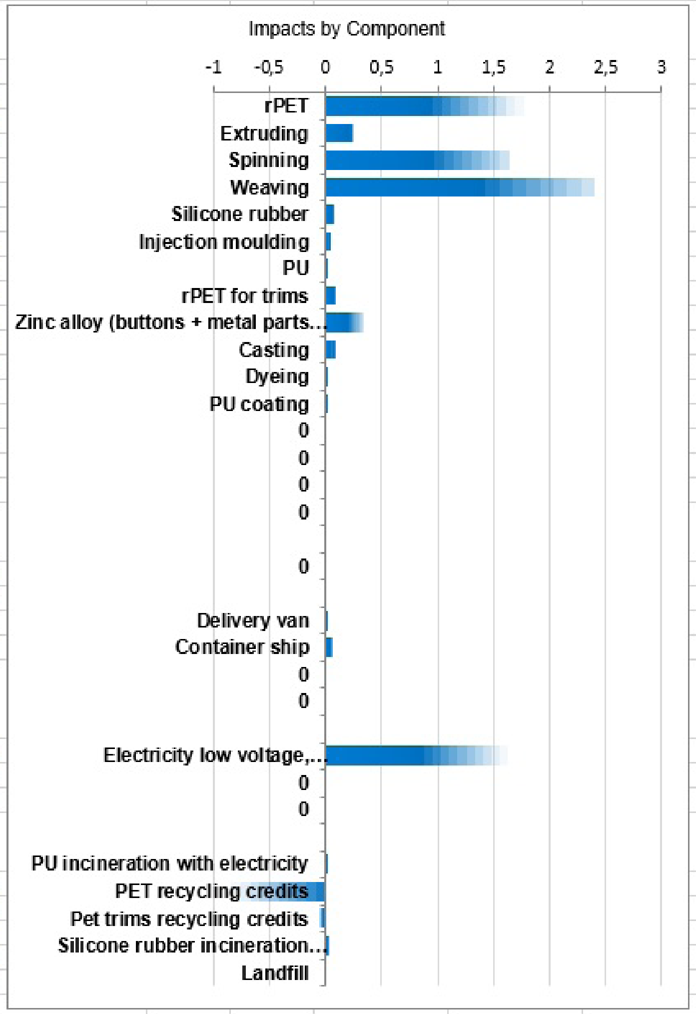
	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

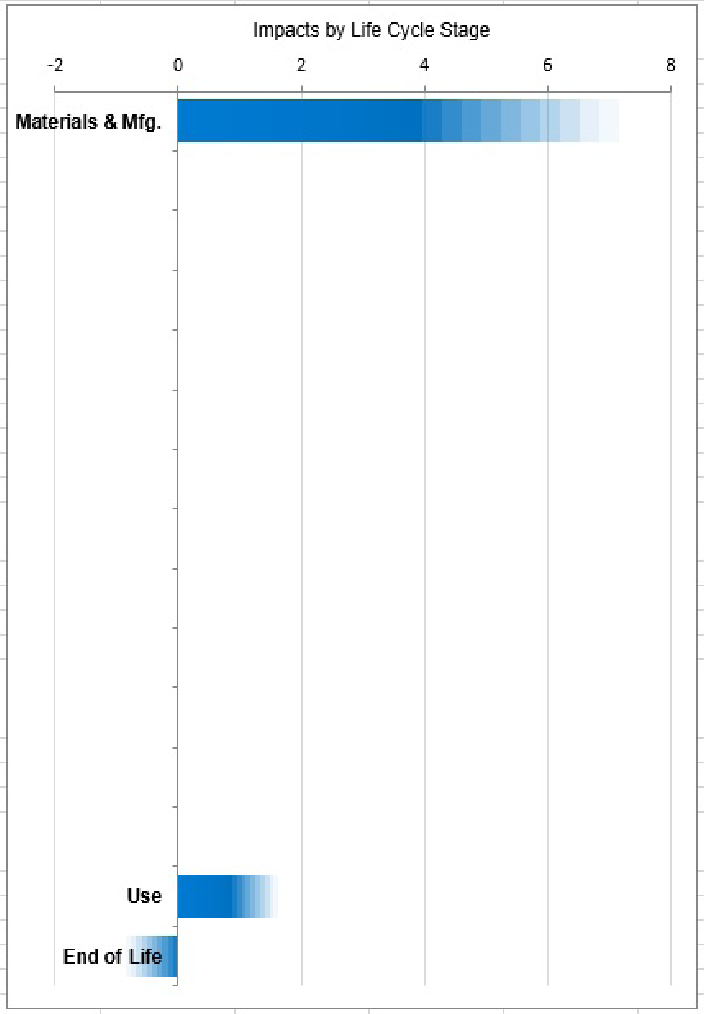
Use

	Eco-intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life

	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column t	0,000213
PET recycling credits	-0,66	0,639	1,00	100%		-0,418861
Pet trims recycling credits	-0,66	0,036	1,00	100%		-0,023587
Silicone rubber incineration with electricity	0,72	0,022	1,00	100%		0,01558
Landfill	0,00	0,782	1,00	70%		0





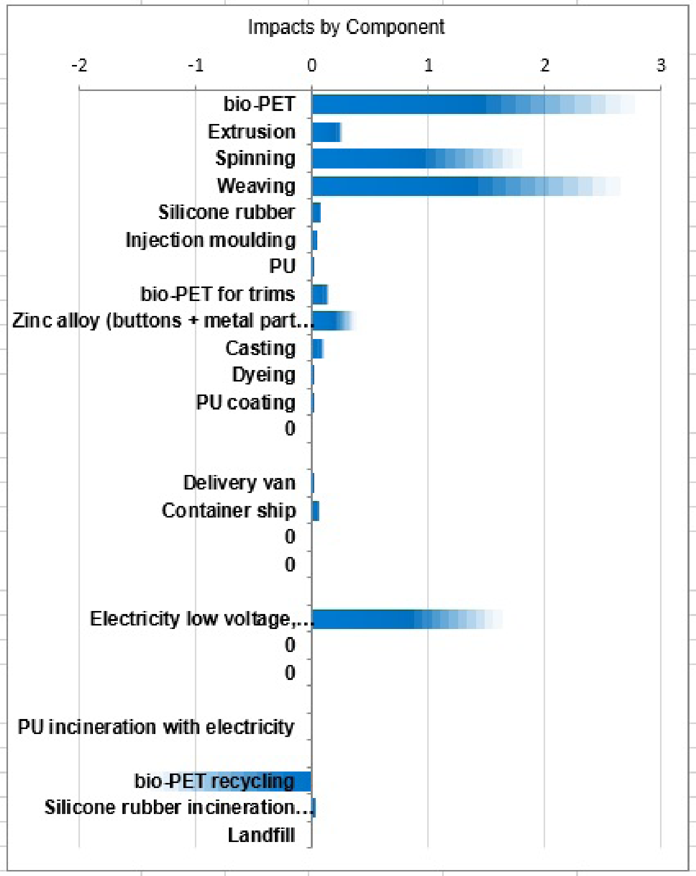
Desig Main material bio-PET
(Nam bio-PET

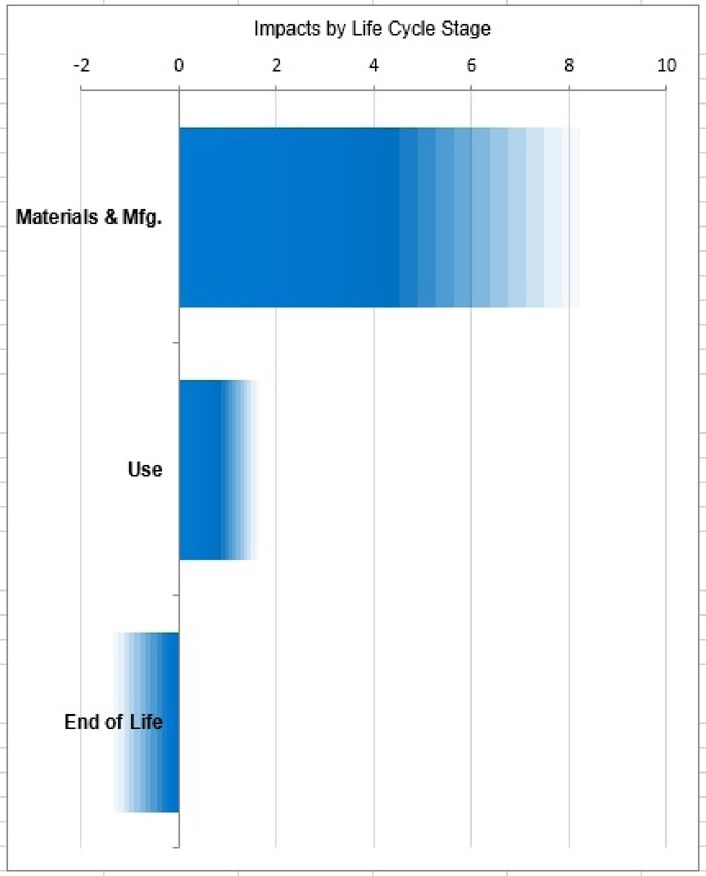
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
bio-PET	3,34	0,639	1,00	30%	Not sure whether	2,133566
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
bio-PET for trims	3,34	0,036	1,00	20%	Not sure whether	0,120145
Zinc alloy (buttons + metal part of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

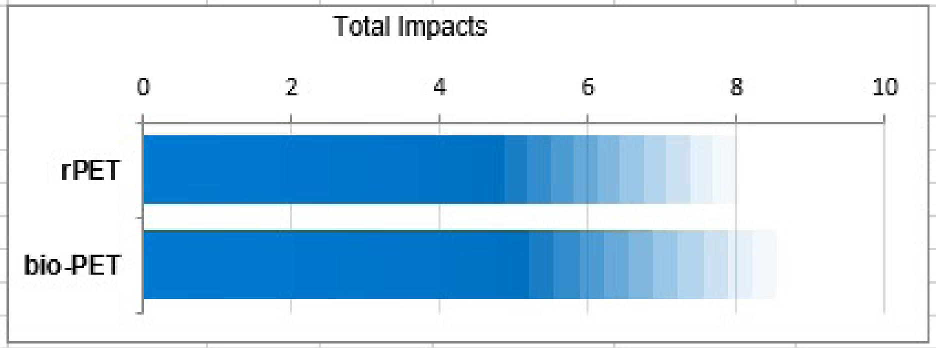
End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	0,00	70%	(Use this column t	0
bio-PET recycling	-1,20	0,675	1,00	70%		-0,81233
Silicone rubber incineration with electricity	0,72	0,022	1,00	70%		0,01558
Landfill	0,00	0,782	1,00	30%		0





Comparison

rPET
bio-PET



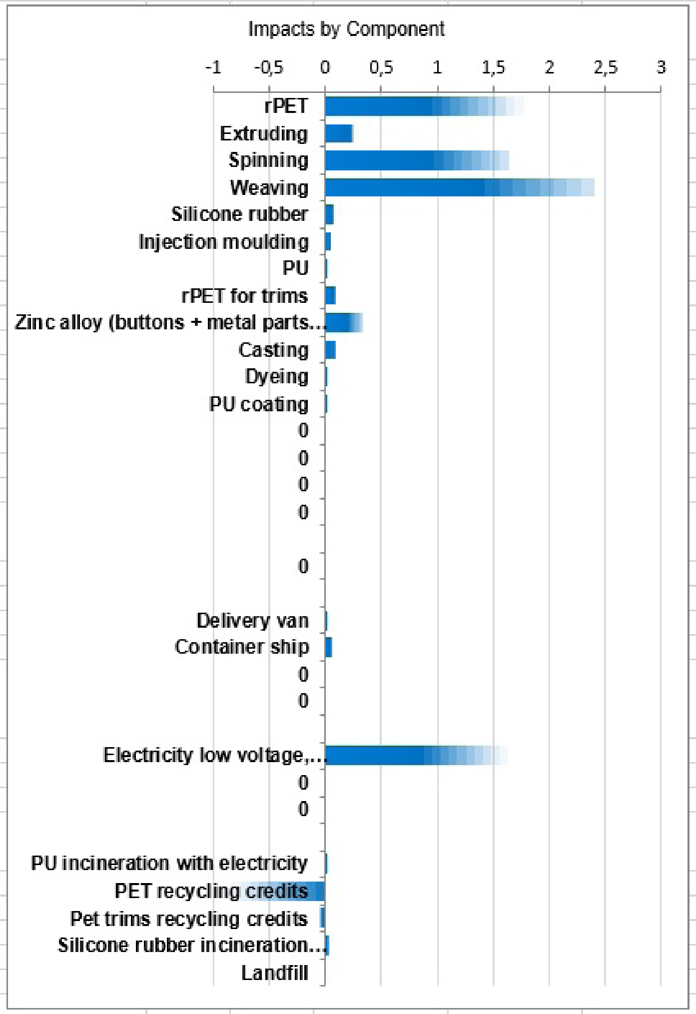
Desig	Main material Recycled PET						
(Nam	rPET						

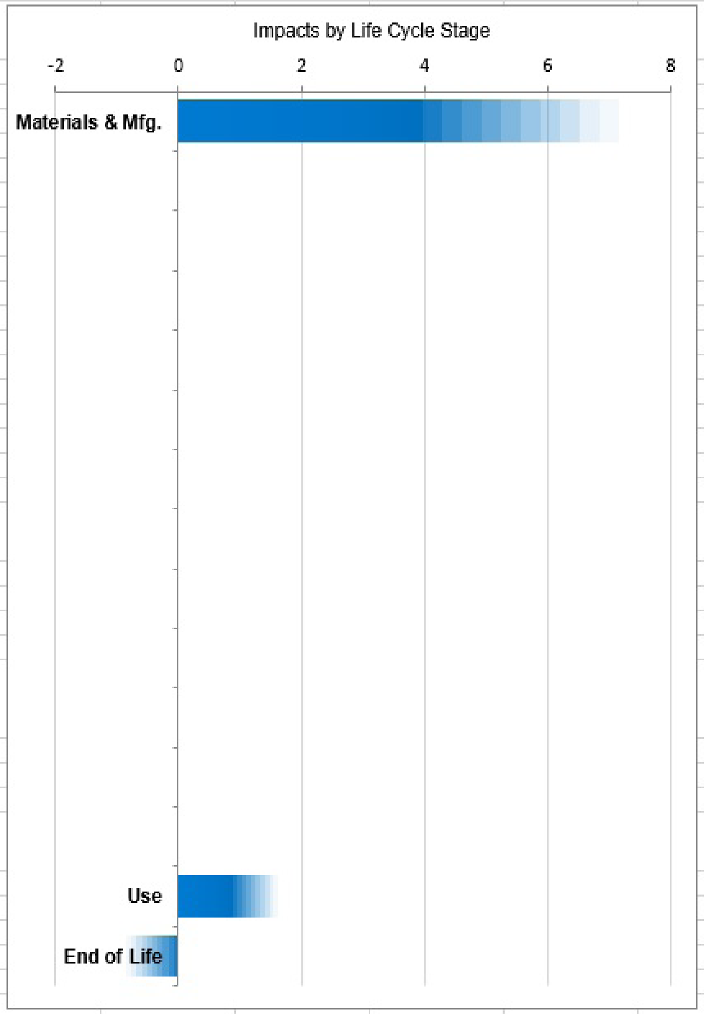
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	2,13	0,639	1,00	30%	Not sure whether	1,364541
Extruding	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
Zinc alloy (buttons + metal parts of zippers)	3,44	0,085	1,00	30%	Assumption on th	0,292306
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0
						0
						0
						0
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		3,89E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	100%	(Use this column f	0,000213
PET recycling credits	-0,66	0,639	1,00	100%		-0,418861
Pet trims recycling credits	-0,66	0,036	1,00	100%		-0,023587
Silicone rubber incineration with electricity	0,72	0,022	1,00	100%		0,01558
Landfill	0,00	0,782	1,00	70%		0





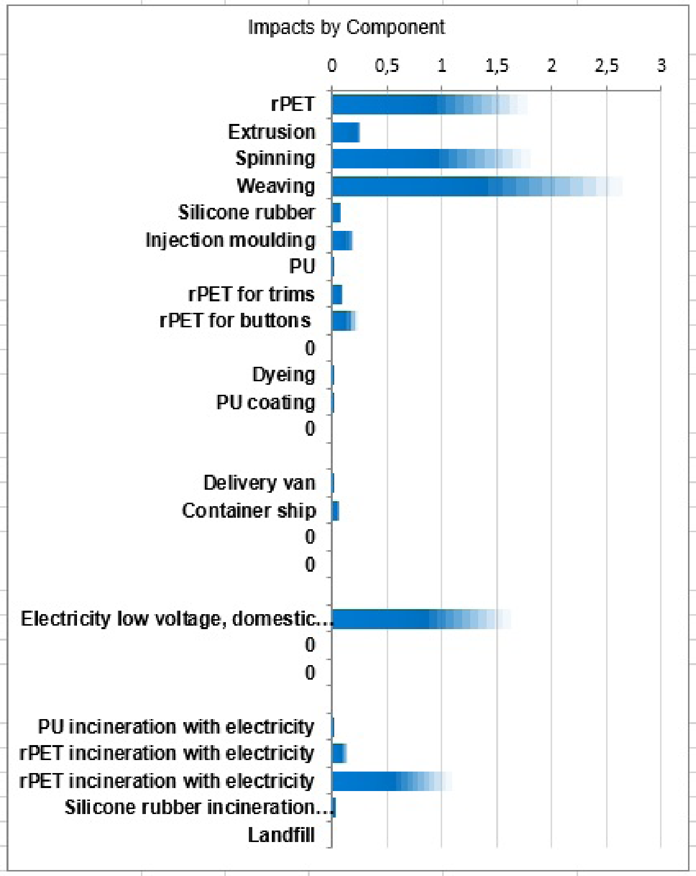
Desig everything in rPET
(Nam rPET everything

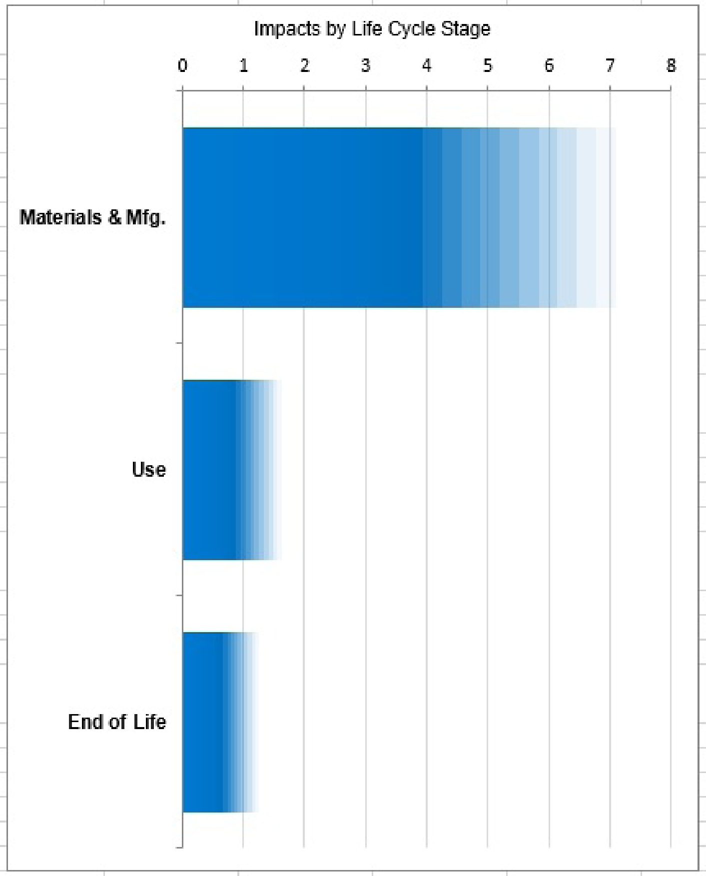
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	2,13	0,639	1,00	30%	Not sure whether	1,364541
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,107	1,00	20%		0,161942
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	2,13	0,036	1,00	20%	Not sure whether	0,076839
rPET for buttons	2,13	0,085	1,00	30%	Assumption on th	0,181427
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

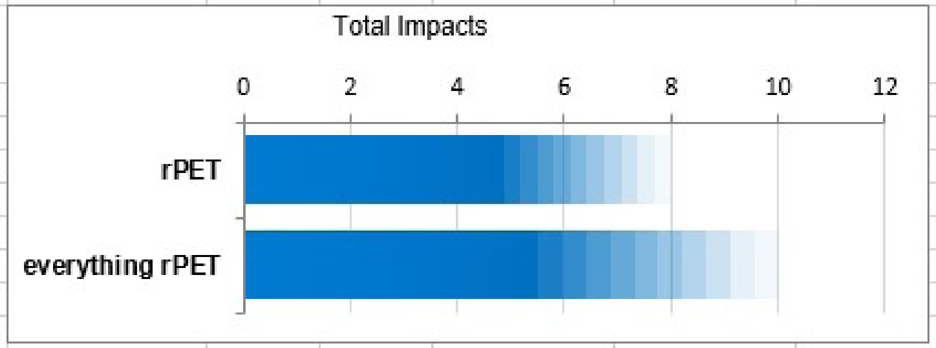
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	40%	(Use this column t	0,000213
rPET incineration with electricity	1,24	0,085	1,00	30%		0,105234
rPET incineration with electricity	1,24	0,675	1,00	30%		0,836054
Silicone rubber incineration with electricity	0,72	0,022	1,00	30%		0,01558
Landfill	0,00	0,782	1,00	30%		0





Comparison

rPET
everything rPET



A Eco-costs

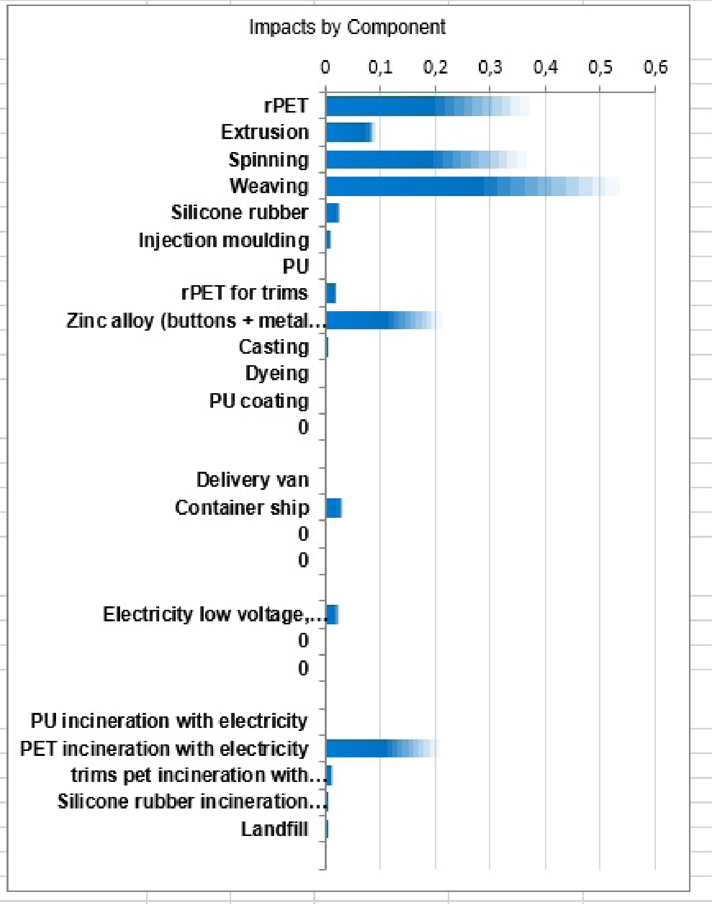
Desig Main material Recycled PET
(Nam rPET

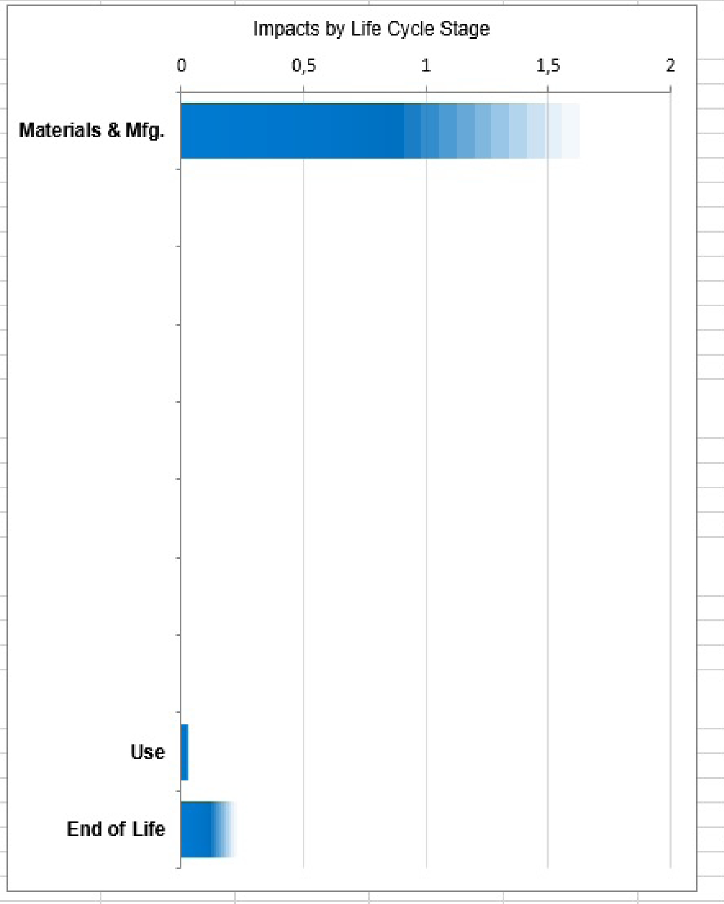
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	0,45	0,639	1,00	30%	Not sure whether	0,285698
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%	Assumption	0,00016
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	30%	**Multiple db optio**	4,31E-05
PET incineration with electricity	0,25	0,639	1,00	30%		0,159915
trims pet incineration with electricity	0,25	0,036	1,00	30%		0,009005
Silicone rubber incineration with electricity	0,15	0,022	1,00	30%		0,003148
Landfill	0,00	0,782	1,00	20%		0,001073
						0





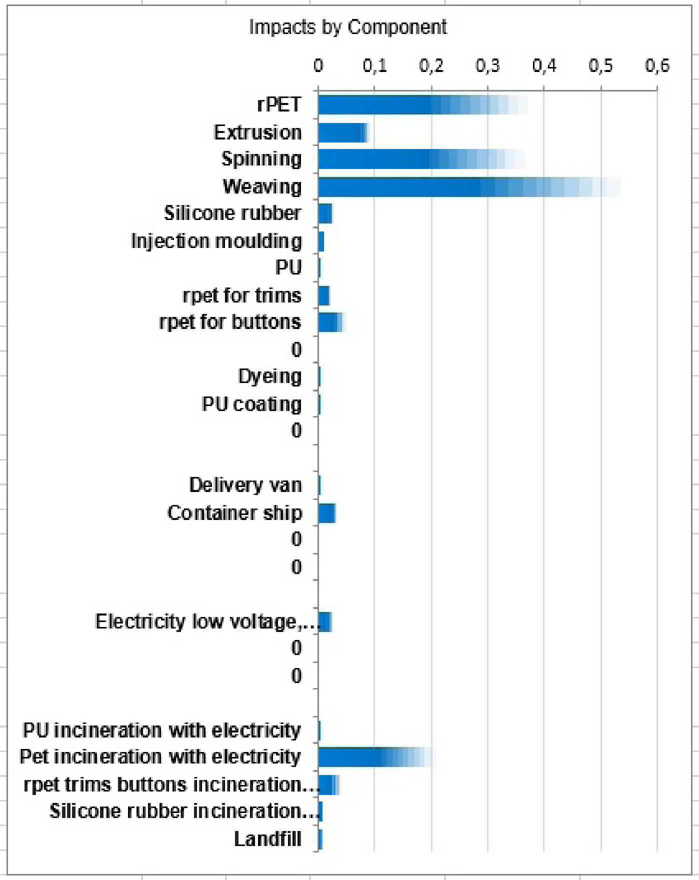
Desig	everything in rPET
(Nam	everything in rPET

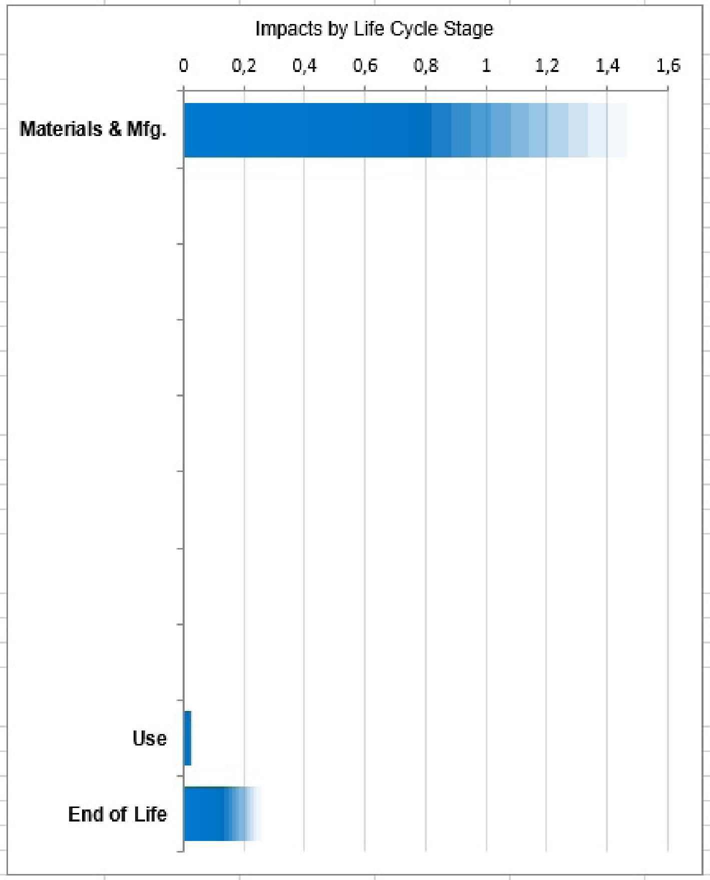
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	0,45	0,639	1,00	30%	Not sure whether	0,285698
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rpet for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
rpet for buttons	0,45	0,085	1,00	30%	Assumption on th	0,037986
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%		0,00016
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

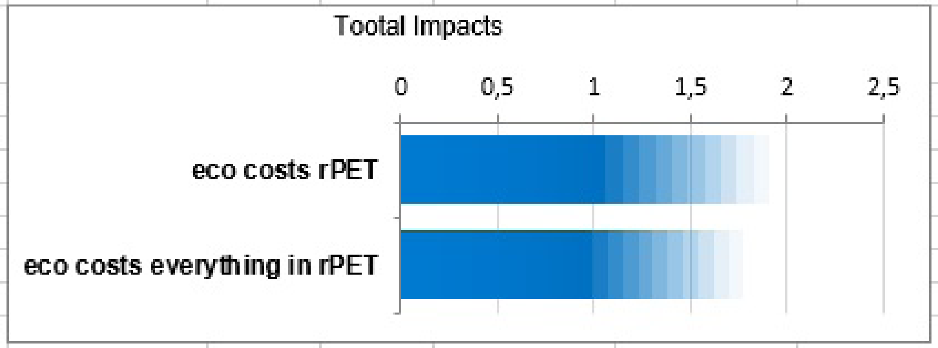
End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	30%	**Multiple db optio**	4,31E-05
Pet incineration with electricity	0,25	0,639	1,00	30%		0,159915
rpet trims buttons incineration with electricity	0,25	0,121	1,00	30%		0,030267
Silicone rubber incineration with electricity	0,15	0,022	1,00	30%		0,003148
Landfill	0,00	0,782	1,00	20%		0,001073





Comparison

eco costs rPET
eco costs everything in rPET



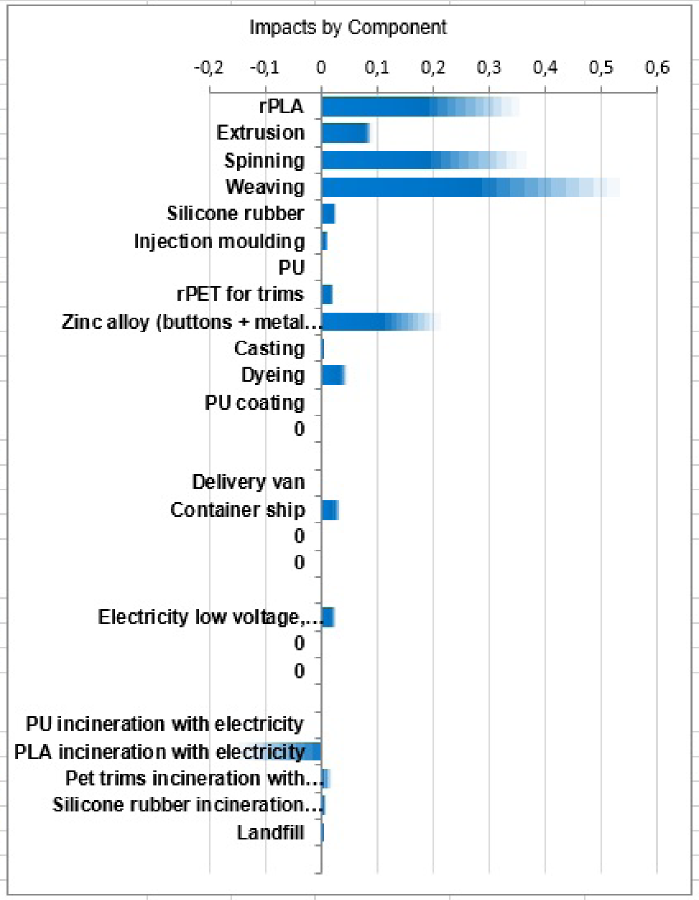
Desig Main material Recycled PLA
(Nam rPLA

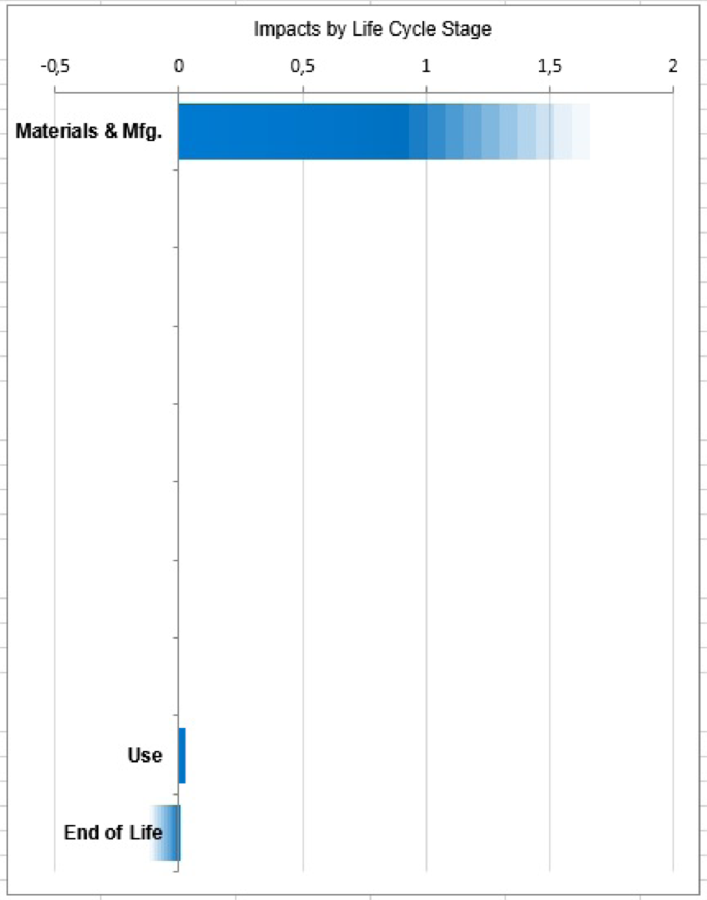
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPLA	0,43	0,639	1,00	30%	Not sure whether	0,273878
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,100	1,00	20%	Not sure about m	0,038718
PU coating	0,80	0,000	1,00	60%	Assumption becau	0,00016
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%	**Multiple db optio**	4,31E-05
PLA incineration with electricity	-0,12	0,639	1,00	100%		-0,0737
Pet trims incineration with electricity	0,25	0,036	1,00	100%		0,009005
Silicone rubber incineration with electricity	0,15	0,022	1,00	100%		0,003148
Landfill	0,00	0,782	1,00	70%		0,001073
						0





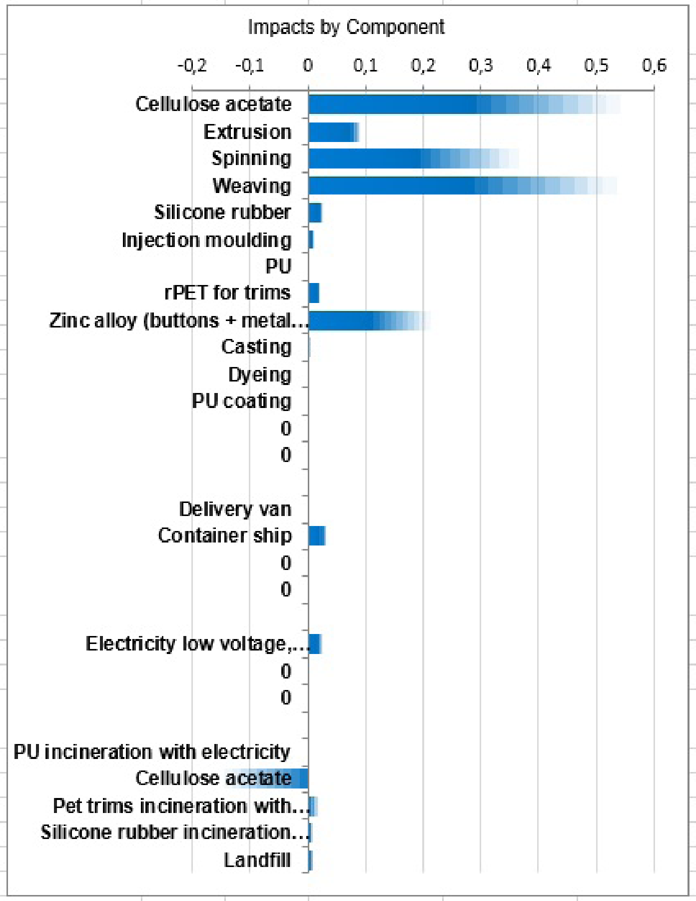
Desig Main material Cellulose Acetate
(Nam CA

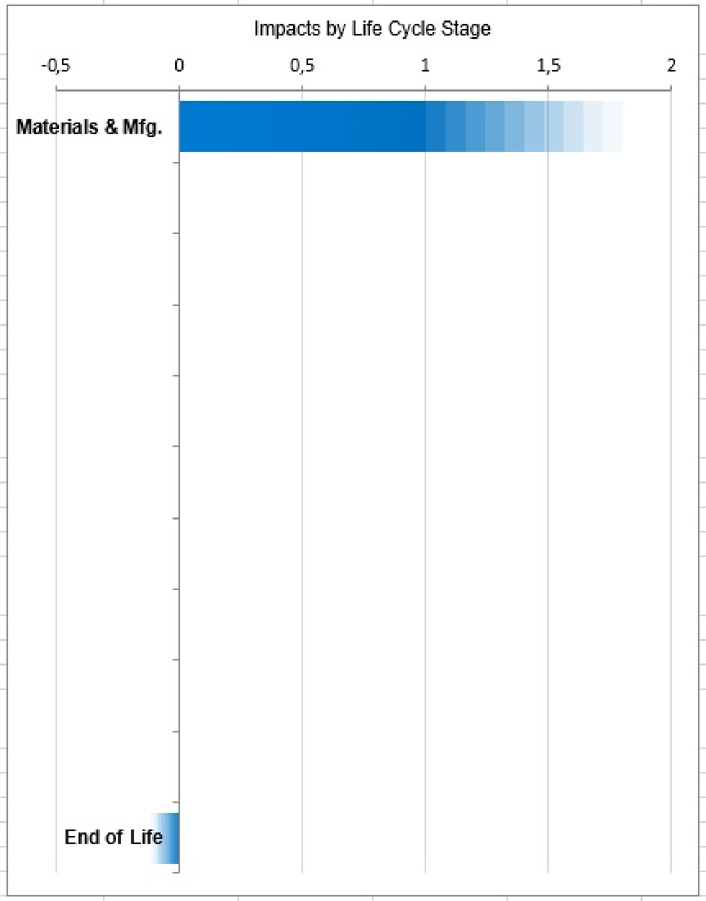
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Cellulose acetate	0,65	0,639	1,00	30%	Not sure whether	0,417171
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%		0,00016
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

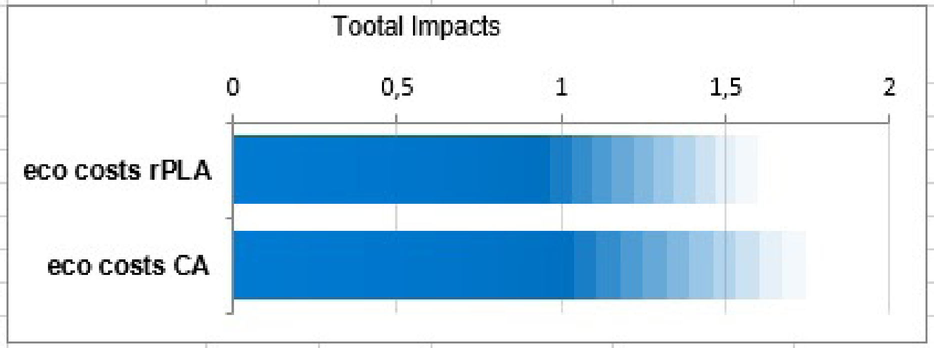
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%	**Multiple db optio**	4,31E-05
Cellulose acetate	-0,11	0,639	1,00	100%		-0,07231
Pet trims incineration with electricity	0,25	0,036	1,00	100%		0,009005
Silicone rubber incineration with electricity	0,15	0,022	1,00	100%		0,003148
Landfill	0,00	0,782	1,00	30%		0,001073





Comparison

eco costs rPLA
eco costs CA



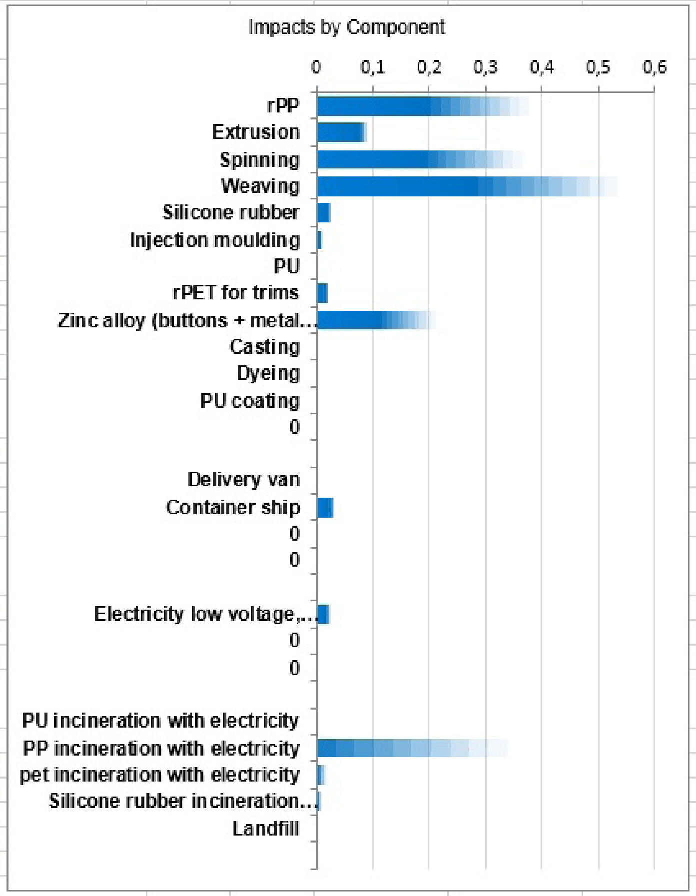
Desig	Main material rPP
(Nam	rPP

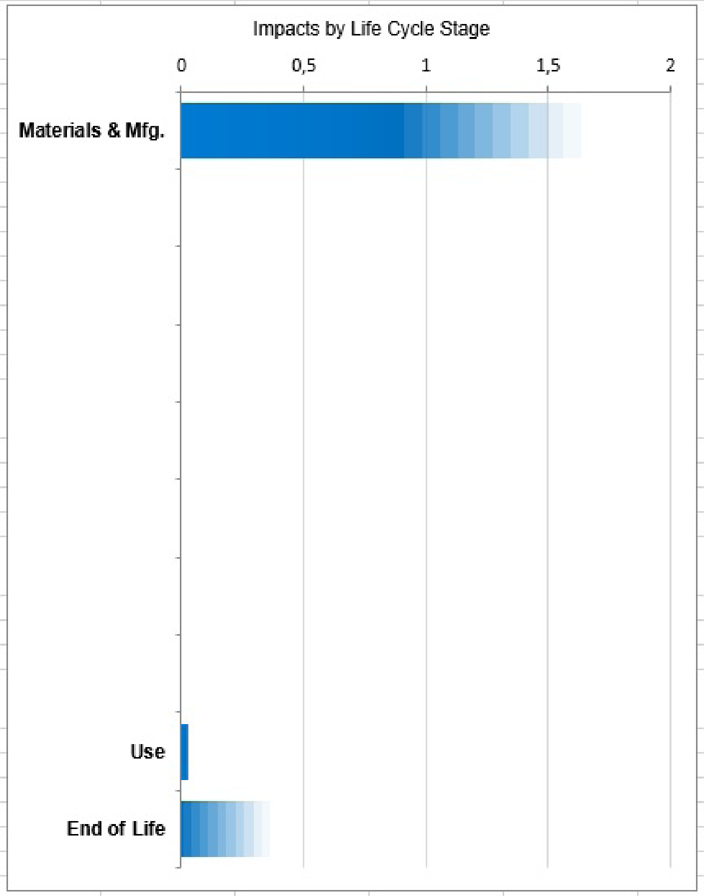
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPP	0,46	0,639	1,00	30%	Not sure whether	0,290913
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%	Assumption	0,00016
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%	**Multiple db optio**	4,31E-05
PP incineration with electricity	0,27	0,639	1,00	100%		0,169649
pet incineration with electricity	0,25	0,036	1,00	100%		0,009005
Silicone rubber incineration with electricity	0,15	0,022	1,00	100%		0,003148
Landfill	0,00	0,782	1,00	30%		0,001073
						0





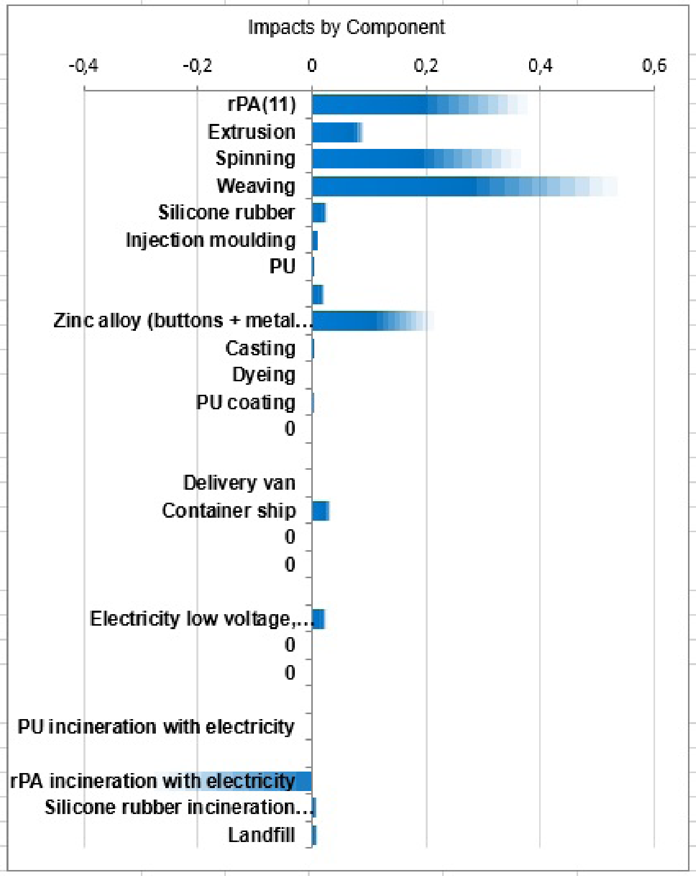
Desig	Main material rPA(11)
(Nam	rPA(11)

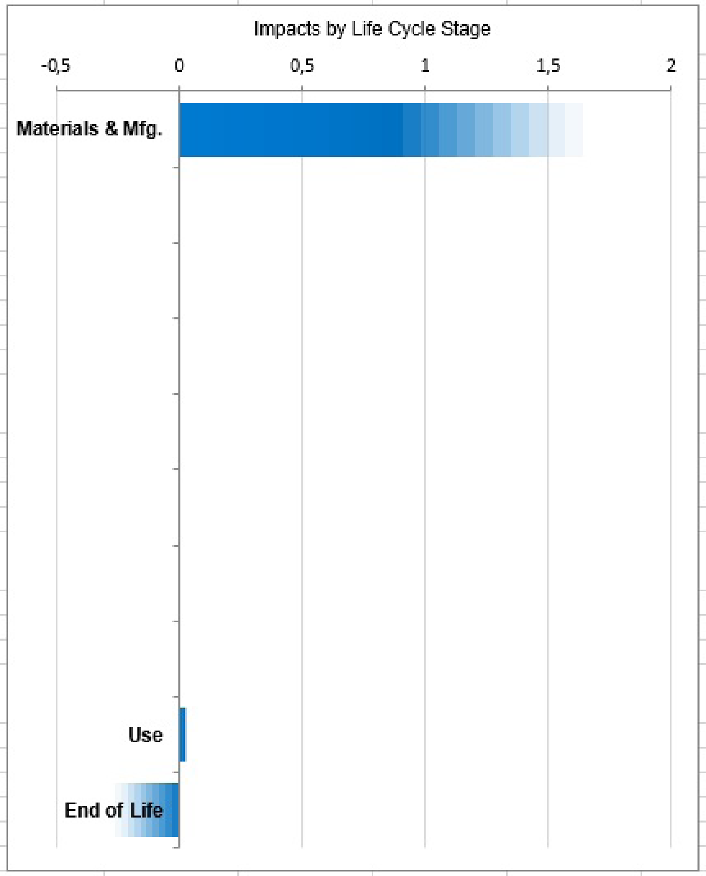
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPA(11)	0,46	0,639	1,00	30%	Not sure whether	0,290913
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	30%		0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%		0,00016
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

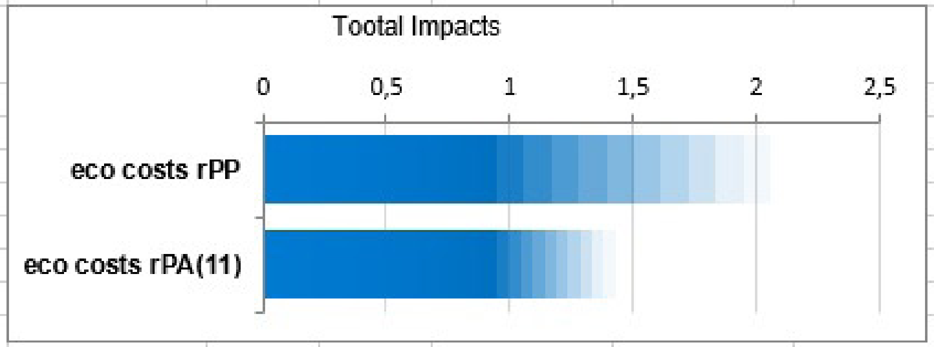
End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%	**Multiple db optio**	4,31E-05
PET trims incineration with electricity	0,25	0,036	1,00	3000%		
rPA incineration with electricity	-0,22	0,639	1,00	100%		-0,139057
Silicone rubber incineration with electricity	0,15	0,022	1,00	100%		0,003148
Landfill	0,00	0,782	1,00	30%		0,001073





Comparison

eco costs rPP	
eco costs rPA(11)	



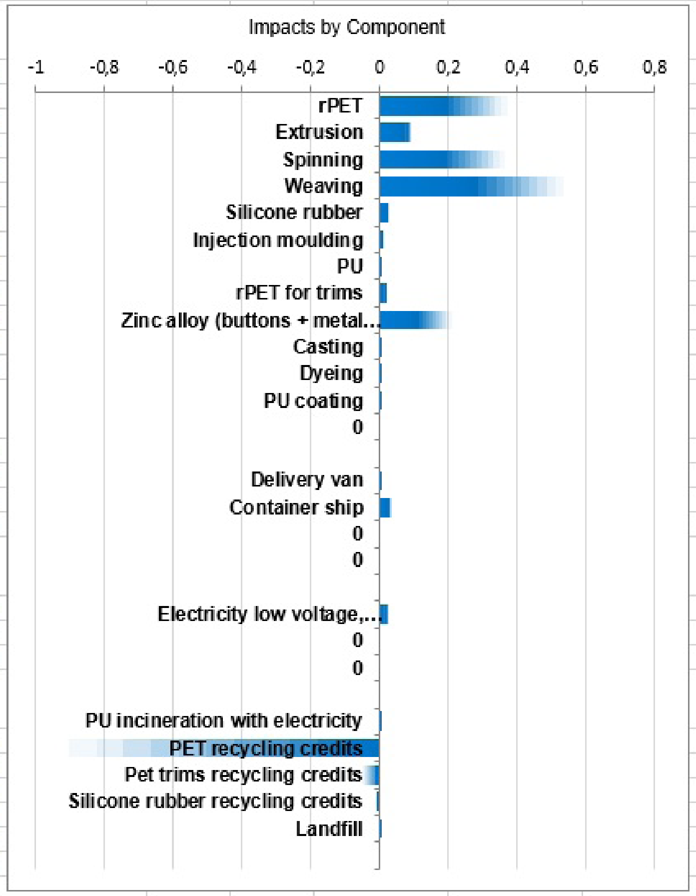
Desig Main material Recycled PET
(Nam rPET

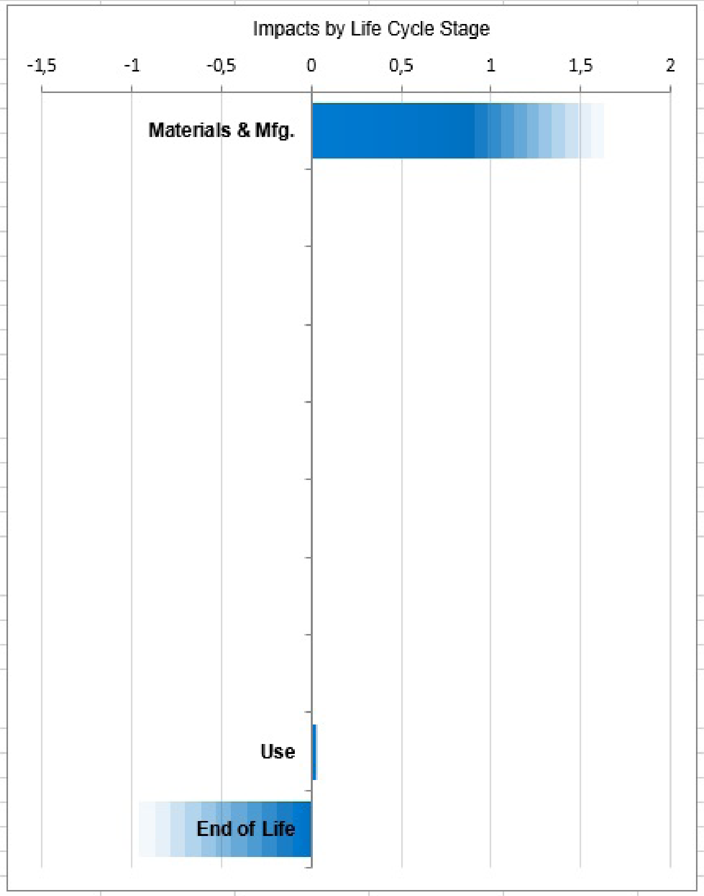
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	0,45	0,639	1,00	30%	Not sure whether	0,285698
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%	Assumption	0,00016
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%		4,31E-05
PET recycling credits	-0,79	0,639	1,00	80%		-0,502791
Pet trims recycling credits	-0,79	0,036	1,00	80%		-0,028313
Silicone rubber recycling credits	-0,08	0,022	1,00	80%	TPS instead of sili	-0,001757
Landfill	0,00	0,782	1,00	80%		0,001073
						0





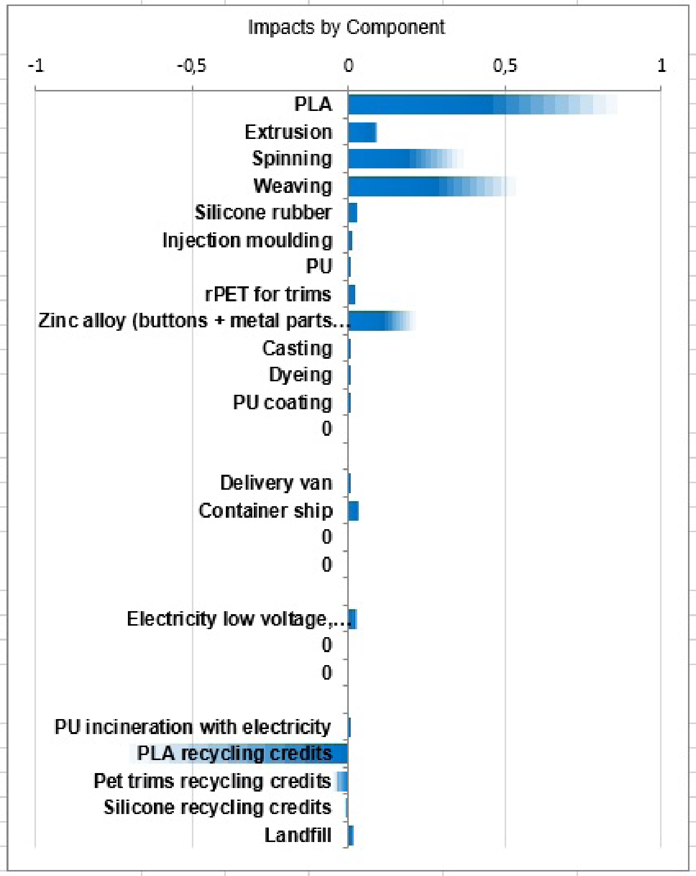
Desig	Main material PLA
(Nam	PLA

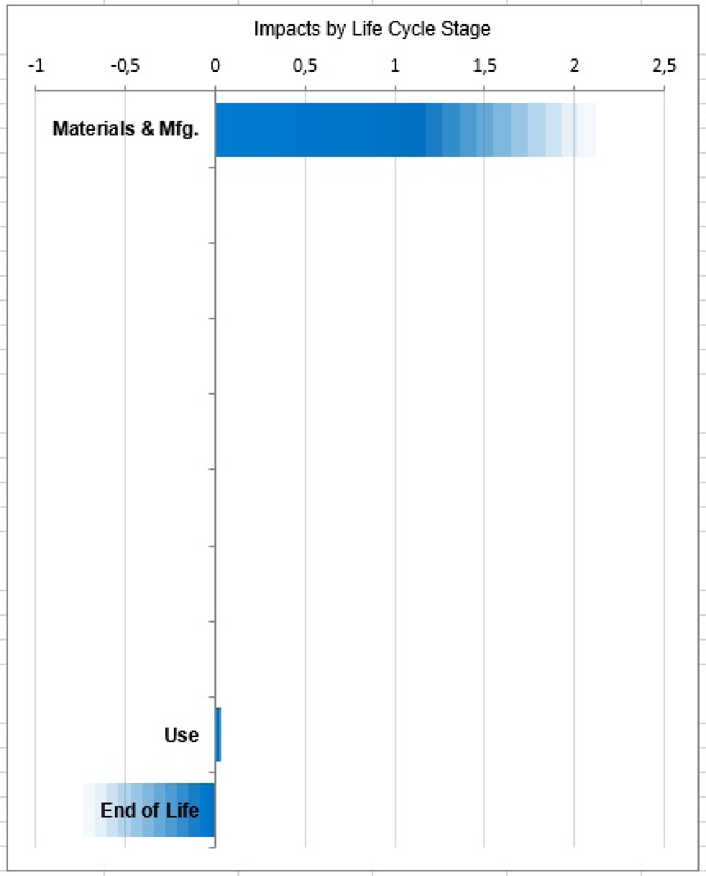
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PLA	1,03	0,639	1,00	30%	Not sure whether	0,661658
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%		0,00016
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

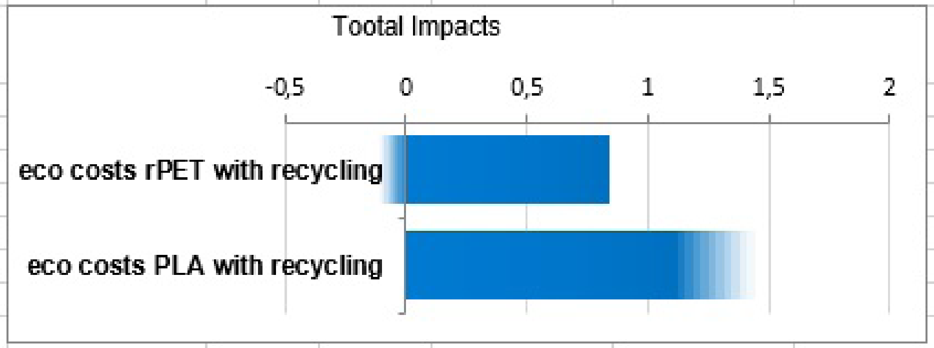
End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%	**Multiple db optio**	4,31E-05
PLA recycling credits	-0,61	0,639	1,00	80%		-0,387779
Pet trims recycling credits	-0,79	0,036	1,00	80%		-0,028313
Silicone recycling credits	-0,08	0,022	1,00	80%	TPS instead of sili	-0,001757
Landfill	0,00	0,782	1,00	80%		0,001073





Comparison

eco costs rPET with recycling
eco costs PLA with recycling



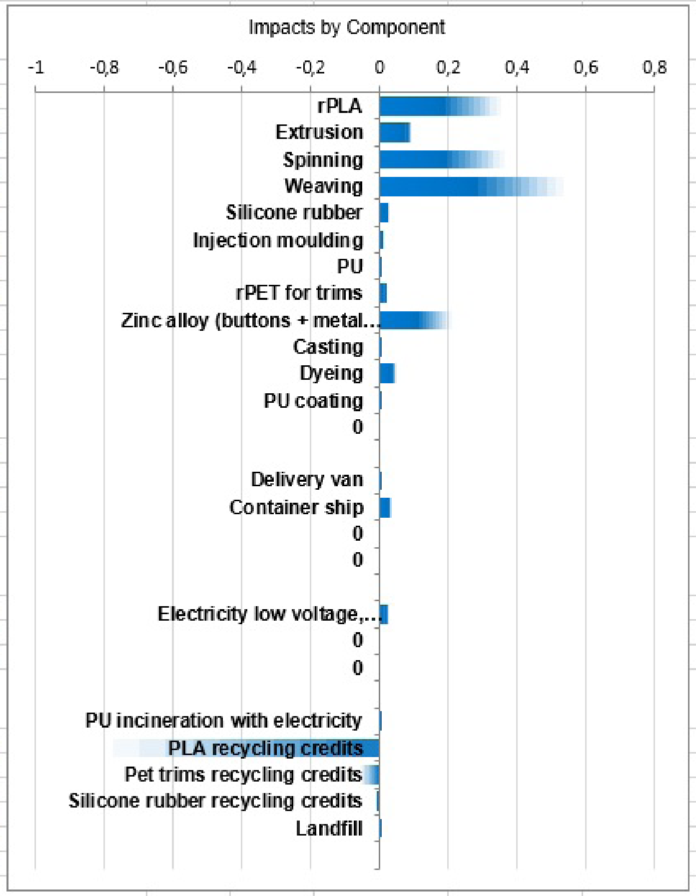
Desig	Main material Recycled PLA
(Nam	rPLA

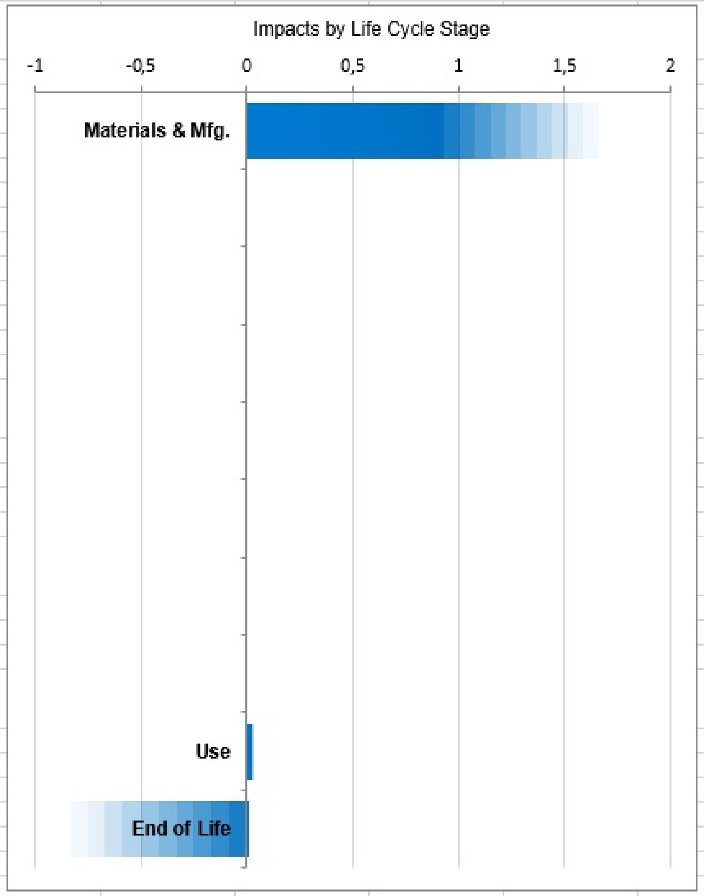
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPLA	0,43	0,639	1,00	30%	Not sure whether	0,273878
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,100	1,00	20%	Not sure about m	0,038718
PU coating	0,80	0,000	1,00	60%	Assumption becau	0,00016
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%		4,31E-05
PLA recycling credits	-0,61	0,639	1,00	100%		-0,387779
Pet trims recycling credits	-0,79	0,036	1,00	100%		-0,028313
Silicone rubber recycling credits	-0,08	0,022	1,00	100%	Tps instead of sili	-0,001757
Landfill	0,00	0,782	1,00	70%		0,001073
						0





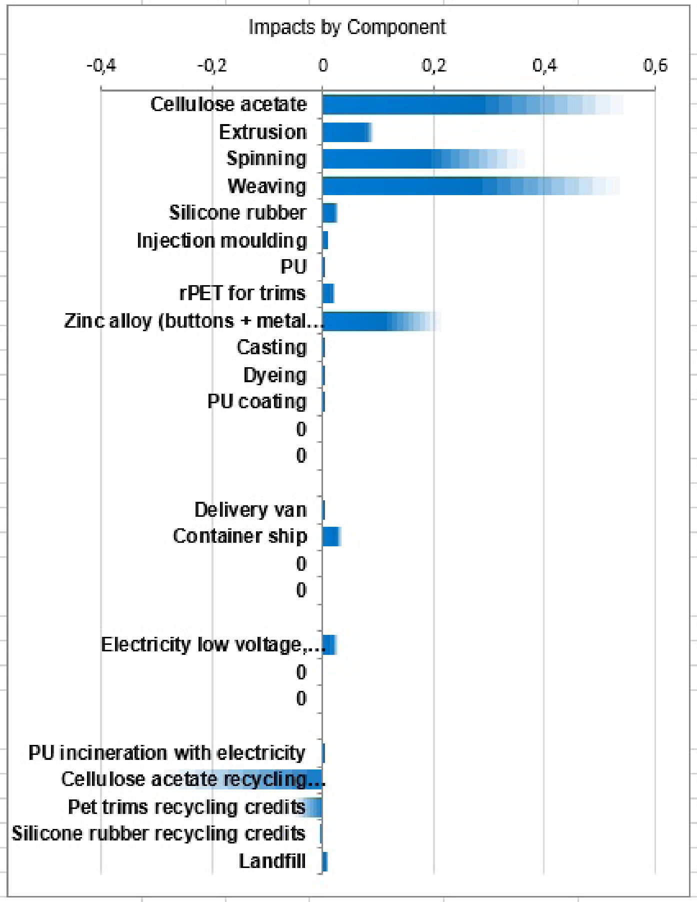
Desig	Main material Cellulose Acetate
(Nam	CA

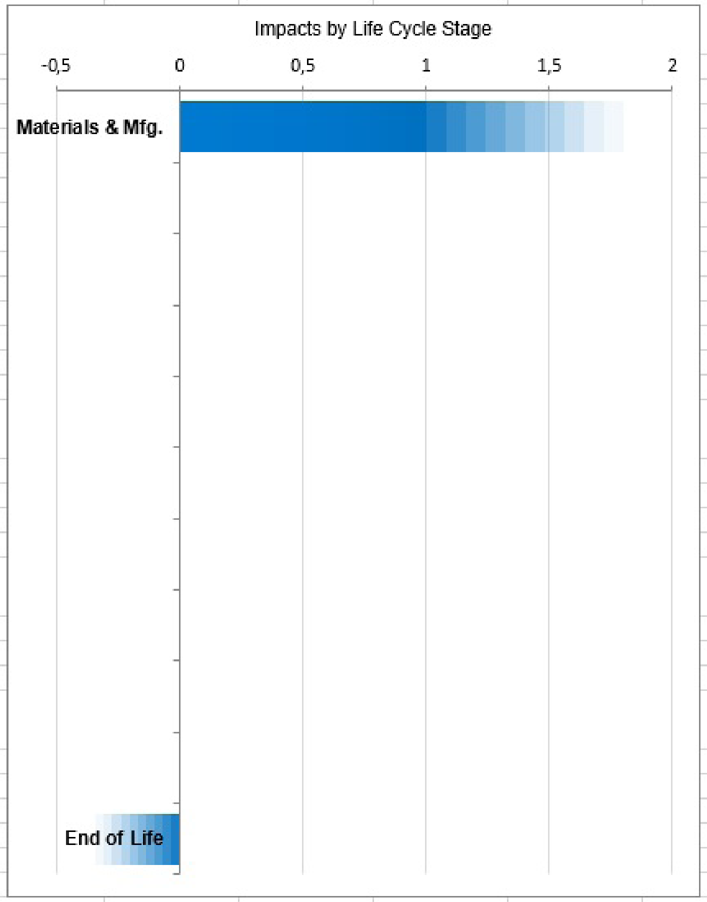
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Cellulose acetate	0,65	0,639	1,00	30%	Not sure whether	0,417171
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%		0,00016
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

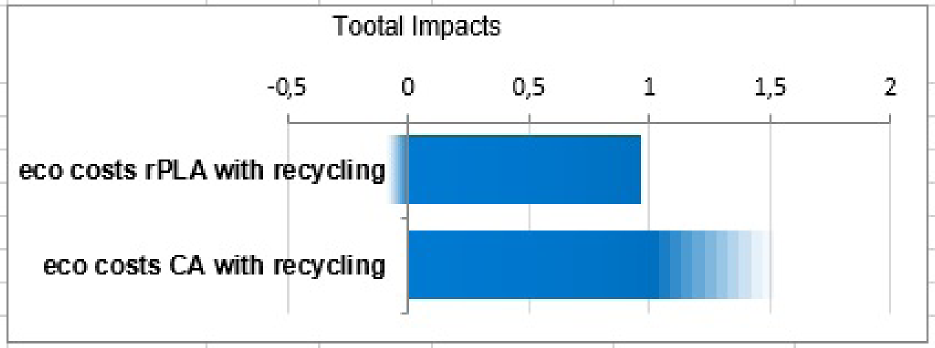
End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%		4,31E-05
Cellulose acetate recycling credits	-0,23	0,639	1,00	100%		-0,143988
Pet trims recycling credits	-0,79	0,036	1,00	100%		-0,028313
Silicone rubber recycling credits	-0,08	0,022	1,00	100%		-0,001757
Landfill	0,00	0,782	1,00	30%		0,001073





Comparison

eco costs rPLA with recycling	
eco costs CA with recycling	



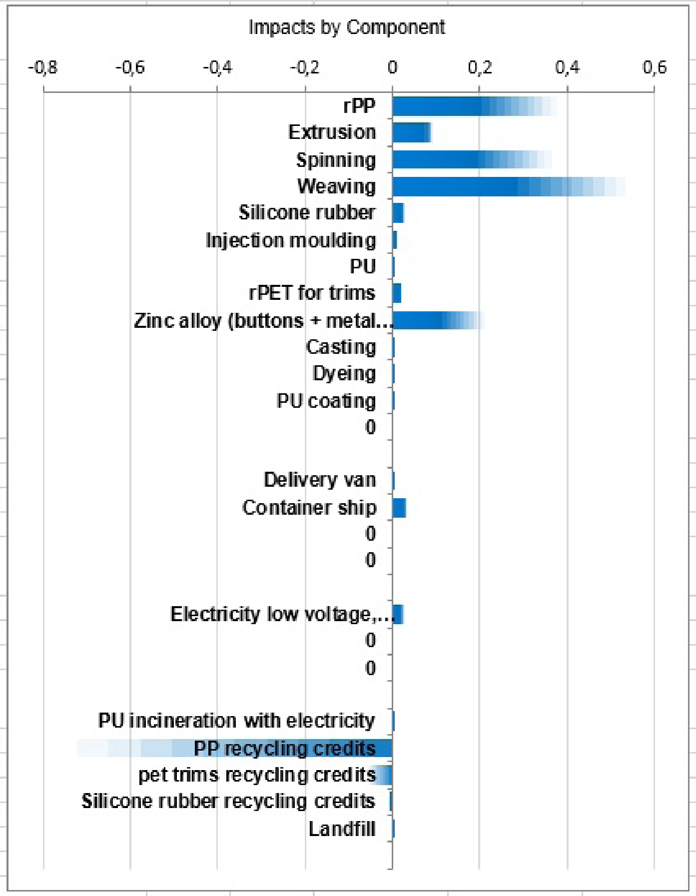
Desig	Main material rPP
(Nam	rPP

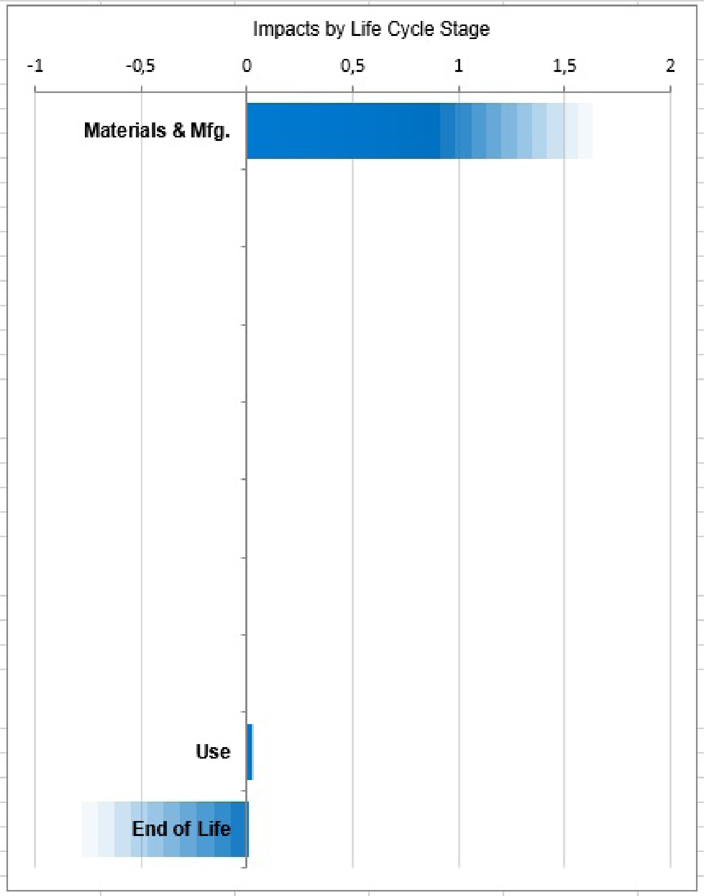
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPP	0,46	0,639	1,00	30%	Not sure whether	0,290913
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036	1,00	20%	Not sure whether	0,016088
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%	Assumption	0,00016
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%	**Multiple db optio**	4,31E-05
PP recycling credits	-0,56	0,639	1,00	100%		-0,360769
pet trims recycling credits	-0,79	0,036	1,00	100%		-0,028313
Silicone rubber recycling credits	-0,08	0,022	1,00	100%		-0,001757
Landfill	0,00	0,782	1,00	30%		0,001073
						0





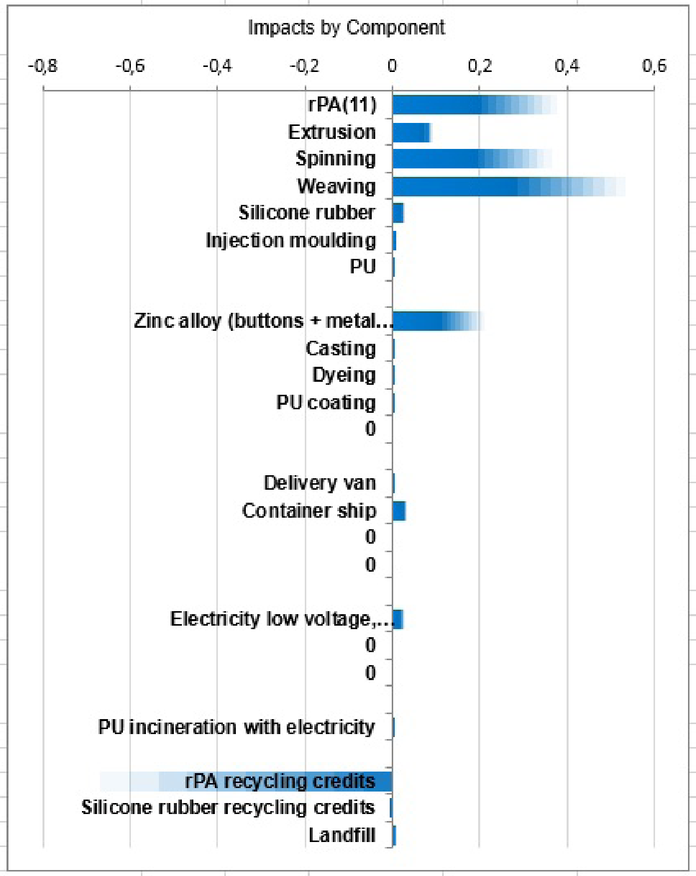
Desig Main material rPA(11)
(Nam rPA(11)

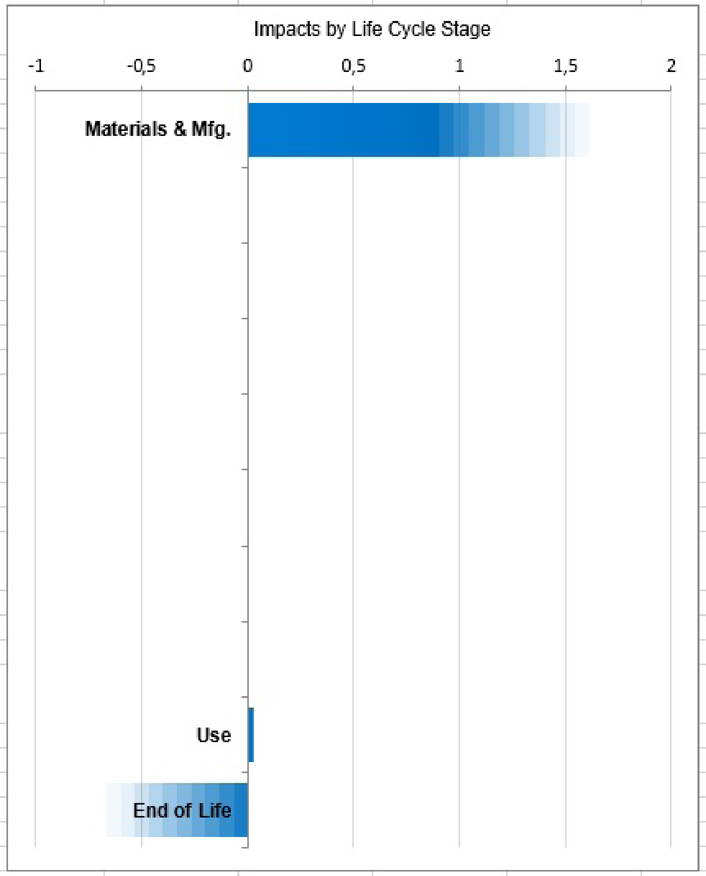
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPA(11)	0,46	0,639	1,00	30%	Not sure whether	0,290913
Extrusion	0,13	0,639	1,00	10%		0,08249
Spinning	0,44	0,639	1,00	30%	Not sure about dt	0,280895
Weaving	0,64	0,639	1,00	30%	Not sure about dt	0,411609
Silicone rubber	0,97	0,022	1,00	20%		0,020967
Injection moulding	0,31	0,022	1,00	20%		0,00663
PU	1,83	0,000	1,00	50%	Not sure whether	0,000366
rPET for trims	0,45	0,036				
Zinc alloy (buttons + metal parts of zippers)	1,93	0,085	1,00	30%	Assumption on th	0,163889
Casting	0,01	0,085	1,00	30%	Process assumpti	0,001121
Dyeing	0,39	0,000	1,00	20%		3,87E-05
PU coating	0,80	0,000	1,00	60%		0,00016
						0

Transport	Eco-intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		1,84E-05
Container ship	0,00	0,001	#####	1,00	20%		0,026221
							0
							0

Use	Eco-intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,02	0,9	1	30%	0,25kWh is the er	0,019095
						0
						0

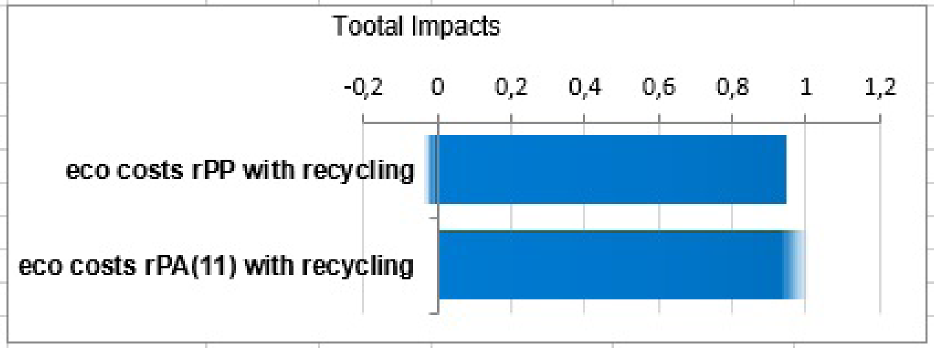
End of Life	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	0,22	0,000	1,00	100%	**Multiple db optio**	4,31E-05
pet trims recycling credits	-0,79	0,036	1,00	100%		
rPA recycling credits	-0,52	0,639	1,00	100%		-0,334843
Silicone rubber recycling credits	-0,08	0,022	1,00	100%		-0,001757
Landfill	0,00	0,782	1,00	30%		0,001073





Comparison

eco costs rPP with recycling
eco costs rPA(11) with recycling



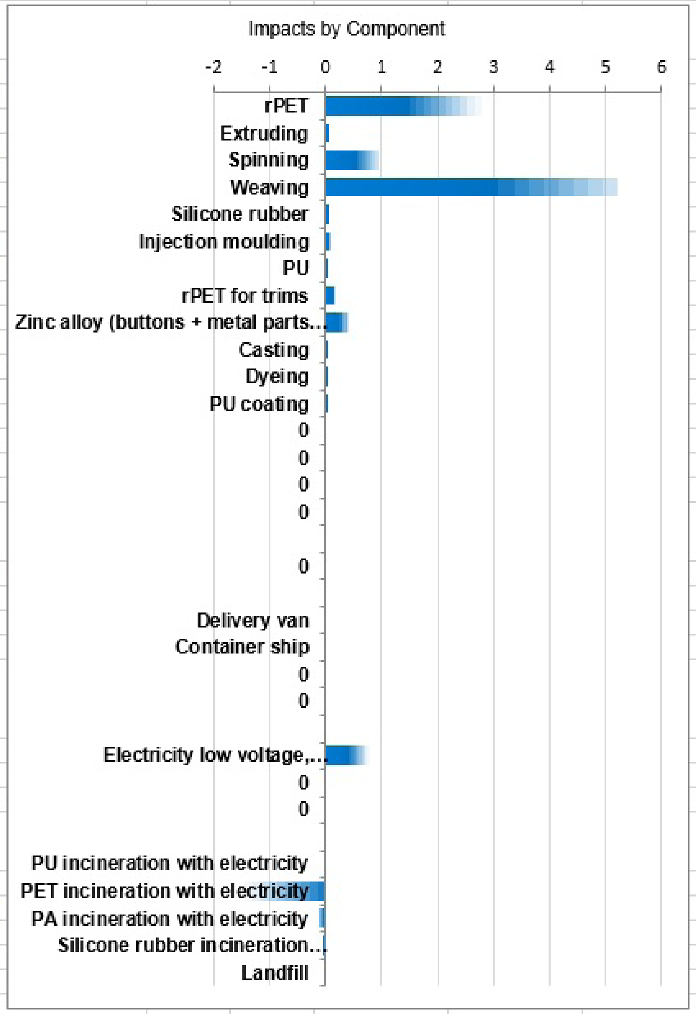
Desig Main material Recycled PET
(Nam rPET

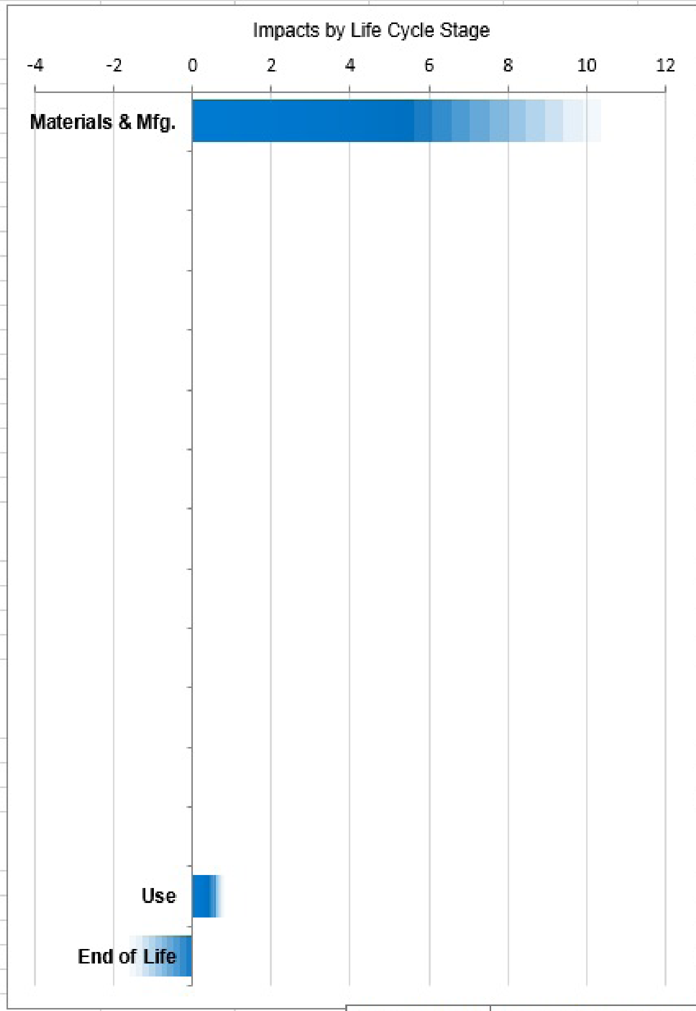
Manufacturing	Eco-intensity MJ	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
rPET	3,35	0,639	1,00	30%	Not sure whether	2,144043
Extruding	0,05	0,639	1,00	10%		0,031326
Spinning	1,24	0,639	1,00	30%	Not sure about dt	0,794432
Weaving	6,91	0,639	1,00	30%	Not sure about dt	4,417488
Silicone rubber	2,22	0,022	1,00	20%		0,04805
Injection moulding	2,47	0,022	1,00	20%		0,053347
PU	3,34	0,000	1,00	50%	Not sure whether	0,000669
rPET for trims	3,71	0,036	1,00	20%	Not sure whether	0,133651
Zinc alloy (buttons + metal parts of zippers)	4,12	0,085	1,00	30%	Assumption on th	0,350526
Casting	0,23	0,085	1,00	30%	Process assumpti	0,019604
Dyeing	3,12	0,000	1,00	20%		0,000312
PU coating	0,84	0,000	1,00	60%	Assumption becau	0,000169
						0
						0
						0
						0
						0
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		0
Container ship	0,00	0,001	#####	1,00	20%		0
							0
							0

Use	Eco-Intensity (impacts/MJ or other)	Amount per wash (MJ or other)	Washes per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,07	0,9	10	30%	0,25kWh is the er	0,607627
						0
						0

End of Life	Eco-Intensity MJ	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	-1,08	0,000	1,00	100%	(Use this column t	-0,000215
PET incineration with electricity	-1,14	0,639	1,00	100%		-0,727297
PA incineration with electricity	-1,48	0,036	1,00	100%		-0,053431
Silicone rubber incineration with electricity	-0,66	0,022	1,00	100%		-0,014177
Landfill	0,00	0,782	1,00	70%		0





Serie9 Punto Area del tracciato

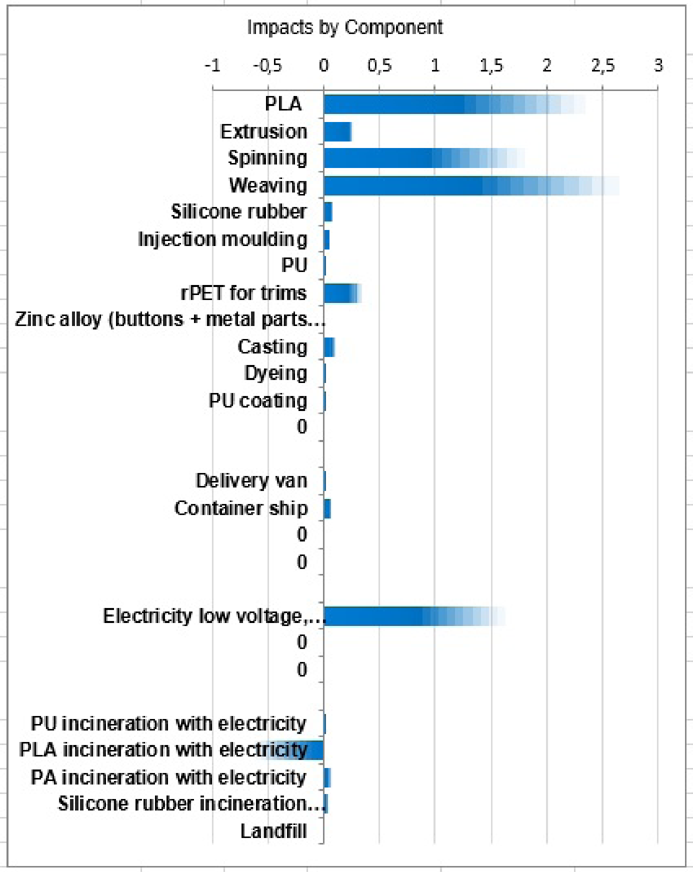
Desig	Main material PLA
(Nam	PLA

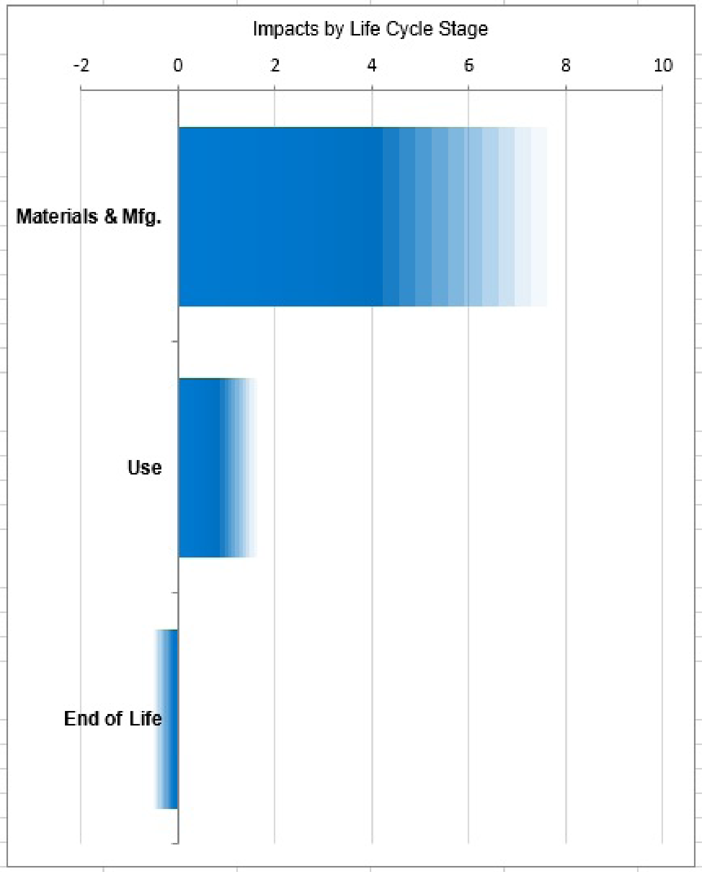
Manufacturing	Eco-intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PLA	2,82	0,639	1,00	30%	Not sure whether	1,802179
Extrusion	0,36	0,639	1,00	10%		0,231815
Spinning	2,17	0,639	1,00	30%	Not sure about dt	1,390259
Weaving	3,19	0,639	1,00	30%	Not sure about dt	2,037212
Silicone rubber	2,75	0,022	1,00	20%		0,05934
Injection moulding	1,52	0,022	1,00	20%		0,032814
PU	5,09	0,000	1,00	50%	Not sure whether	0,001017
rPET for trims	8,02	0,036	1,00	20%	Not sure whether	0,288678
Zinc alloy (buttons + metal parts of zippers)	0,00	0,085	1,00	30%	Assumption on th	0
Casting	0,90	0,085	1,00	30%	Process assumpti	0,0765
Dyeing	1,92	0,000	1,00	20%		0,000192
PU coating	2,50	0,000	1,00	60%	Assumption becau	0,0005
						0

Transport	Eco-Intensity (impacts/ ton-km)	Mass per item (ton)	Distance per item (km)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Delivery van	0,00	0,001	226,000	1,00	30%		4,31E-05
Container ship	0,00	0,001	#####	1,00	20%		0,043234
							0
							0

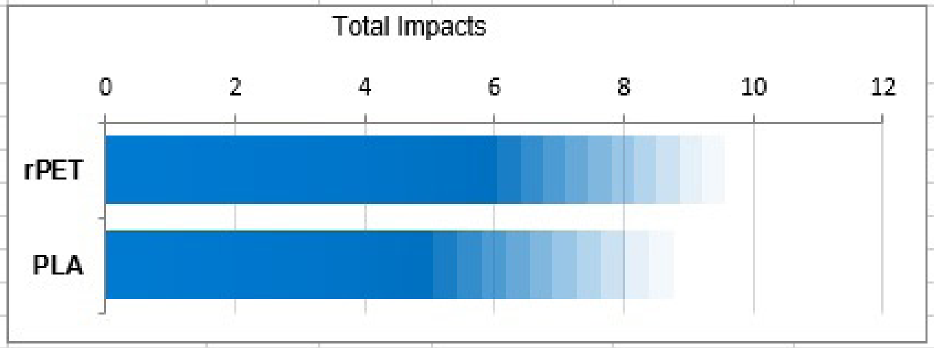
Use	Eco-Intensity (impacts/MJ or other)	Amount per item (MJ or other)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
Electricity low voltage, domestic use NL	0,14	0,9	10	30%	0,25kWh is the er	1,254985
						0
						0

End of Life	Eco-Intensity (impacts/kg)	Mass per item (kg)	Items per func.unit (#)	Uncertainty %	Notes	Calculated Impact
PU incineration with electricity	1,07	0,000	1,00	70%	(Use this column t	0,000213
PLA incineration with electricity	-0,57	0,639	1,00	70%	assumption of prc	-0,364771
PA incineration with electricity	1,06	0,036	1,00	70%		0,038059
Silicone rubber incineration with electricity	0,72	0,022	1,00	70%		0,01558
Landfill	0,00	0,782	1,00	30%		0





Comparison
rPET
PLA



PRESIDIO SUSTAINABILITY BOOSTER

VALUE PROPOSITION – Broad Benefit

- **What could be the larger value proposition beyond the immediate customer need we could meet?**
- How might our product or service further enhance the quality of life (e.g. health, safety, accessibility, education) of our customers beyond its immediate benefit? How might we refine the business model to contribute even more to their ability to thrive?
- Are there opportunities for our product/service to contribute to the solution of larger social or environmental problems beyond its primary purpose?
- In what way does promoting these multiple benefits improve our brand?

- Our products and services could educate consumers to become more aware of the environmental issues that characterise the Fashion industry, and to become more proactive in the everyday choices and activities they can carry out in order to prevent or limit the aforementioned issues. Moreover, there's a great attention towards the choice of materials, so that they are as less toxic (for humans and environment) as possible.
- Partnering up with Eden Reforestation Projects makes it possible to take care of trees and biodiversity of specific environments, not to count the jobs created by this reforestation service - most of the time reforestations happen in poor and exploited areas of the world, and the people who work in the projects can find a way to sustain themselves (under fair working conditions of course).
- It improves the brand by creating awareness and sharing knowledge: by being educated, customers create a special bond with the brand, as they start seeing it as standard-bearer for these types of topics.
- Maium blends techwear and fashion with innovative design, creating the best option for biking during rainstorms while being comfortable and trendy, and makes it possible to take care of the environment with its sustainable practices.

VALUE PROPOSITION – Mindful impact

- **Does our product inadvertently create new problems or needs in its attempt to solve an existing problem or need?**
- Does our product or service potentially create any new problems for the customer? What are the full impacts beyond the intended one? How might we mitigate them?
- Does our product or service create any new problems in society or the environment? How might we mitigate them?

- The biggest problem that it's inherent in the product lays in the raw material collection: even though it's always good to recycle and reuse plastic (especially PET), recycling it to create textile does not solve the overproduction of plastic at all. Indeed, although recycling PET is thought to be extremely sustainable and a sort of closed-loop production, it actually is not: the production of rPET textiles just transfers the end material of a production circle to the beginning of another one. It does not reduce the quantity of plastic used, rather than it just moves it in another industry: this doesn't mean it's bad, yet it's not as good and disruptive as people may think.
- One way to mitigate this issue is to have a recycling process that reuses ALL of the material in a closed and circular loop, but the technology is not there yet.

VALUE PROPOSITION – Customer behaviour

- **How can our product or service help our customers be more sustainable?**
- What are the negative impacts associated with *using* our product/service? How are our products/services actually used or consumed? How much water, energy or other materials will get consumed when customers use them? How might we reduce these impacts?
- What are the negative impacts associated with disposal of our product? What are the options our customers have for disposing of our product at the end of its life? Are we creating a waste disposal problem? Can we design our product/service to be part of a 'circular economy' where all waste streams become resources?
- What positive customer behavior changes does the use of our product or service encourage? Does our product or service encourage our customers to use less energy or water? Recycle more? Be healthier? Generally, have a lower impact? How might we quantify those sustainability benefits in a way that enhances our brand? In what ways might our product or service build a sense of community, relationships and trust (ie, social capital)?

- Usually actually negative impacts operated by raincoats (and more generally by apparel) consist of the disposal possibilities: 80% of garments finish incinerated or in landfills, without any chance to be properly recycled or disposed of. There is a huge waste disposal problem, but unfortunately the road to have a completely circular economy is still quite far, as technology on one side doesn't allow to separate different types of materials (in case of plastics), and on the other there are no institutional helps from government and big companies.
- With the implementation of repair workshops and videos and the educating carelabel, our product could encourage customers to be more proactive in the care of the jackets, thus increasing the lifetime of the product without any particular effort in the production, and to be more responsive and aware of alternatives to the classic linear fashion consumption (i.e. slow fashion, reselling clothes etc.)
- Our product can help customers be more sustainable by educating them on practices that increase the lifetime of the jackets (more care, less water use, more information) and on possible alternatives to the linear consumption.

VALUE PROPOSITION – Branding sustainability

- **What sustainability related issues are going to be an important part of our value proposition? Will sustainability be key to our brand?**
- If we linked sustainability to our brand, what impact would this market position have on our ability to sell? Will we be reaching the market we want? Will we be excluding any other markets that we want? **No, sustainability is already the main part of the brand**
- What aspect of sustainability are we linking our brand to? For example, will we focus on certain social issues (e.g., women's empowerment, literacy, asthma) or environmental issues (e.g. climate change, species depletion)? **Plastic and fashion waste recycling, environmental impact**
- Will our entire offering be sustainable or only one or two offerings/products? If only part of our offerings are sustainable, will this undermine the credibility or attractiveness of our other offerings? **Everything is sustainable**
- What legitimate claims can we make now and in the near future? What evidence would back up those claims? How do we compare in sustainability performance against our competitors?
- If we decide to focus on a particular issue within sustainability, how can we ensure that we don't make other parts of the system worse? If, for example, we focus on toxic elimination, how can we prevent contributing to another issue like inequality by making products too expensive for large segments of the market?
- We've been applying LCAs and Whole system mapping methods to see the environmental impact (carbon footprint, eco-costs and water usage) of the production/post-production of our raincoats. With this we can make comparisons against our competitors, and also have absolute comparisons.
- The main issues regarding sustainability in our brand are related to plastic recycling, closed loop production, reforestation and biodiversity preservation and fashion disposal: these are, besides the product itself (made in rPET), key to our brand

CUSTOMER RELATIONSHIPS – Honoring customers

- **How can we best honor our customers for who they are?**
- (Empathy) What cultural differences (e.g. political beliefs, gender identification, ethnicity, religion, language, values) are we likely to encounter and how can we deepen our understanding of those differences to develop empathy with all our important customer segments? How can we ensure our staff diversity will reflect our customer base so all will feel welcome?
- (Appreciation) How can we demonstrate appreciation for our customers?
- (Value Added) How can we make this not simply a commercial transaction but add value to our customers in multiple ways?

- (Empathy) we are addressing everyone, there is no specific customer segment, apart from people who bike in the rain and care about the environment. Not specifying the customer segment makes it possible to not exclude anyone.
- (Appreciation) we can celebrate purchases on social media, having the customers appear on our instagram page; provide them with discounts on specific occasions + if they bring back clothing; include them in the pursuit of a more sustainable production and post-production…
- (Value added) educating customers always adds value to the product they purchase: they're not just buying a jacket, they're also learning how to take care of it, how to prolong its life, what possible alternatives there are to a classic linear consumption, what to do to help change the system and care for the environment
- We can make customers participate as much as possible in the process: give them information, teach them how to do stuff, give them a platform where to communicate with us (blog?), award them with some discounts when they do something good, and give them visibility on our platforms

CUSTOMER RELATIONSHIPS - Transparency

- **What information would customers want to develop a trusting, honest relationship with us?**
- (Openness) Is there anything about our business model that might cause concerns amongst some of our customers (e.g. ingredients, labor issues, lobbying)? Is there anything about our practices or our associations that would embarrass us if it were made public? If so, how can we change our model to eliminate these concerns?
- (Consistency) In what ways can we 'walk our talk,' demonstrate our commitment to our values and mission? Do we do what we say and say what we mean all the time?
- (Follow through) How can we be sure we deliver on all our promises? What regular practices do we need to implement to assure we continuously share critical information?

- (Openness) probably the fact that all the production is made in China does not help in the perception of sustainability (even if sustainable requirements are met, OEKO-TEX100 and GRS). The model can be changed just if the partners are changed to some closer to the NL (but it's not going to happen probably). So being extremely clear and transparent in all the production process's steps (production, working conditions etc), could definitely help.
- (Consistency) making our achievements clear and easy to understand for everyone, share our milestones and goals achieved (i.e. how many trees have been planted in a month/year etc)
- (Follow through) use the blog to express all our info and activities + desired further steps
- They would definitely want info on the production line (where things are being made, what are the working conditions, where and how the materials are collected etc.), and info on our goals, the steps that are needed to get there, and updates on our achievements (how much we have lowered the environmental impact of the jackets, how many trees we planted etc.)

CUSTOMER RELATIONSHIPS – Emerging needs

- **How might we stay connected to customers, even after the current commercial relationship has finished, so that we can gain insights to their emerging needs?**
- How can we best engage each customer segment during our commercial relationship, while we are doing business, so that we gain insights into their emerging needs?
- How might we stay in touch with our customers in a way that seems natural and supportive to them after our initial interaction to gain important insights about our product's or service's effectiveness and our customers' evolving needs?

- We can use the blog to exchange information, instagram page to get info on needs, what is not going good and what is going well. Having our little take back system and the repir workshops would definitely help to have a further exchange of information and stronger bond with our customers.

CHANNELS - Impacts

- **What are the impacts of our channel choices and how might we mitigate them?**
- What will the likely environmental impact be for each of the channels we are considering (e.g. travel, transportation, energy, waste generation)? **See LCA**
- How might we provide incentives for our customers to use the lower-impact channels when feasible (e.g. provide a discount for online transactions or reimburse bus tickets but not parking)?
- How might we reduce the impacts of the higher-impact channels (e.g. siting manufacturing or product showrooms closer to the customer, reducing the energy needed in travel/transportation, redesigning packaging, providing for back-hauling) and what other business benefits might come from those actions?

- Maium could provide discount on next purchases if customers bring back their used clothes.
- We’re already working on redesigning the packaging to get a less impactful version of it, ideally the production sites could be closer to NL, but probably it’s not going to happen. One way to get the overall impact of the jackets lower would be to be able to prolong the lifetime of the jackets by a repair system: in this very cheap way, customers could work to keep their garments for as much time as possible. This would not eliminate the issue of the waste in the fashion industry, yet it would help to change the consumistic behaviour of customers and change the whole system towards a more closed loop.
- The biggest impacts in our channels are in the manufacturing and processing and in the EOL life cycle stages: this is due to how the fashion industry system is built, a totally linear process that does not take into consideration ways to successfully recycle or remanufacture garments, as well as educate consumers on how to change their consumistic behaviour. We could work on the areas of our process that regard consumer behaviour (educating them on how to mindfully consume, and how to care for sustainable practices in this industry), and start to set an example for other businesses to do the same.

CHANNELS - Accessibility

- **How might we provide channels to make it easier for the underserved to gain access to our product or service?**
- What might be the biggest barriers potential customers who need our product/service might encounter? (Refer to your answers to Customer Segments: Access)
- How might we create or modify our channels to remove those barriers, making it easier for them to benefit from our product or service?

- The biggest barriers could be not having an internet connection (quite unlikely), or difficulty to reach retailers where to purchase or give back used clothes: A way to create accessibility to our services could be to add an informative carelabel to every coat in which the main info regarding the production process, how to take care of the coat so as to keep it in the best conditions all the time: moreover we could add a qr code on it, which redirects users to the website, where they will be able to find all the info they'll need. Maybe we could hand out panflets with all the info on them too (recycled paper), for the people who don't have internet.

COST STRUCTURE – Return on investment

- **What is the expected return on investment for pursuing sustainability as a business strategy?**
- What additional costs might we incur to pursue sustainability (e.g. staff training, consultants, staff time to build sustainability plans, track metrics, and write reports)?
- Where might we incur savings or increase sales by pursuing sustainability (e.g. attracting/retaining talent, finding efficiencies, reducing risks and insurance costs, inventing new products/services)?

- Might have a 50% growth in the future: in the short run it's a pain in the ass, but in the long run it's going to be strictly necessary. ELABORATE

COST STRUCTURE – Externalities

- **What externalities is our business creating or dependent upon and how can we best manage the risks associated with them?**
- What externalities are caused by our industry or our enterprise? What are our company's direct and indirect impacts and dependencies on the environment and society?
- How might we minimize these externalities (e.g. through changes in product design, processes, channels)?
- Can we internalize some of those externalities while enhancing the value of our product/service and covering their cost?
- What industry standards would be necessary to create a 'level playing field' that makes the world better, not worse, environmentally, socially and economically when customers buy our product/service?

- Rain creates opportunities for maium, there are he factoriess in china that produce the raincoats fpr other companies as well, which for us is not good.
- The surplus of plastic helps maium to stay alive, and the sustainability trend definitiely helps the company. Corona helped the company as well because governments pushed towwafrds a more individual approach to life, not using public transports etc.

REVENUE – Sources of revenue

- **What revenue streams could be leveraged so that all who need our product or service could have access to it?**
- What customer segments might need but not be able to afford our product/service? (See Customer Segments: Access.)
- How might we structure our revenue streams to make it affordable for these markets (e.g. subsidize it with other revenue streams)? Lease, 2nd hand
- Which business models (e.g. Freemium, hybrid, non profit, public/private partnership) might provide the highest benefit to the majority of partners/stakeholders?

- Going fully b2c would help, not having agents and such, intermediaries etc.

KEY PARTNERS - Competitors

- **How can we use sustainability to differentiate ourselves from our competitors?**
- How does integrating sustainability into our product or service provide us an edge or distinction?
- If our competitors are already touting sustainability, will we look legitimate in comparison? Is there a gap in their claims that we can fill? Can we be more sustainable? Or can we match their claims while offering a better price or performance?
- If we take this position, what might be the likely reaction of our competitors? How would we manage challenges to our claims or attempts to copy our position?

- Sustainability is already one of the two main selling points of Maium, we are one of the few companies that produce raincoats in rpet and that plant trees for each jacket sold. We definitely can be more sustainable, by moving the production closer to Europe, but unfortunately the company is still a bit too small to try a move like this (now the productioin is in China, which has the obvious benefit of being very cheap). Moreover, linked to the far-away production, there's the issue of safe working conditions and correct collection of the materials: all activities that are not under our direct supervision, but that if they were, and we coul act upon them and show them to customers, it could have a very beneficial effect both for the environment (in a broad sense), and for our business.
- We could differentiate us even more by being exhaustively clear on our mission, and specifically the steps that are needed and taken so as to fulfill our goals: make even more clear and preponderant the work we're doing with Eden Reforestation Project. Push towards an exhaustive research on our processes (we're already doing fast track lcas, but maybe also try and see mmore in depth what our opportunities are). Last thing, we could create an effective disposal system, in collaboration with the government and the industry.

KEY PARTNERS – Owners/Investors/Grantors

- **Who are the primary providers of financial capital for our business and to what degree do they support a sustainable business model?**
- Which investors would share our values and vision?
- What needs or concerns of theirs will we be obliged to address and how can we meet their needs while also benefitting other stakeholders?
- What influence will these stakeholders likely have over our enterprise? How can we ensure this furthers and doesn't detract from corporate responsibility?
- What information will we need to share with them and how can we best facilitate that exchange?

- Owners, Investors, government, crowd: to a very high extend these investors care about a sustainable business model, but on a general standpoint it’s not 100% important

KEY PARTNERS – Communities

- **How do we define 'community' in our context and how could we add value to our community?**
- What challenges are facing our community? What are the prevailing attitudes and culture? How might these issues influence our ability to operate?
- How might our operation impact the lives of the people in our vicinity? Is there anything that we do that hinders our neighbors' ability to lead quality lives and if so, how might we mitigate those?
- How can we help improve the community? How can we ensure the health and safety of those in our communities?
- What information needs to be shared between us and how can we best facilitate that exchange?

- The main challenge is to have sustainable clothes, that have lower and lower environmental impacts, and specifically this means find ways of changing the system from a linear one (produce, consume, die) to a circular one (produce, consume, recycle, repeat). In the last years this topic has become more and more important for many big players in the business (H&M first of all), yet technology doesn't seem to be ready, and to change the whole system requires a lot of effort and time (that so far haven't been there). These influence our operation in quite an obvious way: we cannot be 100% sustainable, as the whole system is corrupted.
- We need to share all the knowledge we have regarding alternative ways of production, and educate costumers towards a more sustainable consumption model, that it's not aimed at accumulation.
- Our community is composed by individuals that care about the environment, that cycle, and that have a fashion sensitivity: we can add value to it by putting them more in the centre of our operation, and not having them as just marginal actors that passively consume our products. We need to understand their needs, without compromising the sustainability of our practices, instead making them participate in new activities that could benefit them, our business and the environment.

KEY PARTNERS – Governments/Regulators

- **Which governmental entities will likely impact our business and are they likely to help or hinder our efforts to be sustainable?**
- Which governing bodies might influence our operations and what are their primary concerns or needs?
- How can we stay ahead of restricting regulations? How can we use this position to our advantage in the market?
- What influence do we have in helping to shape the regulatory environment? How can we encourage legislation or policy changes that will simultaneously benefit us and the common good?
- What information needs to be shared between us and how can we best facilitate that exchange?

- Taxes are not helping, because we’re taxed the same as other companies, who do not care about the right way of production. Government on materials ban.
- Could be a problem if they need to produce everything in EU, for what regards bans and taxes.

- On the retail side they’re making money beause there are big volumes but also they can produce the minimum of what it is required.

KEY PARTNERS – Industry transformation

- **In what ways might we contribute to the transformation of our industry toward sustainability?**
- What business practices do we wish we could change but cannot because of industry standards and conventions?
- What role do we want to play in industry transformation? Who in our industry might be a good partner in helping us make change? Industry associations? NGO's? Suppliers or vendors? Competitors?
- What special knowledge could we share with others in our industry? In what ways could being a leader in sustainability help our industry and market image? Might offering our expertise in issues related to sustainability become an additional source of revenue?
- How will we maintain or improve our position in a transformed industry?

- Just lead by example, and not preach. Considering that maium is at the early stages of their business, they can not put themselves in the position of being the preachers, or the ones people copy from, becaue they would lose money, customers and credibility

C PROJECT BRIEF

TU Delft

Personal Project Brief - IDE Master Graduation

Sustainable opportunities in the Fashion industry — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 13 - 04 - 2021 — 13 - 09 - 2021 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

My project will be about finding opportunities of reducing the environmental impact in the fashion industry, and I will collaborate with the raincoat brand MAIUM in Amsterdam, the forefront of Netherlands fashion industry.

MAIUM already has a sustainable approach to the production of their apparel: they use responsibly sourced fabric that is not only highly durable and waterproof, it is also made from recycled plastic PET bottles and without the use of animal products. They highly value sustainability in the production processes and transport as well as making garments that are good looking and durable.
They also value partnerships with leaders in the industry with conscious moral compass and ethical values.

The choice of materials is of primary importance for MAIUM: all materials used are either fabricated from recycled plastic or are completely biodegradable, and are PFC free. In their coats, they use a variation of materials such as Recycled PET, Organic Cotton, Pongee and PU.

All their materials are certified under GRS and OEKO-TEX(R) Standard 100 principles. The OEKO-TEX (R) label guarantees that every component of a raincoat has been tested for harmful substances and that therefore is harmless in human ecological terms. The GRS is a holistic certification for full products with recycled content, chain of custody, social and environmental practices, and chemical restrictions.

There are many opportunities to improve the sustainability of fashion brands in general, as it is an industry who is just now starting to implement tools and methods to reduce the environmental impact; in my specific case, I want to help MAIUM figure out their priorities for sustainability, and figure out what design strategies will be most effective for them: this means designing a new system, taking into consideration materials and production processes, as well as consumer behaviour and their education towards a more sustainable approach to the consumption of fashion goods. Possible solutions could be the introduction of a refurbishment system or new ways to reduce waste in this industry.

There are, of course, some limitations to the execution of my project: I am aware of the numerous steps that need to be taken so as to definitely change production processes and consumer behaviour as well, and that these steps have limited links to the design practice; moreover, the Covid-19 situation of course limits communication efficiency not only with the company and the university, but also with thorough information obtainment, as it is much more difficult to meet in person and deep dive into a topic.
One last possible limitation could be the possibility of not being able to bear sustainable alternatives on an economic standpoint: it's going to be a challenge to find these alternatives and apply them in the cheapest way possible, without renouncing to the final products' quality.

I am nonetheless confident of being able to find a way between these limitations I am aware of, and I will try to bring as much contribution as possible to the theme of sustainability in the fashion industry, starting from MAIUM.

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Personal Project Brief - IDE Master Graduation

introduction (continued): space for images

image / figure 1: MAIUM's lines of raincoats, for men and women

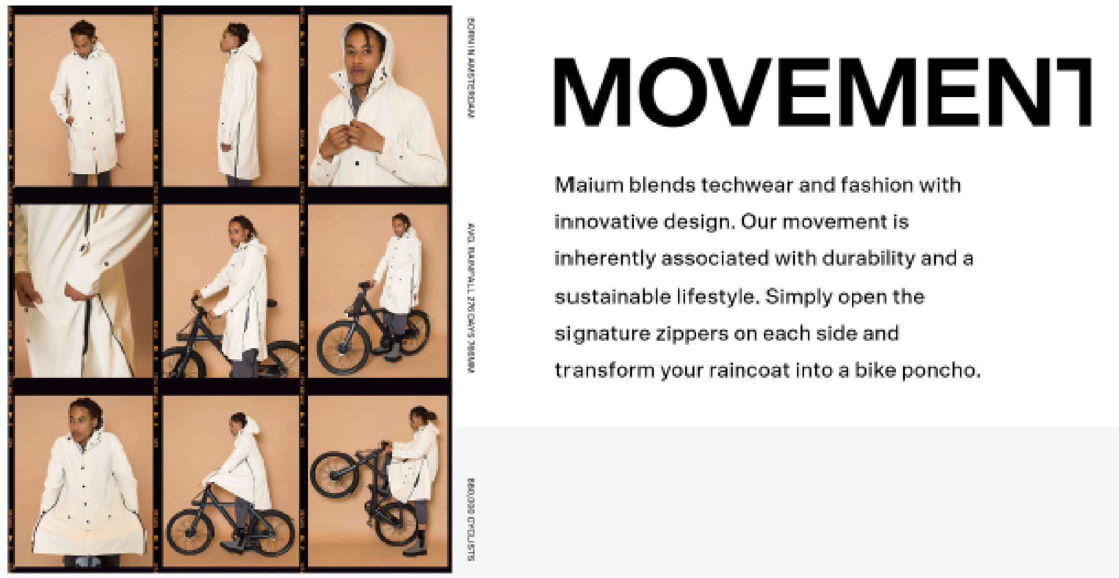

image / figure 2: MAIUM's website

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The current fashion system is a linear economic model that has enormous environmental and social impacts: the Fashion industry is one of the largest polluter industries in the world, for waste, overconsumption and environmental damage. Garments are underutilized and the most common design for this system is fast fashion. Consumption demand and production offer are very closely linked one with the other. Fast fashion companies exploit resources and processes creating unneeded waste of materials and workforce all around the world, to keep up with the market demand, which is continuous and everchanging.
The Netherlands is a country where efficiency and sustainability are kept in high consideration, yet the fashion industry still struggles to make a change in this market dynamics: there are many sustainable fashion brands, but just a few are able to truly be impactful. This is due to how the market and production processes are shaped, as well as how consumer behaviour is taken into account. Solutions must be found to integrate sustainability into the business in economically viable ways.

MAIUM is a small company which has a strong position on this issue, and has been founded on the values of sustainability and fair trade. They still have room to improve though, especially in material and production processes research, and strategies for consumer inclusion in the goal of lowering the impact on the environment. They are currently working on responsible packaging and transportation design, too.

The scope of my work will be exactly this: helping MAIUM to get even higher on the scale of sustainability in the fashion industry by figuring out their priorities for sustainability, and work with them to integrate relevant tools & methods into their standard design process in the long-term (co-create a new design process with them).

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

I will be researching sustainable alternatives to the processes/materials which are not fully eco-friendly yet (through tools such as LCA and/or Whole System Mapping), and design strategies that include consumer behaviour analysis in the sustainability process, as well as possible solutions of lowering the impact of the system MAIUM currently has, such as refurbishment.

I would expect to deliver a strategy by co-creating with them a product development process that works for them: I will start from figuring out what green design tools & methods the company already uses and values, and educating them on others they don't yet know about or use, and see what they value of those.

These will include LCA to set priorities and decide between material alternatives; Whole System Mapping to also set priorities across materials, packaging, transport, etc., and also to ideate and strategize; material databases to find new greener materials, and more.

An important part of this co-creation process will be checking that they get both sustainability value & business value from integrating the tools & methods.

Personal Project Brief - IDE Master Graduation

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PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 13 - 4 - 2021

13 - 9 - 2021 end date

I will start on a theoretical level, investigating the company's approach to their production and its procedures, and conducting a SWOT analysis: what are the milestones the company relies on, who are the partners they work with, what are the dynamics within the company and outside of it.

I will then broaden the investigating area to the product and the brand itself: I will analyse brand image and brand perception, linking it to the products they're selling. I will thus start researching on what kind of green tools and methods they currently use, and their business value at present, the materials and production processes used for the company's products, and when I'll have everything clear I will start conducting LCA and/or WSM, depending on what is more suitable for the company. I will reiterate the use of these tools as well as material databases and other tools for the duration of the whole project, user testing them with MAIUM and adapting them to its needs.

In the meantime, I will also be working in collaboration with the company on their packaging project, which has the aim of lowering the environmental impact of the product, beside the single garment.
Ideation of the strategy will start after the mid-term meeting, and I count on having completed more than half of it before the green light meeting. Progressing with the ideation, which goes in the iterating cycles of the tools and methods, I will work on the final deliverables such as the report, the posters, presentations and the showcase.

IDE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30

Initials & Name AD Domenighini Student number 5087449

Title of Project Sustainable opportunities in the Fashion industry

MOTIVATION AND PERSONAL AMBITIONS
Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

I consider myself to be a person with many and different interests, that grow and change with me through time. I have matured an interest in sustainable fashion in the last years, considering the huge impact this industry has on the environment, and how much work needs to be done before having a satisfying system. I have also direct and indirect experience of design in the fashion industry and the role sustainable solutions play in it, and I have been able to deepen my knowledge of such topics through multiple conversations with designers and counsellors for sustainability in the fashion industry.

For this reason I want to challenge myself to deep dive into this industry, get to know how things work in a company such as MAIUM, and apply on a concrete level the competences I have learnt in my academic career so far.
It's interesting for me to put into practice the knowledge I have accumulated in the last years, such as being able to analyse a company through its market research and its interaction with consumers, come out with design solutions that may help the company to get better in the areas that allow for such change, and get more understanding of the underlying dynamics that characterise the topic.

Specifically, I want to broaden my experience in a subject I don't know too much about, get as thorough knowledge as possible on it, as it is of great importance to me and the environment, and also experiment with tools such as LCA and Whole System Mapping.

These tools and methods have great value, and I want them to be part of my expertise so as to be able to better interact with today's challenges and future's ones. I already have little experience with such tools, as I have attended some specific courses in my master career, yet I am aware that putting them to practice is something I need to practice, and this could benefit enormously me and, hopefully, the companies I will be working at in my future career.

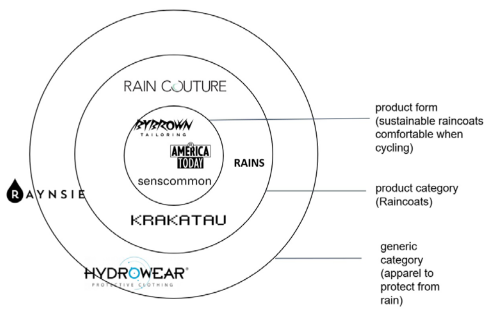
Trying, and hopefully succeeding, in bringing my knowledge and experience into the working world, would mean very much to me; especially in a field of interest such as the one of Fashion, where so much still needs to be done.
Moreover, it would be greatly significant for my professional growth to independently conduct such a project: often some real challenges of design are not directly faced in the academic path, and I want to get an idea of how design processes actually come to life, what are their limitations and what the opportunities. It's my personal ambition to master this type of knowledge in my career, and I value this experience to be a good starting point.

FINAL COMMENTS
In case your project brief needs final comments, please add any information you think is relevant.

D SUMMARY

The fashion industry is one of the most polluting and wasteful industries in the world. This is strictly related to the linearity of its production model, which puts profit and product generation before environmental and social sustainability. Very often this leads to overproduction and huge amounts of waste created. Specifically, the fashion industry that designs clothes made of synthetic fibers faces also the struggle of recycling the material into new clothes, due to technological backwardness and lack of proper systems that could implement it.

Maium is an Amsterdam-based fashion company that produces recycled PET raincoats and that highly values sustainability in its practices, wanting to lead as an example for other fashion brands.
Market and brand analysis (through tools such as 4C analysis and SWOT analysis) are the starting point of this research, which aimed at analysing Maium's environmental impact through Life Cycle Assessments and finding more sustainable alternatives to their current production model. The design process consisted in applying tools like VentureWell's Whole System Mapping and Presidio Sustainability Booster to the results of the LCAs. The process has been an iterative one, so as to best define pain points and opportunities, and thoroughly think of the possible solutions that could be implemented. The iterations have been three in the order LCA-WSM – LCA-WSM – Presidio Sustainability Booster.



STRENGTHS	WEAKNESSES
• Flexibility on the project, thanks to small team;	• Limited knowledge on production processes;
• Ease of communication between «departments» of the company;	• Dependance on Chinese companies for production;
• Sustainable reputation;	• Limited resources to be invested in sustainability pratices (since Maium is still a startup who is trying to impose themselves on the market);
• Bigger ease in product management, since the offer is limited to few products;	
OPPORTUNITIES	**THREATS**
• Consumers are waiting for a strong and real commitment in sustainability from fashion brands, which is still lacking;	• Stiff competition;
• The fashion industry is starting to shift towards a less linear production process and economy;	• Losing partnerships;
• Increase in consumers' sustainable mindset;	
• New technologies and materials are being introduced into the market;	

The design solution has the intent of including the final users in the clothes' lifetime extension process by teaching them techniques and skills that they can apply to their raincoats and to other pieces of clothing as well. Moreover, the intent has been also to provide them with as much information and transparency as possible for what concerns the production processes, the supply chain and alternative business models to the linear one. The design solution consists of three parts: redesign of the care label, website integration of video tutorials and informative articles and a roadmap that describes the necessary steps to take.

The care label redesign has been thought as a way to give easy-to-read information and increase awareness on Maium's activity and the fashion system: it also has a QR code that redirects to the website.
In the website a "repair" page has been included, where three different areas can be explored: "basic repair tutorials", which shows different methods on how to take care of the raincoats, "the industry", which provides informative articles, and "other guides and lessons", which are more exclusive lessons that teach different fashion techniques (such as sewing courses...).
Also an implementation of the take back system for old garments on Maium's end has been proposed: during live events they can collect old garments from users and provide them with workshops or discount on next pruchases.
Finally, a reflection on the methods and tools used has been conducted, together with design and methods recommendations.