



GREEN
SHOES
4ALL

Ecodesign Guide for the Footwear Industry

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1. Scope

Life GreenShoes4All project, supported by European Commission in the framework of Life programme

The project aims to implement, demonstrate and disseminate a Footwear Product Environmental Footprint (PEF) methodology, new recycling and manufacturing solutions and efficient ecodesign to footwear products with low PEF.

The Ecodesign Guide for the Footwear Industry, developed under the Life GreenShoes4All project, intends to support designers and companies in incorporating ecodesign in the development of lower environmental impact footwear products.

This short guide provides strategies to assist footwear companies in the development of footwear products with lower environmental footprint.

2. Introduction

Climate change and sustainability are on the top of our agendas these days. The climate change is a real problem that affects the worldwide population and needs to be addressed with urgent actions by political and scientific communities, but also by the civil society to save the planet. 21st century consumers are better informed and concerned with these issues, want to engage and therefore, they demand more sustainable products and information on their environmental impact.

The footwear industry is conscious and prone to integrate the aspects related with the environmental sustainability and circular economy in the development of new footwear concepts and production processes. Many companies have already started the journey to achieve a "sustainable growth", "carbon economy" and "low carbon footprint" footwear products. The duality between the development of the industry and environmental aggressions is well known, but this mentality is changing, many companies and industries have seen the environmental factor as an opportunity for growth. They can obtain economic and business management benefits by incorporating the environmental factor in their production process and thus decoupling economic growth from environmental impact.

This advantage, together with the increasingly restrictive environmental legislation at European and national levels, as well as the new environmentally friendly mentalities of consumers, makes necessary to address the environmental impact of products and services.

The development of "truly" environmentally sustainable footwear products begins with the design process that should be based on Life Cycle Thinking. At this stage, it is fundamental to define the shoe concept and consider the entire footwear value chain, from the selection of raw materials to product's end-of-life.

Ecodesign can be defined as the "integration of environmental aspects into product design and development, with the aim of reducing adverse environmental impacts throughout a product's life cycle", and should be applied at an early stage in the product development phase leading to improved design specifications. The aim is to develop new sustainable products, minimising the environmental impact throughout the product's life cycle, without compromising the performance, functionality, quality, safety, ergonomics and cost. It is necessary to find the right balance to develop footwear products that fulfil the environmental requirements, the company's business and consumer's expectations.

Currently, several methods and tools, less or more complex, such as MET-matrix, checklists, strategy lists, eco-indicators, carbon footprint, ten golden rules, and Life Cycle Assessment are available to support the implementation of ecodesign. The most suitable tool should be selected according to the type of product, the stage of the product development process, company's objectives, and the development team and resources allocated.

This guide presents strategies to assist footwear companies and designers in the integration of ecodesign in the development of footwear products with lower environmental footprint.

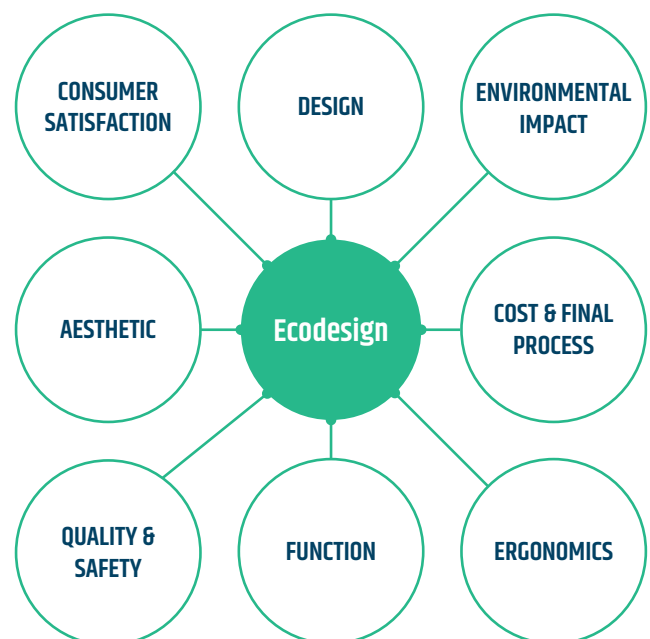


Figure 1 - Aspects to consider in ecodesign

3. Potential benefits of ecodesign

The implementation of ecodesign, during the product development process, may include several potential benefits in different dimensions, namely:

1. Benefits	2. Promotion	3. Identification	4. Improve
Economic benefits by optimising the use of materials and energy, processes efficiency and reducing the waste production and disposal	Promotion of innovation and creativity	Identification of new product concepts and new business models	Improve the image of company and/or brand
5. Enhancement	6. Reduction	7. Compliance	8. Contribute
Enhancement of employee motivation	Reduction of environmental and human risks	Compliance with environmental legal requirements	Contribute to customer loyalty

4. Ecodesign process

The implementation of an ecodesign process in a company requires the involvement of the top management, who can ensure that the new footwear concepts are integrated in the company's business strategy, including the fulfilment of the environmental objectives. The top management must also ensure the allocation of human, technical and financial resources for the planning, implementation and improvement of the ecodesign.

Ecodesign involves the knowledge and competencies of several disciplines and requires a multidisciplinary team and departments that covers the whole shoe development process, such as:

- Designers
- Product engineers
- Material specialists
- Purchasing department (e.g. materials, components, chemical products, etc.)
- Environment
- Quality
- Marketing & sales.

ISO 14006:2020 divides the ecodesign process into six steps, namely:

- Specify of products function.
- Define environmental objectives.
- Improvement of environmental strategies for the product, based on the defined objectives.
- Develop environmental objectives based on improved strategies.
- Establish a product specification addressing the environmental objectives.
- Develop technical solutions to meet the environmental objectives.

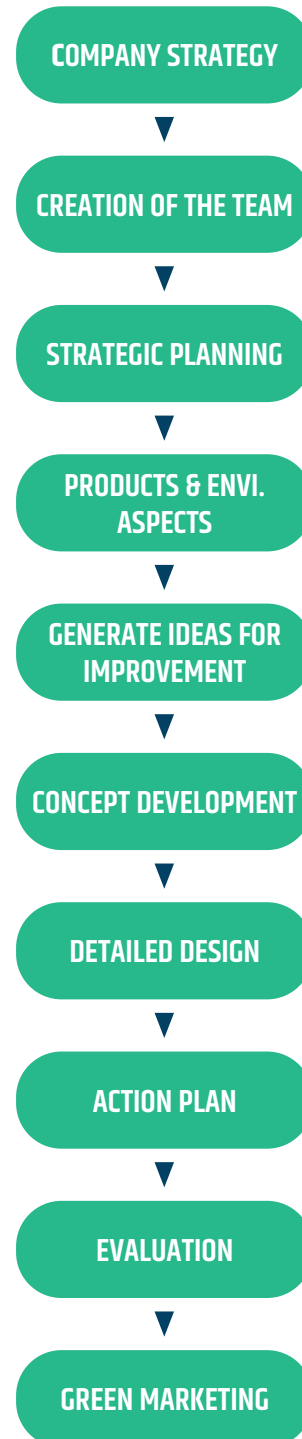


Figure 2: Ecodesign methodology

5. Ecodesign strategies

1. Design for a need

Design for product functional optimisation

Create new footwear concepts with a purpose, considering specific requirements and use, meeting the consumer's needs and the required performance.

- Fashion
- Comfort
- Safety and protective
- Cold weather
- Waterproof
- Athletic

Design for multifunctional use

Create new footwear concepts that can be used in different occasions, reducing the consumption and increasing convenience.

- A shoe combining fashion and comfort, e.g., combination of the nobility of high-quality leather with a soft and flexible outsole.
- A sneaker with a classic style that can be used at work and leisure activities.

Design for modularity and upgradable products

Create modular and upgradable shoes, facilitating customization, but also maintenance, repair and recyclability.

- A customizable design, allowing the substitution or addition of decorative parts, heels, laces, or soles.
- A design with removable and replaceable insoles and or socks/linings to be washed and/or replaced.
- A design that facilitates the separation of components for recycling.

Basic comfort and functional tests to support new footwear concepts

Property	Test method	Specification
Water vapour permeability of upper	ISO 17699	WVP $\geq 0,8$ mg/cm ² .h
Water vapour absorption of upper	ISO 17699	WVA $\geq 8,0$ mg/cm ²
Water resistance of upper	ISO 17702	Penetration time ≥ 60 min, absorption after 60 min ≤ 20 % (water resistant) Penetration time ≥ 180 min, absorption after 180 min ≤ 25 % (highly water resistant) Penetration time ≥ 240 min, absorption after 240 min ≤ 20 % (cold weather)
Water resistance of outsoles	EN ISO 5404	Penetration time ≥ 60 min and after 60 min water absorption ≤ 15 % (only applicable for leather and porous materials)
Thermal insulation	ISO 17705	$\geq 24 \cdot 10^{-3}$ m ² .°C/W

Note: Safety footwear must fulfil specific requirements according to ISO 20345, ISO 20346 and ISO 20347.

2. Design for durability and reparability

Create timeless aesthetic design

A simple, elegant and timeless aesthetic design can extend the life of shoes for several seasons.

- Avoid trendy models that just last one season.
- An attractive, classic and timeless design contributes to footwear longevity and reduces the need to purchase new products.
- Neutral colours and monochromatic shoes increase the number of uses per pair of shoes. For instance, dark coloured footwear, such as black, is less likely to get dirty and can be combined with a wider variety of styles. On the other hand, recycled materials of different origins and colours are converted in black colours.

Create emotional connection to product

Create a concept and tell the story of your product/brand to emotionally connect the consumer. Consumers do not seek only a product, but an experience and a story that identify themselves. Certain iconic designs with a simple and distinctive style are preserved in time throughout the decades.

- Define your sustainable mission statement as well as your objectives and the roadmap to achieve it.
- Create a product/brand that foster an emotional connection with the consumer that promotes and engage him with sustainable values and models, and that allows him to know how to reduce the environmental impact.
- Tell the story of your product/brand to the consumer in a simple, reliable, and transparent way. Lean on images, diagrams and on the product webpage, all this information can be accessed from a QR code.

Design for quality and durability

Develop high-quality and durable footwear products to extend their lifetime.

- Use high-quality and durable materials, such as leather, and footwear robust constructions.
- Ensure the quality control of materials and products and the compliance with the high standard specifications.
- Evaluate the physical performance of the shoes, during the use phase, and identify possible improvements to increase their useful life.

Design for easy maintenance and easy repair

Create footwear concepts that can be easily cleaned, repaired and that can maintain a good look and performance.

- Use durable materials that can be easily cleaned and repaired, for example, some leather after being brushed shine again, and prefabricated outsoles can be easily repaired.
- Use materials that can be easily washed without losing properties and release toxic substances. It is important to pay special attention to potential release of microplastics.
- Use materials with self-cleaning surface treatments, such as hydrophobic or oil repellent materials.
- Use components that are easy to substitute and ensure simple access, for example, decorative pieces, heels, heels top-lifts. Make available to the customer those parts that tend to wear out more easily, explaining in a simple way how to replace them. You can create videos and upload them to the web that explain how to repair the product.

Basic physical mechanical tests to ensure quality and durability

Property	Test method	Specification
Flex resistance of upper	ISO 17694	dry conditions: 100 000 cycles wet conditions: 20 000 cycles
Tear strength of upper	ISO 17696	≥ 40 N average tear force
Colour fastness of upper	EN ISO 17700	Inside staining: method A: if unlined footwear, must comply ≥ 2/3 after 50 cycles with perspiration solution Outside surface colour change and staining: method A: ≥ 3 (grey scale) after 150 cycles dry and 50 cycles wet. method B: ≥ 3 to 4 (grey scale) after 512 cycles dry and 128 cycles wet.
Water vapour permeability of upper	ISO 17699	WVP ≥ 0,8 mg/cm ² .h
Water vapour absorption of upper	ISO 17699	WVA ≥ 8,0 mg/cm ²
Abrasion resistance of lining	ISO 17704	dry conditions: 25 6000 cycles wet conditions: 12 800 cycles without hole through the thickness of the material component
Flex resistance of outsole	EN ISO 17707	cut growth ≤ 4,0 mm and no spontaneous crack
Abrasion resistance of outsole	ISO 20875	0,9 g/cm ³ ≤ d ≤ 200 mm ³ 0,9 g/cm ³ > d ≤ 150 mg
Bondability	EN 1392	≥ 4 N/mm

Create emotional connection to product



3. Design for recycling, reuse and recovery

Design with simplicity

Make it simple!

- Minimise the number of different materials and components, increasing the possibility of recycling and decreasing energy consumption.
- Minimise the mixing of materials, for example, do not mix leather with textiles, fibre or foams of different natures, or rubber with thermoplastic materials. Avoid the use of plastic prints on leather and textiles and the use of metal parts.
- Use materials that are easily distinguishable with diverse characteristics and can be easily separated by automatic classification systems, facilitating the recycling process.
- Evaluate the possibility of combining the essential functions in a single material, requiring less production processes, e.g., use the same material as upper and lining.

Design for easy disassembly

Easy disassembly will facilitate the separation of materials and components for recycling, reuse or recover.

- Design for fast manual or automated disassembly.
- Design for a recyclable product.
- Avoid permanent fixing (adhesives, co-moulding) of different materials.
- Minimise fasteners, decreasing weight and material variety.
- Label products with the composition of materials to facilitate separation and recycling.

Design for biodegradability, compostability and or biobased

- Select biodegradable materials.
- Select compostable materials.
- Select biobased materials.

Design to avoid the use of critical substances

Do not use hazardous substance that contaminates the materials and components.

- Select materials without critical substances avoiding the contamination of recycled, reused or recovered materials. If its use is unavoidable, control the use and management of associated waste.

Design to use of recyclable, reusable and recoverable materials and components

Think of materials and waste as nutrients.

- Select good quality recyclable materials (recyclable fibres, recyclable plastics, ...).
- The use of single materials facilitates their recyclability in current treatment systems.
- Recycle waste materials from other sectors for a second use, e.g., tire rubber to cut and make outsoles.

Implement an internal waste management system

Valorise the manufacturing waste and use as a material.

- Recover your own waste generated in each unit process.
- Implement a reverse logistics system to reintroduce the waste produced in the value chain.
- Take into account the process of adaptation of these recycled materials and the impacts that they may have associated with it.

RECOVER WASTE PROCESS



4. Select less, lighter and lower impact materials

Use less and lighter materials

Reduce the weight of footwear products, ensuring the performance, and develop minimalist products.

- Reduce the quantity and diversity of materials and components.
- Reduce the weight of materials and components because they are critical to reducing footwear environmental impact.
- Reduce the volume of materials and components in a shoe.

Select low environmental impact materials

Use materials that reduce raw material depletion, and are abundant, renewable and sustainable.

- Materials and components with a high content of recycled post-consumer waste (e.g., footwear, textile, grinded tyre rubber).
- Materials and components with a high content of recycled manufacturing waste (e.g., recycled fibres, thermoplastics, rubber).
- Natural and renewable materials (e.g., cork, wood, natural fibres).
- High-quality, durable and timeless materials, e.g., leather produced from hides or skins, a by-product of meat industry, using lower impact production processes. Turning hide into leather is one of the oldest forms of recycling.
- Materials from organic cultures (e.g., organic cotton, organic hemp).
- Biobased and/or biodegradable and compostable materials (e.g., biodegradable thermoplastics).
- Materials with potential to be recycled, using available recycling facilities and technologies.
- Lower energy content materials.
- Choose materials classified as sustainable, e.g., labelled/certified materials of recognised, credible, and transparent certification process.
- Buy local materials and components because they contribute to minimise the resource consumption and emissions associated to their transport, and also support local economy.
- Use trustworthy providers. Avoid materials from countries in conflict and lack of warranty.
- Take into account the pre-processing for the extraction and pre-processing of raw materials, knowing the entire value chain and ensuring the traceability of the material.

Create a database of materials and suppliers

A database of materials and suppliers will support the selection of materials with lower impact.

- An internal database, including certified materials and information about their environmental impact, will help designers in comparing and selecting materials.
- Define a list of materials that might be used in the footwear manufacturing.
- It can be completed with recognised certificates and with nearby suppliers that have such material and can ensure its availability.

Examples of materials impact

Fibres

The following table compares the environmental impact of the most commonly used fibres in the garment industry, which can also be used in the footwear industry. These fibres were scored and organised into one of five classifications (Class a to Class E), based on the following impact categories: greenhouse gas emissions; human toxicity; eco-toxicity; energy; water; and land.

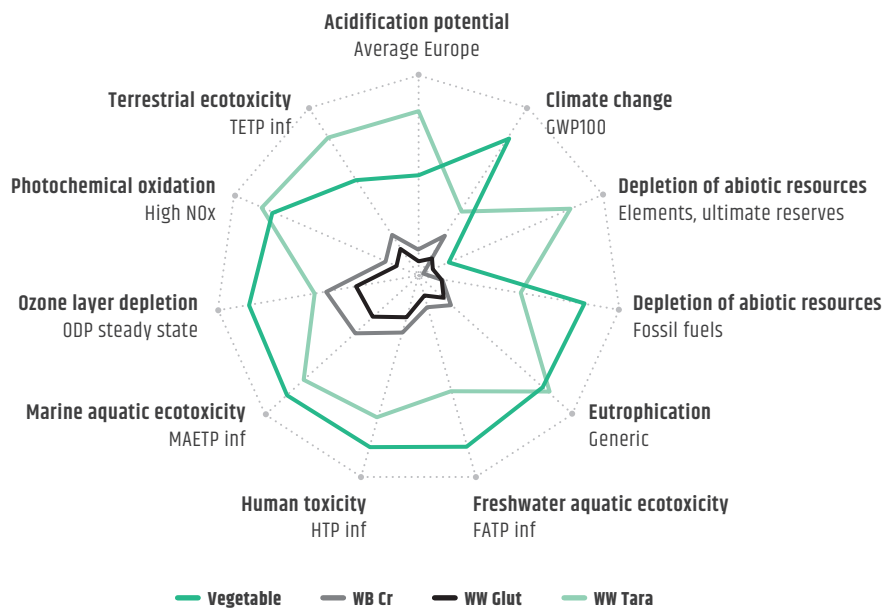
ENVIRONMENTAL BENCHMARK FOR FIBRES

CLASS A	CLASS B	CLASS C	CLASS D	CLASS E	UNCLASSIFIED
Mechanically Recycled Nylon	Chemically Recycled Nylon	Conventional Flax (Linen)	MODAL® (Lenzing Viscose Product)	Bamboo Viscose	Acetate
Mechanically Recycled Polyester	Chemically Recycled Polyester	Conventional Hemp	Poly-acrylic	Conventional Cotton	Alpaca Wool
Organic Flax (Linen)	CRAILAR® Flax	PLA	Virgin Polyester	Generic Viscose	Cashmere Wool
Organic Hemp	In Conversion Cotton	Ramie		Rayon	Leather
Recycled Cotton	MONOCEL® (Bamboo Lyocell Product)			Spandex (Elastane)	Mohair Wool
Recycled Wool	Organic Cotton			Virgin Nylon	Natural Bamboo
	TENCEL® (Lenzing Lyocell Product)			Wool	Organic Wool
					Silk
More Sustainable			Less Sustainable		

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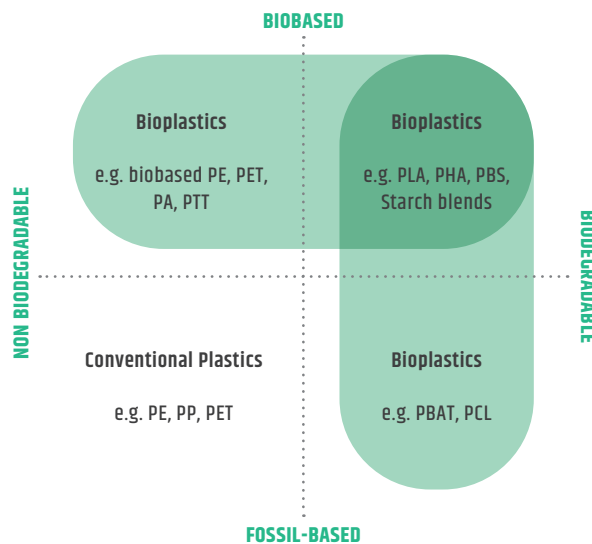
Leather

Leather can be a good choice of circular material, because it is natural, produced from a basic raw material derived from animal sources, a by-product of the meat industry, where all the skins used in the production of leather come from animals raised for food. Avoiding landfill deposition, in addition to being biodegradable and disintegrable, versatile, timeless, durable and repairable.



Plastic materials

Biobased materials indicate that they do not come from sources derived from petroleum, although for their processing they may be dependent on this (for example, for the energy consumption of machinery). Bio-based materials can be biodegradable or not.



5. Avoid potentially hazardous substances and materials

Select materials in compliance with REACH, CADS list, ZDHC MRSL and other applicable legislation

Avoid materials that damage the human health and the environment.

- Test the materials and components for the potential critical substances and/or ask for declarations.
-

Use water-based chemical products

Substitute the solvent base products by water base products.

- Avoid the use of volatile organic compounds, fluorinated gases, among others.
-

Find alternatives to metals

Avoid the use of metals in the products.

- Select and use materials free of heavy metals.
 - Replace metallic pieces with composites materials.
 - Swap metals for rigid polymers.
-

Basic chemical tests

Substances	Test method	Specification
Azodyes	ISO 17234: 2020 (leather) ISO 14362-1:2017 (textiles)	< 20 mg/kg (CADS)
Dyestuffs classified as allergens (coated textiles)	DIN 54231: 2005-11 and BVL B 82.02-10: 2007-03, Draft standard DIN EN ISO 16373-2: 2014-05	< 3,3 mg/l (50 mg/kg)
Dyestuffs classified as carcinogenic (coated textiles)		< 3,3 mg/l (50 mg/kg)
Chromium VI	ISO 17075:2017 (leather)	< 3 mg/kg
Heavy metals	EN 14602: 2012	< 100 mg/kg (Cadmium); < 90 mg/kg (Lead)
Formaldehyde	ISO 17226:2018 (leather) EN ISO 14184:2011 (textile)	< 75 mg/kg
Perfluorooctanesulfonate (PFOS)	DIN CEN /TS 15968: 2010-11	< 1 µg/m ² (textile); < 0,025 mg/kg (leather)
Nonylphenol ethoxylated (NPEO)	ISO 18218:2015 (leather) EN ISO 18254:2016 (textiles)	< 100 mg/kg

Note: Other substances can be considered depending on the material.

6. Optimise production techniques

Simplify the production process

Minimize number of production stages.

- Reduce the number of operations and production steps.
 - Use alternative production techniques.
-

Use of cleaner production techniques

Seek to eliminate toxic emissions.

- Evaluate and identify hazardous emissions in the production process and find alternatives.
 - Replace water curtain cabins with dry filter finishing cabins.
 - Replace solvent-based with water-based adhesives.
 - Use materials that do not need additional treatments, e.g., surface treatment to certain soles prior to bonding.
 - Minimise the use of chemical products during the production process.
 - Fewer/cleaner production consumables.
-

More energy efficient processes

Minimise the use of energy.

- Reduce the use of fossil fuels and increase the use of renewable energy.
- Select more energy efficient equipment, e.g., low energy pumps, compressed air.
- Define good practices in the use of equipment, e.g., turn off machines when not in use, create a periodic maintenance plan.
- Raise workers awareness on the benefits of efficient energy consumption.
- Use co-generation processes to recover energy in the form of heat. Establish synergies with nearby industries for this purpose.

Minimise waste production

Eliminating manufacturing waste saves material and disposal environmental impact and company costs.

- Product design to minimise the waste production.
- Use computer controlled cutting machines to maximise materials and reduce waste production.
- Recycle/reuse subproducts in the company itself.
- Raise workers awareness on the advantages of reducing waste generation.
- Establish control over the waste generated and look for nearby companies that can incorporate some of this waste into their value chain.

Production quality control

Implementation of quality control saves time and resources.

- Establish quality control procedures throughout the production process, saving human and economic resources and avoiding product rejection.
- Certify your product for external recognition of environmental performance, transparency and traceability.

7. Select more environmental efficient distribution

Design new packaging concepts

Conceive new packaging concepts.

- Reduce packaging volume and weight.
- Reduce unnecessary packaging.
- Use single materials.
- Conceive packaging design that can have other uses.
- Provide information on the packaging about your end-of-life treatment (for example: separate the parts and recycle in the paper and cardboard fraction) and information for storage and conservation of footwear (clean and keep dry).

Use lower impact materials

Reduce the impact of packaging materials.

- Recycled materials.
- Recyclable materials.
- Reusable materials.
- Avoid the use of inks and colorants.
- Use local materials and production.

More efficient distribution

Reduce the impact of product distribution.

- Use containers of standard and modular size, to maximise transport.
- Transportation by train or marine container is preferable to the truck because they are less polluting. The use of electric vehicles will always be preferable. Avoid air transport. Use parcel transport bicycle or electric means for transportation in short distances.
- Raise awareness of the sales department to work with local suppliers. This helps reduce transportation cost and generates less stock.

**Design for quality
and durability**

**Use durable
materials that can
be easily cleaned
and repaired**



8. Reduce the environmental impact in the use phase

Information to consumer

Provide information, promoting a change in consumer behaviour in maintenance and repair.

- Best practice guide: Guidance for cleaning, maintenance and repair of footwear (e.g., information folder in shoebox, infographics, mobile app /QR CODE, website, etc.)
- Provide information on the maintenance and repair benefits.

Services to consumer

Provide a service, engaging consumer and extending the life of footwear products.

- Supply a cleaning and maintenance kit.
- Supply a kit with replaceable damage/lost pieces.
- Offer a repair service in the stores/companies.
- Offer a customisation service.
- Offer a discount on future purchases for the collection and management of old footwear.
- Offer a repair guarantee.

9. Optimise the end-of-life

Information to consumer and consumer's behaviour change

Provide information, promoting a change in consumer behaviour in end-of-life.

- Provide a best practice guide with the best alternatives at the product end-of-life.
- Label the products/materials to facilitate the sort and recycling.
- Provide reliable and transparent information about the product, brand and commitment with sustainability.
- Provide information on the recycling benefits.
- Promote collection campaigns.
- Offer incentives to give a second life to product (e.g., charity, second-hand stores, reparation) and to recycling.

Service to consumer

Offer services to consumer, promoting the recycling of footwear at end-of-life.

- Create a recycling business model.
- Establish agreements with companies that collect used footwear to recover certain materials.
- Provide a collection product service, e.g., in-store collection, collecting box and return by postage, container collections, pick-up collection, etc.

Collaborative initiatives

- Promote and collaborate on the creation of footwear collection points for recycling.
- Promote and collaborate on the creation of a management platform of footwear products and components at the end-of-life, integrating all the possibilities: charity, second-hand stores, recycling facilities.



Minimize the number of different materials and components

Design with simplicity

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