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Preparatory study on textiles for product policy instruments

Ecodesign
EU Green Public Procurement
EU Ecolabel

2nd milestone

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Foreword

This document is the 2nd milestone of the preparatory study on textile products, which aims to provide a basis on which the European Commission can consider the development of ecodesign requirements, green public procurement criteria and revised EU Ecolabel criteria for textile products. In particular, the 2nd milestone addresses scope, market, user behaviour, current EU Ecolabel criteria, current EU Green Public Procurement criteria, and the product technologies. The preparatory study is developed within the legal context of the Regulation (EU) 2024/1781 establishing a framework for the setting of ecodesign requirements for sustainable products and the Regulation (EC) No 66/2010 on EU Ecolabel. The project is led by the Joint Research Centre of the European Commission, addressing the request from the Directorate-General for Environment (DG ENV) and the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG GROW).

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1 Introduction

Context

On 13 June 2024, the Regulation on Ecodesign for Sustainable Products (ESPR) ([1]) was published on the Official Journal of the European Union. The ESPR delivers on the commitments made in both the European Green Deal ([2]) and the Circular Economy Action Plan ([3]) to make the European Union (EU) regulatory framework fit for a sustainable future and to ensure that products placed on the EU market become increasingly sustainable.

The ESPR aims to reduce the environmental impacts of products across their life cycle and to improve the functioning of the EU's internal market. It proposes to do this by building on the successful approach pioneered under the Ecodesign Directive ([4]), which applies to energy-related products only. The ESPR proposes to extend the Ecodesign Directive to cover a very broad range of physical products and to strengthen its provisions. This would enable the ESPR to set a range of far-reaching ecodesign requirements for specific product groups, to improve product circularity, energy performance and other environmental sustainability aspects. Ecodesign requirements can be related to the performance of the product or information that must accompany the product. A Digital Product Passport (DPP) will be required to hold and convey the information in question, with traceability features.

The ESPR provides a general framework for these rules, with specific product requirements to be set at a later stage via delegated acts dedicated to a particular product or to groups of similar products. These delegated acts will also serve as the reference for the adoption of implementing acts, which should establish minimum mandatory Green Public Procurement (GPP) requirements for public contracts.

Article 41(4) of the ESPR establishes synergies between the mandatory ecodesign legislative framework and the EU Ecolabel, which is the EU's official voluntary label for environmental excellence awarded to best-in-class products. The ESPR and EU Ecolabel requirements must be coherent and synergic to guarantee that products awarded the EU Ecolabel comply with the ESPR requirements set in the relevant delegated act. The EU Ecolabel remains regulated by the EU Ecolabel Regulation ([5]).

On 30 March 2022 the EC presented the EU Strategy for Sustainable and Circular Textiles ([6]) which aims, *inter alia*, '*to tackle fast fashion and textile waste and to make textiles more durable, reparable, reusable and recyclable'*. The Textile Strategy lays out a forward-looking set of actions, which includes setting ecodesign requirements for textiles under the framework of the ESPR proposal ([7]). The Textile Strategy also announces a revision of the EU Ecolabel criteria for textile products to support its uptake among producers and offer consumers an easily recognisable and reliable way to choose eco-friendly textile products.

Since 2019, the EC has supported the project 'Product Environmental Footprint Category Rules (PEFCR): apparel and footwear', hereinafter named PEFCR A&F ([8]). Part of the textile industry leads this project, which aims to establish rules for the calculation of the Product Environmental Footprint. Once produced, the PEFCR can be used by the industry to voluntarily quantify and report the environmental impacts of specific textile products. The EC follows the development of the PEFCR A&F project as an observer.

[1] ESPR. Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products. Available at this link.

[2] The Green Deal. Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions . The European Green Deal. COM(2019) 640 final. Available at this link.

[3] The Circular Economy Action Plan. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A new Circular Economy Action Plan For a cleaner and more competitive Europe. COM(2020) 98 final. Available at this link.

[4] Ecodesign Directive. Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for energy-related products. Available at this link.

[5] EU Ecolabel Regulation. Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel. Available at this link.

[6] Textile Strategy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. EU Strategy for Sustainable and Circular Textiles. COM(2022) 141 final. Available at this link.

[7] Proposal of ESPR by European Commission. Proposal for a Regulation of the European Parliament and of the Council establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC. COM(2022) 142 final. Available at this link.

[8] 'Product Environmental Footprint Category Rules (PEFCR): apparel and footwear', available at this link. Last accessed on 3 February 2024. It will set rules on the calculation and reporting of life cycle environmental impacts of apparel.

Aim

In this context, this report describes the preparatory study on textile products, which is hereinafter referred to as the PS. The PS aims to provide the scientific and technical basis for:

- the future development of the ecodesign requirements for textile products to be defined in a delegated act within the framework of the ESPR;
- the future development of the mandatory EU GPP requirements for textile products within the framework of the ESPR;
- the future revision of the EU Ecolabel criteria for textile products ([9]), within the framework of the ESPR and the EU Ecolabel Regulation.

Methodology

The PS will follow the structure prescribed by the Methodology for Ecodesign of Energy-related Products (MEErP) (MEErP, 2011). This methodology has over many years proved to be comprehensive and effective for preparing product-related legislation, and is therefore also deemed fit for non-energy-related products. The MEErP consists of seven tasks:

- **Task 1 on scope** defines the boundaries of the system under analysis. It identifies the textile products included in the scope of the PS and their categories. Additionally, it analyses legislative and voluntary frameworks at global, EU and Member State level.
- **Task 2 on market** investigates the market structure, trends and other market characteristics of the products in the scope.
- **Task 3 on user behaviour**. It describes how users relate to the products in the scope. It investigates:
  - (a) aspects influencing the design of the products, identifying potential barriers and restrictions to possible ecodesign measures, due to social, cultural or infrastructural factors;
  - (b) aspects influencing the modelling of environmental impacts and costs of the products in the life-cycle perspective, identifying behaviour not directly quantifiable with conventional standard tests on the products.
- **Task 4 on technologies** entails a general technical analysis of the products in the scope in order to describe the average products on the market, as well as the best available technologies (BAT) and the best not yet available technologies (BNAT).
- **Task 5 on environmental and economic analysis** of the average products on the EU market. It defines *base case* products, which are a conscious abstraction of the reality for practical reasons, and it represents a specific product category. The description of the base case is the synthesis of tasks 1 to 4 and the starting point for the following tasks. The base case is analysed via models based on Life Cycle Assessment (LCA) and Life Cycle Costing (LCC).
- **Task 6 on design options** investigates the monetary consequences of the design options in terms of cost within the life cycle for consumers and society. Environmental costs and benefits are also investigated using the Least Life Cycle Costs (LLCC) and the BAT. The BNAT indicate long-term possibilities.
- **Task 7 on possible policy scenarios** gathers the results of all previous tasks and investigates suitable policy means to achieve the potential improvements in the environmental impacts of the assessed products, as well as estimating economic impacts on consumers and the industry. Finally, it assesses the robustness of the outcomes via a sensitivity analysis.

The methodology used will be adapted to the specific features of the textile product group and the requirements set by the ESPR.

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[9] EU Ecolabel criteria for textile products. Commission Decision of 5 June 2014 establishing the ecological criteria for the award of the EU Ecolabel for textile products. Commission Decision (2014/350/EU). Available at this link.

In addition to following the tasks set by the MEErP, the PS will include all elements of the Preliminary Report, to be used for the revision of the EU Ecolabel criteria for textile products ([9]), as set by the EU Ecolabel Regulation ([5]).

Due to their aims, future mandatory EU GPP requirements and future revised EU Ecolabel criteria of products included in the scope of the PS will be built up from the ecodesign requirements.

Involvement of stakeholders

The development of the PS will include the direct involvement of stakeholders following the principles of the Sevilla process ([10]), which will enable the JRC to verify with stakeholders the work under development and collect additional evidence on the investigated topics.

Table 1 reports the stages of the project that will require the participation of registered stakeholders. Any organisation, institution and citizen can register as a stakeholder by filling in a form on a dedicated webpage ([11]). Stakeholders will be able to register at any stage of the development of the PS.

Table 1. Development of the preparatory study

Milestone	Topic addressed	Date
Initial questionnaire ([12])	Definitions, scope, market analysis, user behaviour, product aspects, EU Ecolabel, EU Green Public Procurement	30 March 2023 – 8 May 2023
1st milestone	Scope, market, user behaviour, current EU Ecolabel criteria, current EU Green Public Procurement criteria	23 February to 22 April 2024
2nd milestone	Technologies, framework and data gaps of environmental and economic model, and a questionnaire about substances and substances of concern	14 November 2024 to 17 March 2025 (*)
3rd milestone	Analysis of base case and design options	To be communicated
4th milestone	Policy scenarios, and elements to be included in the Digital Product Passport	To be communicated

The number and topics of the milestones could be modified to improve the involvement of the stakeholders during the development of the preparatory study.

(*) The 2nd milestone includes the following steps: (a) from 14 November to 8 December 2024, registered stakeholders may read the section on product technologies before the online consultation meeting; (b) from 2 to 9 December 2024, registered stakeholders may read the questionnaire on substances and substances of concern; (c) on 9 and 10 December 2024, registered stakeholders and JRC attended the online consultation meeting; (d) from 18 December 2024 to 3 March 2025, registered stakeholders will be able to provide comments in writing to the working document; (e) from 18 December 2024 to 10 March 2025, registered stakeholders will be able to contribute to the questionnaire on substances and substances of concern; (d) from 18 December 2024 to 17 March 2025, registered stakeholders will be able to contribute to improve the inventory and framework of the environmental and economic model.

For each milestone, the stakeholder consultation will include the following steps:

- The JRC will communicate by email to all registered stakeholders the time and steps of the specific consultation, as well as the document(s) related to the milestone. All documents will be uploaded on the project's website ([13]).
- Registered stakeholders will read the document(s) before the online consultation meeting.
- JRC and registered stakeholders will attend the online consultation meeting. In this meeting, registered stakeholders will be able to have open discussions with the JRC and among themselves.
- Registered stakeholders will provide comments on the working document(s).
- The JRC will publish on the project's website ([13]) a document containing anonymised written comments submitted by the registered stakeholders.

[10] With the 'Sevilla process', the Joint Research Centre of the European Commission works together with scientists, industry, non-governmental organisations (NGOs), national authorities and international institutions to take decisions that are underpinned by solid scientific and technical data, and that are based on consensus and transparency. The process is clearly structured within the framework of the Industrial Emissions Directive (2010/75/EU), and it is legally defined in Commission Implementing Decision 2012/119/EU available at this link. More information is available at this link. The process in the preparatory study on textiles is not legally defined, but it will follow the principles of the "Sevilla process".

[11] Stakeholders can participate in the development of the preparatory study on textile products by registering via this web form.

[12] Initial questionnaire. Preparatory Study on textiles for product policy instruments – the initial questionnaire. Available at this link.

[13] The textile project website is available at this link. Documents will be uploaded in the dedicated section available at this link.

All entities involved in the stakeholder consultations will have enough time to actively participate in the process.

This version of the PS reports the 2nd milestone and it includes some of the information collected by the initial questionnaire ([12]).

Structure of the preparatory study – 2nd milestone

After this introduction, Section 2 provides the definitions of words and expressions used in the document.

Section 3 defines the scope and describes the products included in it, providing also a first insight into their life-cycle stages and main environmental burdens. This brief description provides the reader with a basic knowledge useful to better understand the topics investigated in the following sections.

Section 4 analyses legislation and strategies at different levels: EU, Member State, third country, and global, the latter describing initiatives of the United Nations. Section 4 is completed by the analysis of the most relevant test methods, standards and environmental labels used internationally by the textile industry.

Section 5 analyses the market of the textile products belonging to the scope. The analysis is performed at global, EU and Member State levels. Additionally, Section 5 investigates the market of the main elements affecting the manufacturing of the products included in the scope. The market analysis includes some insights into the market structure, most common business models, and it reports the main characteristics of the value chain. A specific subsection is dedicated to market competitiveness, which is affected by the different costs that companies face around the world due to the different requirements related to environmental protection. Section 5 concludes with a subsection analysing the lifespan of products, because it largely affects the market and the demand for new products.

Section 6 analyses user behaviour, which will be relevant for: (1) modelling the products in the economic and environmental assessment, and (2) the analysis of possible ecodesign requirements within the product aspects listed by Article 5 of the ESPR. The section addresses the behaviour before and after the purchase, as well as behaviour related to the disposal of the textile product.

Section 7 analyses the current EU Ecolabel criteria for textile products in light of their revision. Facts and figures of the current criteria are reported as well as the suggestions received via the initial questionnaire. The section describes the relationship between the new mandatory ecodesign framework (ESPR) and the revision of the EU Ecolabel criteria for textile products. To explore potential synergies with other officially recognised Ecolabels, Section 7 provides a detailed comparison of the criteria for textile products set by the EU Ecolabel, Blue Angel and Nordic Swan.

Section 8 collects information for the future development of mandatory EU GPP criteria. To this aim, this section assesses the current public procurement of apparel in the EU, and the current status of the voluntary EU GPP criteria.

Section 9 provides a general technical analysis of the products in the scope from the perspective of the relevant product aspects listed by Article 5 of the ESPR.

2 Definitions

This section lists the definitions of terms and expressions used in the document. It will be complemented with more definitions as the project goes through its milestones (see Section 1).

Textile fibre

'Textile fibre' means either of the following ([14]):

— a unit of matter characterised by its flexibility, fineness and high ratio of length to maximum transverse dimension, which render it suitable for textile applications;

— a flexible strip or tube, of which the apparent width does not exceed 5 mm, including strips cut from wider strips or films, produced from the substances used for the manufacture of the fibres listed in Table 2 of Annex I to Regulation 1007/2011 and suitable for textile applications.

Textile product

'Textile product' means any raw, semi-worked, worked, semi-manufactured, manufactured, semi-made-up or made-up product which is exclusively composed of textile fibres, regardless of the mixing or assembly process employed, as well as a product containing at least 80% textile fibres by weight.

The definition of textile product is aligned with the definition provided by the Textile Labelling Regulation (TLR) ([14]).

Textile apparel

'Textile apparel' are textile products that aim to cover the body with everything except footwear. In addition, it also means a textile product worn as clothing or a clothing accessory by a person to clothe and/or adorn, and/or shield from, and/or feel comfortable with the outer environment and/or to express their personal and professional identity and/or belonging to a specific social group, with symbolic meanings and aesthetic values.

Technical textile

Technical textiles are textile products meeting technical rather than aesthetic criteria, even if, for certain markets like workwear or sports equipment, both types of criteria could be met. Technical textiles bring a functional answer to a wide range of specific requirements: lightness, resistance, reinforcement, filtration, fire retardancy, conductivity, insulation, flexibility, absorption and so on. The definition does not depend on the raw material, the fibre or the technology used, but on the expected inherent functionality of the product itself. Technical textiles can be used by professionals or not.

Textile apparel meeting the definition above is defined as *technical textile apparel*.

The definition of technical textiles is aligned with the definition provided by the European Economic and Social Committee ([15]).

Home/interior textiles

Textile products used indoor or outdoor to protect the object they are used on/with, decorate the home/interior environment, or dry the body or parts of the body after they have become wet.

Footwear

'Footwear' means all articles with applied soles designed to protect or cover the foot, including parts marketed separately ([16]).

[14] Textile Labelling Regulation. Regulation (EU) No 1007/2011 of the European Parliament and of the Council of 27 September 2011 on textile fibre names and related labelling and marking of the fibre composition of textile products and repealing Council Directive 73/44/EEC and Directives 96/73/EC and 2008/121/EC of the European Parliament and of the Council. Available at this link.

[15] CCMI/105, Technical textiles, Brussels, 17 April 2013, OPINION of the European Economic and Social Committee on Growth Driver Technical Textiles. (own initiative opinion). Rapporteur: Ms Butaud-Stubbs. Corapporteur: Ms Niestroy. Available at this link. Last accessed on 30 March 2023.

[16] Directive 94/11/EC of European Parliament and Council of 23 March 1994 on the approximation of the laws, regulations and administrative provisions of the Member States relating to labelling of the materials used in the main components of footwear for sale to the consumer. Available at this link.

Textile waste

Textile waste is a textile product which the holder discards or intends or is required to discard ([17]).

Post-industrial textile waste

Post-industrial textile waste is textile waste generated during the manufacturing of textile products and their precursors (manufacturing of fibre, yarn and fabric, and during confectioning) (Huygens et al., 2023)

Pre-consumer textile waste

Pre-consumer textile waste is textile waste generated as a result of discarding unsold textile products.

Post-consumer textile waste

Post-consumer textile waste is a textile product that have been discarded after consumption and use by the citizen or end-users of commercial and industrial activities (hotel, care, automotive, etc.). For this reason it is commonly referred to as household and commercial post-consumer textile waste, respectively (Huygens et al., 2023).

Final product

A final product is understood to be a product that is already suitable for users ([18]).

Intermediate product

'Intermediate product' means a product that requires further manufacturing or transformation such as mixing, coating or assembling to make it suitable for end-users ([19]).

Table 2 reports the definitions of the 16 product aspects reported in article 5 of the ESPR. The hierarchy applied for selecting the most appropriate source for each definition was the following: the current legislation, standards and scientific literature. In some cases, the authors have adapted the definition from those sources.

Table 2. Definition of product aspects

Product aspect	Definition	Source
Durability	The ability of a product to maintain over time its function and performance under specified conditions of use, maintenance and repair.	ESPR
Reliability	The probability that a product functions as required under given conditions for a given duration without an occurrence which results in a primary or secondary function of the product no longer being performed	ESPR
Reusability	Ability of a product or component that is not waste to be used again for the same purpose for which it was conceived.	JRC (adapted based on Directive 2008/98/EC definition for *'Re-use'*)
Upgradability	Ability of a product to be accessible for implementing actions to enhance its functionality, performance, capacity, safety or aesthetics.	JRC (adapted based on ESPR definition for *'Upgrading'*)
Repairability	Ability of a defective product or waste object to return to a condition where it fulfils its intended use.	JRC (adapted based on ESPR definition for *'Repair'*)
Possibility of maintenance	Ability of a product to be kept in a condition where it is able to fulfil its intended purpose through one or more actions.	JRC (adapted based on ESPR definition for *'maintenance'*)

[17] The definition of textile waste is inspired by the definition of waste reported by the Waste Framework Directive (WFD). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance). Available at this link.

[18] The definition of final product is implied from the ESPR.

[19] The definition of intermediate product is reported in Article 2(3) of the ESPR.

Product aspect	Definition	Source
Possibility of refurbishment	Ability of a product or a discarded product to be prepared, cleaned, tested, serviced and, where necessary repaired to restore its performance or functionality within the intended use and range of performance originally conceived at the design stage at the time of the placing of the product on the market.	JRC (adapted based on ESPR definition for *'refurbishment'*)
Presence of substances of concern	The presence of substances that: - meet the criteria laid down in Article 57 of Regulation (EC) No 1907/2006 and are identified in accordance with Article 59(1) of that Regulation - are classified in Part 3 of Annex VI to Regulation (EC) No 1272/2008 in one of the hazard classes or hazard categories listed under Article 2(27)(b) of ESPR - are regulated under Regulation (EU) 2019/1021; or - negatively affect the reuse and recycling of materials in the product in which they are present	ESPR
Energy use and energy efficiency	Energy use: Use of energy in all lifecycle stages of a product Energy efficiency: the ratio of output of performance, service, goods or energy to input of energy.	JRC JRC
Water use and water efficiency	Water use: Use of water in all lifecycle stages. Water efficiency: The ratio of output of performance, service, goods to input of water.	JRC JRC
Resource use and resource efficiency	Resource use: Use of raw materials, mainly abiotic (minerals, metals, fossil fuels), in all lifecycle stages. It can also include other biotic resources such as land, air, ecosystems. The use of natural resources can be accounted for as the volumes of resources consumed (materials) or used (land, air, ecosystems), or the impacts derived from the use of resources. Water and energy are not considered within resources under the scope of ESPR. Resource efficiency: The ratio of output of performance, service, goods to input of resources, raw materials, air, land, soil and ecosystem services.	JRC and (BIO Intelligence Service, DG for Enterprise and Industry (EC), 2013)
Recycled content	Proportion, by mass, of recycled material, from pre- and post-consumer waste, in a product or packaging.	ISO 14021
Possibility of remanufacturing	Possibility of producing through actions a new product from objects that are waste, products or components and through which at least one change is made that may affect the performance, purpose or type of the product.	JRC (adapted based on ESPR definition for *'Remanufacturing'*)
Recyclability	Ability of products after becoming waste to be reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.	JRC (adapted based on Directive 2008/98/EC definition for *'recycling'*)
Possibility of recovery of materials	Ability of products after becoming waste to be recovered through any recovery operation, other than energy recovery and the reprocessing into materials that are to be used as fuels or other means to generate energy. It includes, inter alia, preparing for re-use, recycling and backfilling.	JRC (adapted based on Directive 2008/98/EC definition for *'material recovery'*)
Environmental impacts	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from a product during its life cycle	ESPR
Expected generation of waste	Generation of any substance, or object that the holder discards or intends or is required to discard.	JRC (adapted based on Directive 2008/98/EC definition for *'waste'*

Source: own elaboration

3 Scope

This section selects and describes the products included in the scope of the PS. The first subsection (Section 3.1) reports the thought process followed to select the scope in accordance with the framework set by the ESPR. The second subsection (Section 3.2) lists the products included in the scope and specifies those that are excluded. The final subsection (Section 3.3) describes two important aspects of textile products that apply to the products in the scope, i.e. the life-cycle stages and their main factors influencing the negative environmental impacts. This last section is the essential basis for fully understanding a number of topics addressed in subsequent sections about environmental labels (Section 4.5), the market analysis (Section 5), and the analysis of product technologies (Section 9). Nevertheless, the topics mentioned in Section 3.3 will be detailed in the following milestones, when the PS addresses Task 5 of the MEErP.

3.1 Selection of the scope

Within the framework of the European Industrial Strategy ([20]), the Annual Single Market Report 2021 ([21]) identifies the products included in the **industrial ecosystem of textiles**: *'transformation of natural (e.g. cotton, flax, wool), man-made and artificial (synthetic polyester and viscose) fibres into yarns and fabrics, production of yarns, home textiles, industrial filters, technical textiles, carpets and clothing. The ecosystem also includes production of footwear and leather.'*

The EC is currently working on the first ESPR Working Plan, taking into account among other things a report ([22]) entitled 'Ecodesign for Sustainable Products Regulation: Study on new product priorities', hereinafter referred to as the **Product Priorities Study**. It suggests a number of product groups and horizontal measures that may be suitable candidates for prioritisation under the ESPR. The first Product Priorities Study served as the basis for an open public consultation ([23]). Among the many product groups in the scope of the ESPR, the Product Priorities Study assesses a product group named '**textiles and footwear**', which includes products belonging to the industrial ecosystem of textiles. Respondents to the open public consultation agreed to prioritise this product group (58% of respondents), and they considered it of highest priority (68% of respondents). 38% of respondents considered that apparel should be prioritised, followed by footwear (25%) and home/interior textiles (18%).

The scope of the PS was defined following the Product Priorities Study, and the selection criteria reported in Article 5(4), Article 5(7) and Article 18 of the ESPR.

Within the product group textiles and footwear, the Product Priorities Study identifies four main subgroups: (1) textile apparel, (2) home/interior textiles (e.g. bed linen, towels, tablecloths, curtains), (3) footwear, and (4) technical textiles not included in previous subgroups, usually or also meant for consumers, such as truck covers (tarpaulins) and cleaning products, or specifically meant for industry (automotive, construction, medical, agriculture, etc.). Although it is not specified in the Product Priorities Study, the subgroups textile apparel, home/interior textiles and technical textiles are understood to be products containing at least 80% by weight of textile fibres, as defined by the TLR ([14]). This interpretation of subgroups is also adopted in the PS.

The product group textiles and footwear is considered to be too heterogeneous for the setting of common ecodesign requirements. This heterogeneity is driven by the specific functions and end uses of each subgroup, as reported in **Table 3**, as well as their material and chemical compositions. The specific function of a product requires specific tests to be performed on the product to verify its performance.

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[20] European Industrial Strategy. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery. COM(2021) 350 final. Available at this link.

[21] Annual Single Market Report 2021. Accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions Updating the 2020 New Industrial Strategy: Building a stronger Single Market for Europe's recovery. SWD(2021) 351 final. Available at this link.

[22] Ecodesign for Sustainable Products Regulation: Study on new product priorities. Available at this link. Last accessed on 17 December 2024.

[23] New product priorities for Ecodesign for Sustainable Products. Available at this link. Last accessed on 5 February 2024.

Table 3. Function and intended use of subgroups in the textiles and footwear product group

Subgroup	Function and intended use
Textile apparel	Textile apparel have the following functions and intended uses: (1) protect the human body from the outer environment, such as preventing heat loss, exposure to the sun, penetration of water, etc.); (2) comply with legal obligations related to public body exposure, because in EU countries being necked in public is forbidden; (3) self-representation, driven by expression of personal identity and/or expression of belonging to a specific social group, with symbolic meanings and aesthetic values; (4) social acceptance when gathering with other people, for example at parties, work places, religious ceremonies, etc.
Home/interior textiles [(a)]	Most home/interior textiles have at least two functions: (1) protect the object they are used on/with, e.g. a cushion case protects the enveloped cushion, a tablecloth protects the table underneath, a curtain protects the indoor environment by filtering the light coming from outside, etc.; (2) decorate the home/interior environment. Products like towels have the function of drying the body or parts of the body after they have become wet (e.g. after washing, swimming, etc.).
Footwear [(b)]	Footwear has similar functions to apparel: (1) protect the feet from the outer environment; (2) self-representation, driven by expression of personal identity and/or expression of belonging to a specific social group, with symbolic meanings and aesthetic values.
Technical textiles	Technical textiles have specific technical (non-aesthetical) functions according to their final application. Two examples are reported. Textile cleaning products have the function of removing dust and dirt from surfaces, interacting with detergents and other cleaning chemicals. Reusable textile absorbent hygiene products have the function of handling fluids, delivering protective properties like absorption, protecting the environment from unintentionally released body waste. In particular, reusable baby diapers must be flexible, so that they are comfortable and adaptable to changing body size.

[(a)] Construction products, as defined in Regulation (EU) No 305/2011, are not considered home/interior textiles.
[(b)] According to Directive 94/11/EC ([24]), 'footwear' means all articles with applied soles designed to protect or cover the foot, including parts marketed separately. Due to the significant relative weight of soles in the overall weight of a footwear article and to the fact that soles are seldom composed of textile fibres, footwear products are seldom textile products.

The identified subgroups were further analysed following criteria reported in Article 5(4), Article 5(7) and Article 18 of the ESPR. Article 18 of the ESPR states the following:

W*hen prioritising products to be covered by ecodesign requirements, the Commission shall analyse the potential contribution of those products to achieving Union climate, environmental and energy efficiency objectives, taking into account the following criteria:*

a) the potential for improving the product aspects without entailing disproportionate costs, [...];

b) the volume of sales and trade of the product within the Union;

c) the distribution across the value chain of the climate and environmental impacts, energy use, resource use and waste generation concerning those products;

d) *the need to regularly review and adapt delegated acts adopted pursuant to Article 4 in light of technological and market developments.*

Article 5(4) of the ESPR states the following:

Ecodesign requirements shall be set for a specific product group ([25]). They may be differentiated for any specific product that belongs to that specific product group.

Article 5(7) of the ESPR states the following:

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[24] Directive 94/11/EC of European Parliament and Council of 23 March 1994 on the approximation of the laws, regulations and administrative provisions of the Member States relating to labelling of the materials used in the main components of footwear for sale to the consumer. Available at this link.

[25] Article 2 of the ESPR establishes the following definition: *'product group'* means a set of products that serve similar purposes and are similar in terms of use, or have similar functional properties, and are similar in terms of consumer perception.

Where two or more product groups display one or more similarities allowing a product aspect to be effectively improved based on common information requirements or performance requirements ([26]), horizontal ecodesign requirements may be set for those product groups ('horizontal ecodesign requirements'). When considering whether to set horizontal ecodesign requirements, the Commission shall also take into account the positive effects of those requirements towards reaching the objectives of this Regulation, in particular the ability to cover a wide range of product groups in the same delegated act. The Commission may supplement the horizontal ecodesign requirements through the setting of ecodesign requirements for a specific product group.

For all subgroups of the textiles and footwear product group reported in the Product Priorities Study, the following subsections report information related to the three main scope selection criteria pointed out by Article 18: (a) potential for improvement (Section 3.1.1), (b) volume of sales and trade in the EU (Section 3.1.2), and (c) the distribution of the climate and environmental impacts, energy use, resource use and waste generation across the value chain (Section 3.1.3). Point (d) of Article 18 was not considered because there is no delegated act on textiles and footwear products to be reviewed.

Information related to the textiles and footwear sectors is reported with a granularity that changes according to the aims of the specific studies. The subsequent sections (from 3.1.2 to 3.1.3) try to interpret the available data in the most holistic way to meet the requirements set by Article 18 of the ESPR.

3.1.1 Potential improvement considering product aspects in Article 5(1) of the ESPR

The analysis reported in this section is only a first indicative investigation of potential improvements based on a literature review. Once the scope is defined, specific improvement potential will be assessed via environmental and economic assessments in the following stages of the PS. In particular, this will be performed in the following milestones addressing tasks 5 to 7 of the MEErP (see Section 1).

Article 5(1) of the ESPR lists the following product aspects:

— durability;

— reliability;

— reusability;

— upgradability;

— repairability;

— the possibility of maintenance and refurbishment;

— the presence of substances of concern;

— energy use and energy efficiency;

— water use and water efficiency;

— resource use and resource efficiency;

— recycled content;

— the possibility of remanufacturing;

— recyclability;

— the possibility of the recovery of materials;

— environmental impacts, including carbon footprint and environmental footprint;

— expected generation of waste.

[26] Article 2 of the ESPR establishes the following definitions:
'*ecodesign requirement*' means a performance requirement or an information requirement aimed at making a product, including processes taking place throughout the product's value chain, more environmentally sustainable;
'*performance requirement*' means a quantitative or non-quantitative requirement for or in relation to a product to achieve a certain performance level in relation to a product parameter referred to in Annex I;
'*information requirement*' means an obligation for a product to be accompanied by information as specified in Article 7(2).

Many studies underline the great potential for improvement regarding product aspects of textile apparel. In particular, the literature suggests six most important product aspects:

- Increasing all features of product **durability** (Ellen MacArthur Foundation, 2017; Bauer, Watson, Gylling, Remmen, Lysemose, Chatarina Hohenthal, et al., 2018; Sandin, Roos, Spak, et al., 2019; Claxton and Kent, 2020a; Goworek, L. Oxborrow, et al., 2020; Niinimäki et al., 2020; Cooper and Claxton, 2022a; Nordic Ecolabelling, 2022; OVAM, 2022; Horn et al., 2023; TAUW, 2023; Dodd and Gama, 2017; Aakko and Niinimäki, 2021).
- Possibility of **maintenance** and how best to use the textile product during its lifetime (Ellen MacArthur Foundation, 2017; Bauer, Watson, Gylling, Remmen, Lysemose, Chatarina Hohenthal, et al., 2018; Nordic Ecolabelling, 2022; OVAM, 2022; Horn et al., 2023).
- **Repairability** (Bauer, Watson, Gylling, Remmen, Lysemose, Chatarina Hohenthal, et al., 2018; Niinimäki et al., 2020; Botta, 2021; EEA, 2022a; OVAM, 2022; TAUW, 2023).
- Regulating the **presence of substances of concern**, from the perspective of eliminating or reducing the use of these substances (Ellen MacArthur Foundation, 2017; Bauer, Watson, Gylling, Remmen, Lysemose, Chatarina Hohenthal, et al., 2018; Niinimäki et al., 2020; Mohapatra and Gaonkar, 2021; EEA, 2022b; Nordic Ecolabelling, 2022; OVAM, 2022; TAUW, 2023; Dodd and Gama, 2017).
- **Recycled content and possibility of recovery of materials** (Ellen MacArthur Foundation, 2017; Bauer, Watson, Gylling, Remmen, Lysemose, Chatarina Hohenthal, et al., 2018; Niinimäki et al., 2020; ECOS et al., 2021; EEA, 2022b; Nordic Ecolabelling, 2022; OVAM, 2022; Horn et al., 2023; Dodd and Gama, 2017).
- **Possibility of recycling** (Niinimäki et al., 2020; ECOS et al., 2021; EEA, 2022b; Nordic Ecolabelling, 2022; OVAM, 2022; Horn et al., 2023; TAUW, 2023; Dodd and Gama, 2017).

Most of the studies listed above do not specify the kind of requirements, but they suggest focussing on the specific product aspect to best decrease the environmental impacts of the apparel:

- Significant improvement potential is associated with increasing the product lifespan, which could be achieved by increasing the physical and emotional durability ([27]) of the product, improving product care, and facilitating/supporting reparability. Increasing the durability of products is considered an effective strategy to decrease the environmental impacts of this product group. It was estimated that, over the last 20 years, the use time of apparel decreased by 36%, with each product used only seven or eight times on average (Ellen MacArthur Foundation, 2017). This results in a significant amount of waste originating from used apparel. Extending the lifespan of 50% of apparel by an extra 9 months of active use would reduce carbon, water and waste footprints by around 4-10% each (WRAP, 2017a).
- The literature reports a relevant concern about the hazards of substances used and contained in textile apparel. The use of alternative substances with a reduced hazard profile is considered a crucial aspect to pursue.
- In line with the Circular Economy Action Plan, the literature considers product circularity aspects to show good improvement potential, such as increasing the recycled content and promoting recyclable products.

Only Bauer et al. (2019), OVAM (2022) and TAUW (2023) further suggest specific criteria that would decrease the environmental footprint of textile apparel. Differently, (Sandin, Roos, Spak, et al., 2019) reports the possibility to decrease the environmental impacts of these products using a less impacting source of energy, such as solar energy.

Most of the product aspects listed above could also be valid for home/interior textiles and footwear, which are usually included in studies focusing on generic textile products. This is the case of studies like Ellen Macarthur Foundation (2017), ECOS (2021), and Mohapatra and Gaonkar (2021). However, any ecodesign requirement under a specific product aspect should always consider the specific function that the textile product performs.

[27] Emotional durability is the product's ability to stay relevant and desirable to the consumer (Anthesis, 2015).

Therefore, the potential adoption of the same product aspects for textile apparel and home/interior textiles should consider that the two subgroups, and their categories, perform different functions. This distinction is one of the numerous factors driving the grouping of textile products that are included in the scope of the PS.

The literature review did not reveal specific studies about potential improvements to generic technical textiles. This could be explained by the numerous specific applications of the technical textiles that are adopted in many sectors.

The literature review showed that textile apparel, but also to some extent home/interior textiles and footwear, have the potential for improvement under various product aspects. In the following milestones, the PS will assess all the product aspects set out in Article 5(1) of the ESPR.

3.1.2 Amount of sales and trade in the EU

Information reported in the PRODCOM database ([28]) was processed and analysed to quantify the amount of sales and trade in the EU in the textiles and footwear subgroups. The classification of products into subgroups was based on the European Statistical System, which is described in detail in Section 10.1.

The analysis targeted the market indicators production, import, export and apparent consumption ([29]) of the EU-27 ([30]) in 2019. This year was chosen because it was the latest year free from market disruptions, such as the COVID-19 pandemic (2020) and the increase of EU energy prices (2022). **Table 4** reports the results of the analysis, which show that the textile apparel subgroup has the largest share of the market for all market indicators expressed in value and the largest share of the import and apparent consumption expressed in mass.

Table 4. Economic indicators of textiles and footwear in the EU-27 in 2019

Subgroup	Production		Import		Export		Apparent consumption	
	Mass (bn kg)	Value (bn EUR)	Mass (bn kg)	Value (bn EUR)	Mass (bn kg)	Value (bn EUR)	Mass (bn kg)	Value (bn EUR)
Textile apparel	0.8	33	4.67	80.84	0.62	36.02	4.85	77.82
Home/interior textiles	1.83	14.87	2.04	12.09	0.59	4.9	3.28	22.07
Footwear	0.57	19.83	1.72	21.27	0.28	14.46	2.01	26.64
Technical textiles	3.65	18.07	0.69	4.03	0.79	6.24	3.55	15.86

N.B. Colour shades from red to white rank the subgroups from the largest to the smallest share of the economic indicator.

Figures related to economic indicators expressed in mass could be underestimated because some PRODCOM codes did not contain information. This is caused by the data collection system that allows Member States to avoid, in specific cases, reporting information expressed as quantity of goods. More information is available in Section 10.1.

Source: own analysis using PRODCOM dataset DS-056120 (data extracted on 15 November 2023)

3.1.3 Environmental impacts and waste generation across the value chain

The literature shows that environmental impacts caused by textile products were studied using numerous levels of granularity. Most of the studies focused on 'textiles', 'textile sector', 'textile industry', without clearly specifying which subgroup was included. In this screening of the literature, the term 'textiles' is assumed to include textile apparel, home/interior textiles and technical textiles.

The literature seems to treat the terms 'apparel', 'clothing' and 'garments' as synonyms, which raises doubts on whether clothing accessories are always included; whereas it addresses footwear separately. The same literature refers to 'fashion', which forms a major component of the product group 'apparel and footwear', and it can be understood as including the subgroups textile apparel and footwear. The authors understand that fashion includes leather and fur apparel, which are not part of this PS in view of its focus on textile products according to the definition under the TLR.

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[28] PRODCOM database (Sold production, exports and imports – DS-056120). Available at this link.

[29] The apparent consumption is defined as the sum of production and import, minus the export. Production, import and export refer to the entire EU. Therefore, the economic indicators used from the PRODCOM database were: PRODQNT and PRODVAL, which describe production with mass-related units and in euro, respectively; IMPQNT and IMPVAL, which describe import with mass-related units and in euro, respectively; EXPQNT and EXPVAL, which describe export with mass-related units and in euro, respectively.

[30] The 27 Member States are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

Table 5 reports the result of a literature review focusing on specific subgroups of the textile and footwear product group, or textiles in general. For the home/interior textiles, footwear and technical textiles subgroups only a few articles were found, showing the very limited attention paid by the scientific community to these subgroups. Most of the literature focuses on textile apparel and textiles in general.

Table 5. Literature studies investigating environmental impacts of textile products

Granularity of textile products in the literature	Reports and scientific papers	Number of studies
Textile apparel	Cai and Choi (2020) reviewed 108 studies; Munasinghe et al. (2021) reviewed 57 studies.	108
Home/interior textiles	Kalliala and Nousiainen (1999).	1
Footwear	Gottfridsson and Zhang (2015); Quantis (2018); Jadhav and Jadhav (2020); Muthu (2020); Van Rensburg et al. (2020).	5
Technical textiles	Shishoo (1994); Sohail and Sun (2019); Aldalbahi et al. (2021).	3
Textiles in general	Amicarelli et al. (2022) reviewed 54 studies; Luo et al. (2023a) reviewed 107 studies.	107

Source: own analysis

In 2022, the European Environment Agency published a study analysing the environmental impacts of textile apparel, home/interior textiles and footwear (EEA, 2022b). **Table 6** reports an overview of the environmental impacts related to the upstream supply chain of textile apparel, home/interior textiles and footwear. Most of the impacts generated by the subgroups investigated occur outside the EU and are due to textile apparel production. The contributions of footwear and home/interior textiles are very similar to each other.

Table 6. Environmental impacts related to the supply chain of textile products

Environmental aspect	Amount	Attribution of impacts (%)		Attribution to specific subgroup (%)		
		Inside EU	Outside EU	Apparel textiles	Home/interior textiles	Footwear
Use of primary raw materials	175 m t 391 kg/person	20	80	40	30	30
Water use	5 000 m m^3 9 m^3/person	Contribution not relevant	Most of the contribution	40	30	30
Land Use	180 000 km^2 400 m^2/person	8	92	43	23	35
Greenhouse gas emissions	121 m t CO_2eq 270 kg CO_2eq/person	25	75	50	30	20

Source: EEA (2022)

Huygens et al. (2023) performed an analysis of waste generation along the value chain of textile products including textile apparel, home/interior textiles and technical textiles. The analysis does not show which product subgroup generates more waste, but it distinguishes between the generation of post-industrial, pre-consumer and post-consumer waste. In 2019, the EU-27 generated 12.6 Mt of textile waste; 11% was post-industrial waste, 3% was pre-consumer waste, and 86% was post-consumer waste (Huygens et al., 2023).

The review of the available literature on the environmental impacts caused by textile products showed that textile apparel is the most impactful and the most investigated subgroup in the textiles and footwear product group.

3.2 Proposed scope

All products in the scope of the PS should be sufficiently homogeneous in terms of function, material composition, chemical composition and technologies used. This homogeneity should allow the development of common ecodesign requirements within the aspects listed in Article 5 of the ESPR, tailoring them to product subgroups as appropriate.

3.2.1 Products included in the scope

The analysis reported in Section 3.1 revealed that, within the product group textiles and footwear, textile apparel is the most suitable subgroup to be addressed by the PS because it:

- has potential improvements already investigated by the literature (Section 3.1.1);
- has the largest share in the EU market (Section 3.1.2),

— produces the largest share of the environmental impacts, based on the available literature (Section 3.1.3).

Table 7 reports all textile apparel categories and their description. **Table 59** (Section 10.1.4) reports all PRODCOM codes of products included in the scope of the PS. The identified product categories are aligned with the ongoing work of the PEFCR A&F ([8]). This alignment allows the JRC to use the work performed by the project PEFCR A&F whenever it is appropriate within the frameworks of the ESPR and the EU Ecolabel.

Table 7. Product categories of textile apparel included in the scope of the preparatory study

ID	Category	Description
01	T-shirts	Garment to cover the upper body to the elbow (e.g. singlets, vests, t-shirts, polo shirts, other short-sleeved shirts)
02	Shirts and blouses	Garment to cover the upper body including the entire arm (e.g. long-sleeved shirts, blouses, base layers)
03	Sweaters and mid-layers	Garment to keep the upper body warm and covered (e.g. pullovers, cardigans, hoodies, jerseys, sweatshirts, sweaters)
04	Jackets and coats	Garments to put on top of a shirt or sweater or to protect from the natural elements (e.g. blazers, suit jackets, overcoats, other light jackets, rain jackets, outdoor winter jackets, parkas, outdoor vests, anoraks)
05	Pants and shorts	Garment to cover the lower body, may protect from the elements (e.g. casual pants, outdoor pants, dress pants, jeans, sports pants, capri pants, shorts)
06	Dresses, skirts and jumpsuits	One-piece garment that covers both the upper and lower body, or the lower body only, other than pants and shorts (e.g. short- and long-sleeved, strapless, wrap, long and short, one-piece suits)
07	Leggings, stockings, tights and socks	Tight garment to cover the legs and/or feet. (e.g. opaque and sheer tights, pantyhose, fishnets, ankle socks, knee socks, low-cut socks)
08	Underwear	Garment worn under clothes, often next to the skin of the upper or lower body (e.g. boxers, briefs, panties, bras, body-shaping suits)
09	Swimwear	Garment worn for water-based or sun-based activities (e.g. bikinis, bathing suits, racing-style swimwear, board shorts)
10	Textile apparel accessories	Hats – Garment to cover the head for warmth or as a fashion item (e.g. caps, flat caps, woollen hats/beanies, fedoras, panamas, bowlers, newsboys, berets); Scarves and ties – Garment worn around the neck for warmth or as a fashion item (e.g. warm and light scarves, buffs, neckerchiefs, headscarves, shawls, bowties); Belts – Flexible band or strap worn around the waist or over the shoulders used to secure or to hold up clothing such as pants (e.g. dress belts, casual belts, buckle belts, tie-up belts, suspenders); Gloves and mittens – Articles of clothing that protect hands and wrists from the elements or as a fashion item. Used in pairs (e.g. fingerless gloves, fashion gloves, outdoor sports gloves, mittens).

Source: own production based on the ongoing work performed within the development of PEFCR A&F.

Technical textile apparel, such as workwear and sportswear are included in the scope of the PS, as long as (1) it is textile apparel (containing at least 80% by weight of textile fibres, as defined above) and (2) they do not belong to the list of excluded products defined in section 3.2.2.

Sportswear could be considered technical textiles due to its high performance in terms of thermoregulatory properties ([31]). Besides these thermoregulatory properties, sportswear and leisurewear have the same, or very similar, features that allow these two types of products to be addressed in the same PS with the same ecodesign requirements, which fall in the domain of the aspects listed by Article 5 of the ESPR.

Workwear textile apparel not excluded from scope (as per section 3.2.2) ([32]) and leisurewear also have same, or very similar, features that allow these two types of products to be addressed in the same PS with the same ecodesign requirements, which fall in the domain of the aspects listed by article 5 of the ESPR.

Nevertheless, this approach on workwear and sportswear will be reassessed when the PS addresses task 6 of the MEErP on ecodesign options.

[31] The textile industry certifies or reports the performance of sportswear following the guidelines contained in the technical report PD CEN/TR 16422:2012, available at this link. Last accessed on 5 February 2024. These guidelines establish an evaluation system with three levels of performance related to thermoregulatory properties: (a) thermal insulation, (b) water vapour transmission (breathability), (c) air permeability, (d) water penetration resistance and repellence, and (e) liquid sweat management.

[32] Examples of workwear textile apparel included in the scope are uniforms used in hospitals, hotels and restaurants.

3.2.2 Products excluded from the scope

The following textile apparel are excluded from the scope because they are very different to products included in the scope in terms of their function and physical characteristics:

- **smart textiles** ([33]), which are textiles able to sense and react to environmental conditions and external stimuli (e.g. mechanical, thermal, and chemical stimuli) thanks to a number of sensors incorporated in the textiles;
- **electronic textiles** or **e-textiles** ([33]), which are textile-based systems that exhibit an intended and exploitable response as a reaction either to changes in their surroundings/environment or to an external signal/input ([34]);
- **textile apparel identified as personal protective equipment (PPE)** in accordance with Regulation (EU) 2016/425 ([35]);
- **textile apparel identified as medical devices or as an accessory for a medical device** in accordance with Regulation (EU) 2017/745 ([36]);
- **textile apparel identified as toys** in accordance with the Directive 2009/48/EC ([37]).

E-textiles are excluded from the scope of the PS, however all products included in the scope will be able to use information carriers based on technologies such as Ultra High Frequency (UHF), Radio-frequency identification (RFID) and Near-Field Communication (NFC).

Additionally, all **intermediate products**, such as fabrics, yarns, fibres, etc., are excluded from the scope of the PS, because their characteristics should be strictly related to the function of the specific textile apparel they are part of. For example, a cotton fabric should have different characteristics when used as a t-shirt component to when used as a table cloth. Exclusion of intermediate textile products from the scope of this PS does not exclude the possibility to set specific requirements and parameters on the intermediate textile product once incorporated in the selected products in the scope. This means that all intermediate textile products, which are part of textile apparel in the scope, are indirectly addressed by the PS.

Aspects related to customised textile apparel and upcycled textile apparel ([38]) will be addressed in the impact assessment that will follow the PS in the policy-making process.

In accordance with Article 5(2) of the ESPR, the initial questionnaire ([12]) investigated the possibility to include in the scope further textile products, such as bed linen, kitchen textiles, towels and bathrobes, textile cleaning products, reusable textile hygiene products. The very different functions of these textile products ([39]) compared to textile apparel does not allow the extension of the scope of the PS, because they cannot be considered similar to apparel. A product category with a different function to textile apparel requires a specific study which includes

[33] Definition of smart textiles is inspired by ISO/TR 23383:2020. Textiles and textile products — Smart (Intelligent) textiles — Definitions, categorisation, applications and standardization needs. Available at this link. Last accessed on 5 February 2024.

[34] Textile apparel containing batteries to produce lights and/or sounds are excluded from the scope of this preparatory study.

[35] Personal protective equipment (PPE) Regulation. REGULATION (EU) 2016/425 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 9 March 2016 on personal protective equipment and repealing Council Directive 89/686/EEC. Available at this link.

[36] Medical devices Regulation. Regulation (EU) 2017/745 of the European Parliament and of the Council of 5 April 2017 on medical devices, amending Directive 2001/83/EC, Regulation (EC) No 178/2002 and Regulation (EC) No 1223/2009 and repealing Council Directives 90/385/EEC and 93/42/EEC. Available at this link.

[37] Toy Safety Directive (TSD). Directive 2009/48/EC of the European Parliament and of the Council of 18 June 2009 on the safety of toys. Available at this link.

[38] Upcycled textiles meant here as textile products manufactured by making use of used and/or waste components of other textile products.

[39] *Bed linens* (bed sheets, pillowcases, duvet/blanket cover) have the function to cover the human body during sleep, and they have a decorative function for the bed.
Kitchen textiles (tablecloths, kitchen tea towels, napkins, aprons) have the function of protecting the surfaces they cover and have a decorative function for an interior environment.
Towels and bathrobes have the function of drying the body or parts of the body after they have become wet (e.g. after washing, swimming, etc.).
Textile cleaning products (floor cloths, dishcloths, dusters and similar cleaning cloths) have the function to remove dust and dirt from surfaces, interacting with detergents and other cleaning chemicals.
Reusable textile absorbent hygiene products have the function of handling fluids, delivering protective properties like absorption, protecting the environment form unintentionally released body waste. In particular, reusable baby diapers must be flexible, so that they are comfortable and adaptable to changing body size.

the investigation of the user behaviour, the testing methods to check the performance of the products, and consequently a different approach when establishing ecodesign requirements. Additionally, a different function of the textile product affects the fate of its end-of-life. For example, during their use phase, textile cleaning products interact with many chemicals that are absorbed and could hinder the recycling processes. These aspects deserve to be addressed by a specific study different to this PS. In particular, due to their functions and technical characteristics, textile cleaning products and reusable textile absorbent hygiene products are considered technical textiles.

3.3 Composition, life-cycle stages and main negative environmental impacts of products included in the scope

This section provides a literature review concerning the main characteristics of the textile industry in terms of composition and life-cycle stages (Section 3.3.1), and the main factors influencing the negative environmental impacts (Section 3.3.2). Implicitly, this section refers to textile apparel, which represent a major part of the textile industry production, import, export and apparent consumption (**Table 4**). An overview of the life-cycle stages of textile apparel and the main factors affecting the environmental impacts are essential bases to fully understand numerous topics addressed in the following sections. The main environmental impacts are crucial to understand the environmental areas addressed by environmental labels described in Section 4.5. Meanwhile, the description of the life-cycle stages is very important to put in context specific concepts addressed in the market analysis (Section 5), notably (1) manufacturing stages spread over different countries, (2) the main elements affecting apparel manufacture, (3) the characteristics of the value chain, and (4) global competitiveness related to costs of environmental compliancy.

The description reported in this section is further detailed in Section 9 and the following milestone, when the PS addresses 5 of the MEErP.

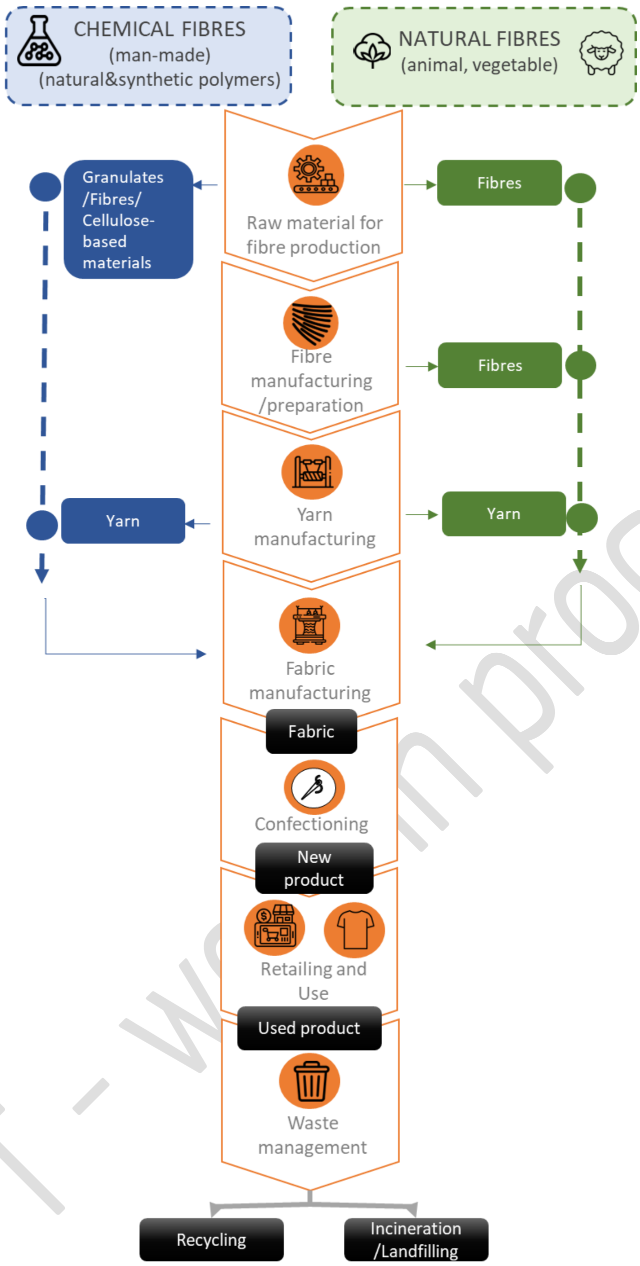
3.3.1 Composition and life-cycle stages

The textile products included in the scope of the PS are mostly made of textile fibres – at least 80% by weight. The Textile Labelling Regulation 1007/2011 lists 50 different types of fibres, but not all of them are commonly used for manufacturing textile apparel (e.g. carbon, ceramic, glass, and metal fibres). Textile fibres most commonly used by the textile apparel industry were classified in the BREF on textiles (Roth et al., 2023) as follows:

- Natural origin fibres:
  - animal origin, including wool, silk and hair;
  - vegetable origin, including cotton, flax and jute.
- Chemical fibres (man-made):
  - natural polymer fibres / man-made cellulosic fibres (MMCF), including viscose, cupro, lyocell, acetate, triacetate;
  - synthetic polymer fibres, specifically organic polymers, including polyester (PES), polyamide (PA), acrylic (PAC), polypropylene (PP), elastane (EL).

Despite the fact that textile apparel is produced with specific fibres and fibre combinations, technologies and resources, the life cycle of textile apparel can be described by eight distinct stages: (1) raw material for fibre production, (2) fibre manufacturing/preparation, (3) yarn manufacturing, (4) fabric manufacturing, (5) confectioning (often called ‘Cut, Make-up and Trim’ (CMT)), (6) retailing, (7) use, and (8) waste management. **Figure 1** shows these stages in a linear model that does not mark recycling routes, and it depicts some peculiarities of chemical and natural fibres. **Table 8** reports processes, technologies and resources used at each life-cycle stage of textile apparel. Section 10.2 provides more details.

Figure 1. Main textile life-cycle stages



Source: own production adapted from McKinsey & Company (2022), icons from www.flaticon.com

Table 8. Life-cycle stages of textile apparel – processes, techniques and resources

Stage	Input	Process and techniques	Main resources	Output
(1) Raw material for fibre production	Fibres from crops is used for vegetable origin fibres	Cultivation with subsequent processing.	Land Water Agrochemicals	Staple fibre
	Animals and insects are used for animal-based fibres	Animal farming with shearing and sericulture with silk extraction. Pre-treatments are needed.		
	Cellulose mainly from wood is used for man-made chemical fibres using natural polymers	Dissolving pulp from various sources is dissolved with chemicals and further processed.	Energy Chemicals Land Fossil fuels	Staple fibre, Filament fibres, Granulates

Stage	Input	Process and techniques	Main resources	Output
	Petroleum-based material is used for man-made chemical fibres using synthetic polymers	Specific chemicals and processes are used to produce specific polymers.		
(2) Fibre preparation / manufacturing	Natural staple fibre	Preparation stage usually includes scouring and/or cleaning processes before carding. The processes vary according to the natural fibre.	Energy Water Chemicals	Carded natural fibres
	Staple fibre bale of MMCF	Opening, carding, drawing and additional specific processes according to the spinning technology used.	Energy	Carded MMCF
	Chemical granulates	No process required.	None	Granulates
(3) Yarn manufacturing	Carded natural fibres	Ring spinning and open-end spinning .	Energy Water Chemicals	Yarns
	Carded MMCF	Ring spinning, air-jet spinning, wet spinning and open-end spinning.		
	Polymers in solution or as granulates (for chemical fibres)	Wet or dry spinning from a solution and melt spinning from granulates		
(4) Fabric manufacturing	Yarn (for weaving and knitting) Fibres and filaments (for non-woven)	A two-dimensional structure is created by interlacing yarns. Weaving is the predominant fabric manufacturing technique. It involves interlacing two sets of yarns at right angles on a loom. Knitting is the second most used fabric manufacturing method. Yarns are interlooped using needles to form fabric on knitting machines. Non-woven technology produces textile structures by bonding fibres or filaments together, either mechanically, thermally, or chemically.	Energy	Fabrics
Finishing processes	Yarn and/or Fabric	Numerous wet treatments for sizing, desizing, pre-treatment, dyeing, printing, finishing, coating, laminating, and many more. These treatments are applied based on the specific requirements of the final products, and are not applied sequentially. Each treatment utilises specific technologies and chemicals.	Chemicals Energy Water (dyeing)	Finished yarn, Finished fabric
(5) Confectioning	Fabric Non textile components	Product design, fabric spreading and cutting, product assembly, sewing and ironing.	Energy Manual labour	Textile apparel
(6) Retailing	Textile apparel	Transportation and sale via numerous channels, such as shops, on the internet.	Fuel (transport) Energy Manual labour	Textile apparel owned by the user
(7) Use	Textile apparel owned by the user	Washing, cleaning, drying, ironing, as well as wear and tear.	Water Energy Chemicals	Used textile apparel
(8) Waste management	Used textile apparel	Used textile apparel are usually incinerated and landfilled. However, circular solutions are also possible, such as: textile apparel reuse, fabric recycling, fibre recycling (mechanical process), raw material recycling (chemical process).	Specific to the fate of the used product	Specific to the fate of the used product

Source: own elaboration

3.3.2 Main factors influencing the negative environmental impacts

This section aims to provide a general overview about the factors that negatively affect the environment due to the consumption of textile apparel, or textiles in general. This is done via a literature review to provide some background useful for the understanding of the environmental areas addressed by environmental labels described in Section 4.5. A complete environmental assessment will be performed in Task 5 and reported in the following milestone.

The textile production processes are characterised by a large use of resources and numerous emissions into water bodies and into the atmosphere. The European Environment Agency estimated that the textile industry is the fifth industrial sector for primary use of materials and greenhouse gas emissions, and the third industrial sector for water and land use (EEA, 2022b).

Use of land

The European Environment Agency estimated that in 2020 the purchase of apparel by European households used about 77 400 km^2 of land (EEA, 2022b). About 92% of this land is located outside Europe, and it is mainly used for cultivation of cotton in China and India (Manshoven et al., 2019). The grazing of sheep and cashmere goats for the production of animal fibres such as wool require also use of land. In this case the attribution of environmental impacts to the fibre should take into account that the same animals are used to produce meat, milk and leather. The United Nation Environment Program estimates that the use of land in cellulose supply for the production of MMCF and the production of synthetic fibres is smaller than what is requested by natural fibres (UNEP, 2020).

In general, use of land and land use change are relevant because they influence biodiversity and the emission of greenhouse gases (Newbold et al., 2016; IPCC, 2023).

Use and discharge into water

The textile industry's water consumption is estimated to account for 4% of global freshwater extraction (Ellen MacArthur Foundation, 2017). The European Environment Agency reported that the production of clothing, footwear and household textiles purchased in the EU in 2020 was equal to 4 000 million m^3 of blue water ([40]), meaning about 9 m^3 per person (EEA, 2022b). Water is mainly used in numerous stages of the entire life cycle of textile apparel (**Table 8**). The BREF for the EU textile industry sets ambitious thresholds for emissions into water due to their highly negative effects. Numerous parameters are considered including carbon-load-related parameters (chemical oxygen demand (COD), biological oxygen demand (BOD), total organic carbon (TOC)), suspended solids, nitrogen and phosphorus compounds, metals, adsorbable organic halides (AOX), pesticide, flame retardants and many more. Use of dyes generates highly polluted wastewater, which needs to be properly treated before its release into the environment. Also, other processes like production of polyester fibres and the treatment of knitted fabrics generate wastewater with a high load of heavy metals, such as antimony, and with a high hydrocarbon oil index (HOI), respectively (Roth et al., 2023). Additionally, when treating natural fibres, a series of substances, such as biocides, are released into the wastewater even before pre-treating the fibres (Zhang et al., 2022; Roth et al., 2023).

Use of chemicals

Numerous life-cycle stages of textile apparel involve the use of chemical substances and mixtures (hereafter called 'chemicals') (**Table 8**). Some of them are pesticides, solvents, surfactants, dyes and pigments, water and stain repellents, flame retardants, biocides and many more (Ellen MacArthur Foundation, 2017). Some of these chemicals are directly in contact with soil and water bodies, like during the cultivation of natural fibres using fertilisers and pesticides. Other chemicals are usually dissolved and released in the wastewater produced in several processes (Zhang et al., 2022; Roth et al., 2023).

Humans are also directly exposed to chemicals used in textile apparel. Farmers and factory workers face exposure to these chemicals, and people wearing textile products are potentially at risk due to chemicals that remain bound to the products placed on the market (Ellen MacArthur Foundation, 2017). **Use of energy**

Almost all life-cycle stages of the textile apparel have a significant energy consumption (**Table 8**). In particular, some processes are highly energy-demanding, like the extraction of raw materials, specifically in the cases of

([40]) 'Blue' water is reported as 'surface water or groundwater that is consumed or evaporated during irrigation, industry processes or household use' in (EEA, 2022b).

fibres like silk or synthetic fibres, and production processes such as spinning, knitting, and weaving. Furthermore, thermal treatments are crucial during production, as well as in the use phase for washing, ironing and drying (Niinimäki et al., 2020; Munasinghe et al., 2021).

Generation of waste

In 2019, the EU generated about 12.6 Mt of textile waste, including post-industrial, pre-consumer and post-consumer waste, representing 11%, 3% and 86% of the total, respectively. Nevertheless, regarding waste generation, it is not possible to distinguish the impact of textile apparel from other textile products (Huygens et al., 2023).

Huygens et al. (2023) estimated that, in 2019, about 90% of post-industrial and pre-consumer waste was incinerated and landfilled, and about 10% was recycled. Additionally, in the same year, about 8.5 Mt of post-consumer waste was not separately collected and was sent to incinerators or landfilled. The majority of post-consumer waste that is separately collected is sent outside the EU as 'used product', producing negative environmental and social impacts (Lingås et al., 2023; Huygens et al., 2023).

The landfilling and incineration of waste generates pollution, especially if it is not well controlled (Christensen, 2010). The Ellen MacArthur Foundation estimates that about 2 000 tonnes of hazardous substances annually are released in the EU due to degradation of textiles in landfills (Ellen MacArthur Foundation, 2017).

Emissions into the atmosphere

The apparel industry is responsible for about 6.5% of global greenhouse gas emissions. This mainly depends on the use of energy and the sources employed for its production (Niinimäki et al., 2020). The European Environment Agency estimated that textile consumption in the EU in 2020 emitted 121 million tonnes of greenhouse gases. Around 75% of the emissions occurred outside Europe, specifically in Asian countries (EEA, 2022b).

The BREF for the EU textile industry sets ambitious thresholds for emissions into the atmosphere due to their highly negative effects. Numerous parameters are considered including volatile organic compounds, formaldehyde, oil mist, dust, ammonia, carbon monoxide, sulphur oxides and many more (Roth et al., 2023). These compounds are generated in processes associated with thermal treatments, wet processes (coating, laminating and other finishing), and the use of agents and carriers in the production phase (Roth et al., 2023).

Pollution originated from textile fragmentation

Due to the publication of recent studies highlighting the adverse environmental and health impacts of microplastics, the release of synthetic fragmented fibres from textile products is under the spotlight (Amobonye et al., 2021; Leslie et al., 2022). One of the leading sources of microplastics pollution is the fragmentation of synthetic textiles (Boucher and Friot, 2017). Fibres are released throughout the textile value chain, from the production phase to the end-of-use phase. During the manufacturing stages, microplastics are released into the atmosphere and into the wastewater produced. Household laundering during the use phase is another leading source of microplastics release into wastewater. During the end-of-use phase, landfilling, incineration and recycling are believed to be an important source of airborne and terrestrial microplastics (UNEP, 2020). Estimations of microplastics releases exhibit considerable uncertainty, with annual figures for the EU oscillating between 1 649 tonnes and 61 078 tonnes (DG ENV, 2023). This uncertainty is primarily attributable to the scarce data available regarding the production and use phases of the microplastics life cycle, and a complete lack of information for the disposal stage. The imprecision comes from the challenge of quantifying microplastics emissions, rather than any issues with the underlying assumptions of the baseline projection (DG ENV, 2023). Current patterns indicate that emissions of microplastics from textiles are projected to rise by approximately 22% by the year 2030 (DG ENV, 2023).

Once released into the environment, microplastics can be ingested by organisms, leading to problems due to physical and chemical properties of the microplastics. Their small size and persistence make them difficult to remove from the environment, and they can act as vectors for other pollutants, including persistent organic pollutants (POPs) that can adhere to their surfaces (Xiang et al., 2022). The ubiquity of microplastics has prompted global concern, necessitating research into their environmental distribution, fate, and long-term implications.

Despite the biodegradability of natural fragmented fibres, their potential risk is still under evaluation, because their release could be associated with harmful substances (UNEP, 2020). The release of natural fragmented fibres is an emerging environmental concern that parallels the issues posed by synthetic fragmented fibres (microplastics). Although natural fragmented fibres are biodegradable, their extensive release into aquatic systems may still result in ecological disruption. (Athey and Erdle, 2021; Zambrano et al., 2021) The concern is that, similar to synthetic fragmented fibres, they can transport hazardous substances, introduce invasive species via attachment, and affect the feeding behaviour within food webs. Additionally, understanding the full environmental impact of natural fragmented fibres, including their degradation rates and interactions with aquatic life, remains a critical area to be explored.

Table 9 provides an overview of important negative environmental impacts in the value chain of textile apparel based on available literature:

- Climate impacts are mainly generated during the processes of bleaching / dyeing and finishing.
- Fresh water is mainly affected during the use phase, the processes of bleaching / dyeing and finishing, and in raw material production.
- The impacts on land use are mainly generated during the raw material production.
- Impacts on both ecosystem quality and human health are mainly generated in raw material production, the processes of bleaching / dyeing and finishing, and during the use phase.

Table 9 Negative environmental impacts across the global apparel value chain

Phase	Process	Climate (% in the value chain)	Water resources (% in the value chain)		Land use (% in the value chain)	Ecosystem quality (main factors)	Human health (main factors)
			Freshwater use	Water scarcity footprint			
Fibre production	Raw material production	12	21	33	56	Habitat loss when using land, Water use, Soil degradation, Agrochemicals use	Emission of harmful substances
	Material processing & sourcing	NA	NA	NA	NA	NA	NA
	Fibre preparation	NA	NA	NA	NA	NA	NA
Yarn and fabric production	Yarn preparation (spinning)	12	7	21	6	NA	NA
	Weaving, knitting, bonding	10	7	16	4	NA	NA
Textile production	Bleaching / dyeing and finishing	36	24	10	10	Chemicals released in fresh waters, High use of energy based on fossil fuels	Emission of harmful substances and due to the extraction and burning of fossil fuels
	Assembly	5	5	2	12	NA	NA
Consumption	Distribution and retail	1-11	< 1	< 1	< 1	NA	NA
	Use	14-24	35	18	13	High electricity consumption	Hazardous chemicals retained in the textile apparel
End-of-life	Collection and sorting	< 1	< 1	NA	< 1	NA	NA
	Landfilling / waste to energy	< 1	NA	NA	NA	NA	NA

NA: Not Available
Breakdown of phases is aligned with the analysis reported by UNEP (2020).
Source: own elaboration based on (Ellen MacArthur Foundation, 2017; Niinimäki et al., 2020; UNEP, 2020).

4 Legislation, strategies and voluntary environmental labels relevant for the textile sector

The sound development of the PS includes a good understanding of the EU legislation (existing and in preparation) and legislation from outside EU. This will allow the proposed ecodesign requirements to establish synergies with other legislation and strategies at EU and global level. For this reason, this section analyses the textile legislative context at different levels: EU, Member State, and third country (Sections 4.1 and 4.2). Textile strategies promoted by the United Nations are addressed in Section 4.3.

The textile industry currently uses numerous standards to measure and identify numerous technical aspects/parameters of a textile product. Section 4.4 analyses and classifies many standards used by the textile industry because they could potentially be used to propose and/or verify ecodesign requirements, when the PS addresses tasks 6 and 7 of the MEErP.

Finally, Section 4.5 provides an overview of the voluntary environmental labels used in the textile sector. This analysis focuses on the type and the environmental aspects mostly addressed by these labels. This investigation is mainly important for the following points:

- the background for the revision process of the EU Ecolabel criteria for textile products (see Section 1);
- the identification of the most recognised negative environmental impacts of the textile industry;
- the identification of requirement areas, which could inspire future requirements;
- the analysis of possible information on environmental labels to potentially be reported in the Digital Product Passport.

4.1 EU legislation

Currently the EU has no specific legislation addressing the mandatory sustainability of textiles. As mentioned in Section 1, there are the current EU Ecolabel criteria for textile products ([41]), which belong to a voluntary scheme for companies willing to show the good environmental performance of their products. Additionally, a number of EU legal acts have a direct impact on the placing on the market of textile products. Furthermore, profound changes in the EU acquis in the areas of consumer protection, consumer rights and product policy were, at the time of drafting this study, at different stages of the ordinary legislative procedure. In addition, a number of important policy documents, adopted by the Commission following the European Green Deal Communication, and mentioned in Section 1, address the relevance of textiles as a key product group. This section outlines the most relevant acts, existing and in preparation, related to textile products.

4.1.1 Existing EU legislation

Textile Labelling Regulation (TLR) ([14])

The TLR applies to textile products and products with textile components made up of at least 80% by weight of textile fibres. It defines rules on:

- the labelling and marking of the fibre composition of textile products;
- the labelling or marking of textile products containing non-textile parts of animals;
- the determination of the fibre composition of textile products, including of textile fibre mixtures.

The Regulation, which is currently under revision, aims to improve the functioning of the internal market and provide accurate information to consumers. It sets out a framework on how the textile composition is to be declared and how fibre composition should be determined. The introduction of rules on labelling domains such

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[41] EU Ecolabel criteria for textile products. Commission Decision of 5 June 2014 establishing the ecological criteria for the award of the EU Ecolabel for textile products. Commission Decision (2014/350/EU). Available at this link.

as sustainability and circularity, care, origin, size and presence of allergenic substances is currently under consideration, with a view to proposing a fundamental revision of the Regulation soon.

Industrial and Livestock Rearing Emission Directive

The Industrial and Livestock Rearing Emissions Directive (IED 2.0) ([42]) is the main EU instrument regulating pollutant emissions from industrial installations and intensive livestock farms (pig and poultry). Industrial activities listed in Annex I to the Directive are required to operate in accordance with a permit based on the principles and provisions of the Directive. The IED 2.0 is based on several pillars, in particular an integrated approach, the use of best available techniques and public participation.

The integrated approach means that permits must take the whole environmental performance of the plant into account. This covers emissions to air, water and land, generation of waste, use of raw materials, energy efficiency, noise, prevention of accidents, and restoration of the site upon closure.

The permit conditions including emission limit values must be based on the Best Available Techniques (BAT). In order to define BAT and the BAT-associated environmental performance at EU level, the Commission organises an exchange of information with experts from Member States, industry and environmental organisations. This process results in BAT Reference Documents (BREFs) ([43]); the BAT conclusions contained in the BREFs are adopted by the Commission as Implementing Decisions. The IED 2.0 requires that these BAT conclusions are the reference for setting permit conditions.

The IED 2.0 ensures that the public has a right to participate in the decision-making process, and to be informed of its consequences, by having access to permit applications, permits and the results of the monitoring of releases. Through the European Industrial Emissions Portal (EIEP), established by Regulation (EU) 2024/1244 ([44]), environmental data reported by Member States, and some other countries ([45]), are made accessible in a public register ([46]).

The IED 2.0 and the EIEP Regulation focus on emissions into air, water and land, prevention of waste generation, energy, water and material efficiency and reuse, in addition to promoting the use of safer, less toxic or non-toxic chemicals in industrial processes. They:

— ensure full and consistent implementation of the IED 2.0 across Member States, with tighter permit controls on air and water emissions;

— increase investment in new, cleaner technologies taking into account energy use, resource efficiency and water reuse whilst avoiding lock-in to obsolete technologies;

— support more sustainable growth of sectors that are key to building a clean, low-carbon and circular economy;

— cover intensive farming and industrial activities, ensuring that sectors with significant potential for high resource use or pollution also curb environmental damage at source by applying Best Available Techniques;

— establish an Innovation Centre for Industrial Transformation and Emissions (INCITE) ([47]);

— integrate the previously separate requirements for depollution and decarbonisation so that future pollution control investments take better account of greenhouse gas emissions, resource efficiency and water reuse;

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[42] Industrial Emissions Directive 2.0. Directive 2010/75/EU on industrial and livestock rearing emissions (integrated pollution prevention and control). Available at this link.

[43] Best Available Techniques Reference Documents (BREFs), which are available at this link. Last visited on 12 September 2024.

[44] EIEP Regulation (EC) No 2024/1244 on reporting of environmental data from industrial installations, establishing an Industrial Emissions Portal. Available at this link.

[45] Iceland, Liechtenstein, Norway, Serbia, Switzerland and the United Kingdom.

[46] European Industrial Emissions Portal. Available at this link. Last visited on 12 September 2024

[47] The European Innovation Centre for Industrial Transformation and Emissions (INCITE). Available at this link. Last visited on 12 September 2024.

— enhance data transparency and public access to environmental information by making permit summaries available online and providing more opportunities for public participation in the setting and review of permits.

The currently valid BREF for the textile industry dates back to 2023 (Roth et al., 2023). The associated Best Available Techniques (BAT) conclusions were adopted as Commission Implementing Decision (EU) 2022/2508 ([48]). However, the industry belonging to the value chain of textile apparel could find relevant other BAT conclusions, such as Commission Implementing Decision (EU) 2019/2010 ([49]) and Commission Implementing Decision (EU) 2018/1147 ([50]), which are based on the corresponding BREFs dealing with waste incineration and waste treatments (Pinasseau et al., 2018a; Neuwahl et al., 2019).

REACH Regulation ([51])

The Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) has the main purpose of ensuring the safe use of chemicals in the EU. More specifically, REACH aims to ensure a high level of protection of human health and the environment from risks resulting from the intrinsic properties of chemical substances, as well as the free circulation of substances on the internal market, while enhancing competitiveness and innovation. REACH regulates, amongst many other aspects, the restriction of the placing on the market and use of certain substances listed in its Annex XVII, including in some cases, the incorporation of substances into articles. Consequently, restrictions also cover recycled substances and the presence of restricted substances in recovered materials. The authorisation title of REACH applies to the placing on the market and use of substances of very high concern (SVHC), aiming at their progressive substitution by less hazardous substances or technologies and by subjecting their use to specific conditions.

A number of restrictions in Annex XVII to REACH specifically mention textiles in their scope. These include entries: 4 - Tris (2,3 dibromopropyl) phosphate; 7 - Tris(aziridinyl)phosphinoxide; 8 - Polybrominatedbiphenyls; 18 - Mercury compounds; 20 - Organostannic compounds; 43 - Azocolourants and Azodyes; 46/46a - Nonylphenol and Nonylphenol ethoxylates; 47 - Chromium VI compounds (relevant to leather articles); 68 - C9-C14 PFCAs and 72 - CMRs in textiles and footwear. Other restrictions, of general application to articles placed on the market for supply to the general public, or covering all articles placed on the market, may also apply to textile articles, for instance entries 50 – (certain) polycyclic aromatic hydrocarbons; 51 and 52 (certain phthalates); 61 - Dimethylfumarate; and 63 – Lead and its compounds.

In addition, Article 33 of REACH sets up a supply chain communication duty requiring suppliers of articles containing SVHC above 0.1% to communicate certain information to the recipients of those articles.

Regulation on the classification, labelling and packaging of substances and mixtures (CLP) ([52])

Regulation (EC) No. 1272/2008 (CLP) focuses on the identification and classification of the intrinsic hazards of chemicals, i.e. the hazardous effects of chemicals on human health or the environment, and on communicating them to users of chemicals and decision makers (consumers, industry and authorities). Identifying the intrinsic hazardous properties of substances to derive a hazard classification is the first step in assessing chemical risks.

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[48] BREF for the textile industry. Commission Implementing Decision (EU) 2022/2508 of 9 December 2022 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions, for the textiles industry. Available at this link.

[49] BREF for waste incineration. Commission Implementing Decision (EU) 2019/2010 of 12 November 2019 establishing the best available techniques (BAT) conclusions, under Directive 2010/75/EU of the European Parliament and of the Council, for waste incineration. Available at this link.

[50] BREF for waste treatment. Commission Implementing Decision (EU) 2018/1147 of 10 August 2018 establishing best available techniques (BAT) conclusions for waste treatment, under Directive 2010/75/EU of the European Parliament and of the Council. Available at this link.

[51] REACH Regulation. Regulation (EC) No 1907/2006 of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH), establishing a European Chemicals Agency, amending Directive 1999/45/EC and repealing Council Regulation (EEC) No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC, 93/67/EEC, 93/105/EC and 2000/21/EC. Available at this link.

[52] CLP Regulation. Regulation (EC) No 1272/2008 of the European Parliament and of the Council of 16 December 2008 on classification, labelling and packaging of substances and mixtures, amending and repealing Directives 67/548/EEC and 1999/45/EC, and amending Regulation (EC) No 1907/2006. Available at this link.

CLP requires manufacturers, importers and downstream users to classify hazardous substances and mixtures and provides rules on how to classify them, applicable throughout the EU. For a substance that has a harmonised classification (an entry in Annex VI to CLP), that classification is legally binding for the hazard classes and differentiations covered in the entry. The substances not covered in the entry, as well as mixtures, must be evaluated and self-classified. The hazard classification determines the appropriate labelling and packaging of the chemicals in the supply chain, in particular to protect workers, consumers and the environment.

Hazard classifications under CLP, including the new hazard classes defined in the recently adopted Delegated Commission Regulation (EU) 2023/707, are very relevant in determining obligations imposed by many relevant EU acts, including on products. Article 2(28) of ESPR refers to specific hazard classes under Annex VI of CLP to define “substances of concern”, whereas under Regulation (EC) No. 66/2010 on the EU Ecolabel, its Article 6(6) specifies that an EU Ecolabel cannot be awarded to goods containing substances or mixtures meeting the criteria for certain hazard classifications in accordance with CLP.

POPs Regulation ([53])

The POPs Regulation focuses on persistent organic pollutants, and it implements the international obligations of the EU as a party to the Stockholm Convention. The objective of the Regulation is to protect human health and the environment from POPs by prohibiting, phasing out as soon as possible, or restricting the manufacturing, placing on the market and use of substances subject to the Stockholm Convention. Substances listed in Annexes I and II to the Regulation are, respectively, prohibited or limited, in terms of their manufacture, placing on the market and use, with some specific exemptions. Some of these restrictions are relevant to textiles, for instance those associated with certain brominated flame retardants (e.g. certain PBDEs), surface-active substances such as PFOS or PFOA, or substances with biocidal properties such as pentachlorophenol.

Waste Framework Directive (WFD) ([54])

The WFD sets the basic concepts and definitions related to waste management, including definitions of waste, recycling and recovery. It lays down waste management principles, which contribute to the reduction of the adverse impact of waste management on human health or the environment, with an emphasis on waste prevention. The WFD contains provisions on waste prevention, encouraging the reuse of products and the setting up of systems promoting repair and reuse activities, including in particular for textiles (Article 9), and requires Member States to set up separate collection for textiles by 1 January 2025 (Article 11) in order to promote high-quality recycling. Article 9 of the Directive also promotes the reduction of the content of hazardous substances in materials and products by defining a reporting obligation that applies to suppliers of articles (as defined under REACH), requiring them to provide information regarding the presence of SVHC in articles, including textile articles, pursuant to Article 33 of REACH, to the European Chemicals Agency (ECHA), as of 5 January 2021. This information is collected in a database, operated by ECHA, and access is provided to waste treatment operators and consumers.

Waste Shipment Regulation (WSR) ([55])

This Regulation aims to (1) ensure that the EU does not export its waste challenges to third countries and contributes to environmentally sound management of waste; (2) strengthen enforcement to prevent illegal shipments of waste occurring within the EU, as well as from the EU to third countries; (3) increase traceability of waste shipments within the EU and facilitate recycling and reuse. Although the WSR entered into force on 20 May 2024, most provisions will apply from 21 May 2026 and most export rules will apply from 21 May 2027.

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[53] POPs Regulation. Regulation (EU) 2019/1021 of the European Parliament and of the Council of 20 June 2019 on persistent organic pollutants (recast) (Text with EEA relevance) Text with EEA relevance. Available at this link.

[54] Waste Framework Directive (WFD). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance). Available at this link.

[55] Waste Shipment Regulation (WSR). Regulation (EU) 2024/1157 of the European Parliament and of the Council of 11 April 2024 on shipments of waste, amending Regulations (EU) No 1257/2013 and (EU) 2020/1056 and repealing Regulation (EC) No 1013/2006. Available at this link.

Corporate Sustainability Due Diligence Directive (CSDDD) ([56])

The primary objective of the CSDDD is to promote sustainable and responsible corporate practices throughout companies' operations and global value chains. The new rules aim to ensure that in-scope companies identify and mitigate adverse human rights and environmental impacts arising from their activities, both within and outside the EU.

This Directive establishes a mandatory corporate due diligence obligation, comprising the following key elements:

- Companies must identify and address potential and actual human rights and environmental impacts within their own operations, subsidiaries, and value chains, including those of their business partners.
- Large companies are required to adopt and implement, to the best of their abilities, a transition plan for climate change mitigation, aligned with the 2050 climate neutrality objective of the Paris Agreement and intermediate targets under the European Climate Law.

The CSDDD applies to: (1) large EU limited liability companies and partnerships with more than 1,000 employees and a global turnover exceeding EUR 450 million, and (2) large non-EU companies with a turnover of more than EUR 450 million in the EU. Micro companies and small and medium-sized enterprises (SMEs) are exempt from the proposed rules. However, the Directive provides supportive and protective measures for SMEs that may be indirectly affected as business partners in value chains

The Corporate Sustainability Reporting Directive (CSRD) ([57])

The CSRD modernised and strengthened the rules governing the social and environmental information that companies must report. A broad range of large companies, including listed small and SMEs, are required to report on sustainability. Non-EU companies generating over EUR 150 million on the EU market are also subject to reporting requirements.

The CSRD aims to provide investors and other stakeholders with access to the necessary information to assess the impact of companies on people and the environment, as well as to evaluate financial risks and opportunities arising from climate change and other sustainability issues. Furthermore, the harmonisation of reporting requirements is expected to reduce reporting costs for companies in the medium to long term.

Companies subject to the CSRD will be required to report according to the European Sustainability Reporting Standards (ESRS), drafted by an independent body representing various stakeholders. The first set of ESRS was published in December 2023, in the form of a Delegated Regulation ([58]). These standards apply to all companies within the scope of the CSRD, regardless of their sector of operation. The ESRS are aligned with EU policies, while also building on and contributing to international standardisation initiatives.

The CSRD also requires assurance on the sustainability information that companies report and will provide for the digital taxonomy of sustainability information.

The first companies will be required to apply the new rules for the 2024 financial year, with reports to be published in 2025.

Unfair Commercial Practices Directive (UCPD) ([59])

[56] Corporate Sustainability Due Diligence Directive (CSDDD). Directive (EU) 2024/1760 of the European Parliament and of the Council of 13 June 2024 on corporate sustainability due diligence and amending Directive (EU) 2019/1937 and Regulation (EU) 2023/2859. Available at this link.

[57] Corporate Sustainability Reporting Directive (CSRD). Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014, Directive 2004/109/EC, Directive 2006/43/EC and Directive 2013/34/EU, as regards corporate sustainability reporting. Available at this link.

[58] Commission Delegated Regulation (EU) 2023/2772 of 31 July 2023 supplementing Directive 2013/34/EU of the European Parliament and of the Council as regards sustainability reporting standards. Available at this link.

[59] Unfair Commercial Practices Directive (UCPD). Directive 2005/29/EC of the European Parliament and of the Council of 11 May 2005 concerning unfair business-to-consumer commercial practices in the internal market and amending Council Directive 84/450/EEC,

The UCPD concerns unfair business-to-consumer commercial practices, and it aims to boost consumer confidence and make it easier for businesses, especially small and medium-sized enterprises, to trade across borders. It regulates unfair commercial practices that occur before, during and after a business-to-consumer transaction has taken place.

The Directive does not provide specific rules on environmental claims or specifically for textiles. However, it provides a legal basis to ensure that traders do not present environmental claims in ways that are unfair to consumers. It does not prohibit the use of 'green claims' as long as they are not unfair. On the contrary, the UCPD can help traders invest in the environmental performance of their products by enabling them to communicate these efforts to consumers transparently and by preventing competitors from presenting misleading environmental claims. The Directive states that claims should not be misleading and that all claims which lead a consumer to choose one product over another must be trustworthy. The Directive's Annex I lists which practices are considered unfair and misleading in all circumstances.

The proposal from the Commission for a Directive on empowering consumers for the green transition will amend the Unfair Commercial Practices Directive and the Consumer Rights Directive, introducing specific provisions to avoid greenwashing. See further details in Section 4.1.2.

Directive on empowering consumers for the green transition ([60])

The proposal from the Commission for a Directive on empowering consumers for the green transition will amend the Unfair Commercial Practices Directive (2005/29/EC) and the Consumer Rights Directive (2011/83/EU). It addresses problems identified with consumer information at the point of sale, in particular the fact that consumers lack reliable information for choosing more environmentally sustainable products, and aims to protect consumers against certain unfair commercial practices.

This is to be achieved through the improved participation of consumers in the circular economy by providing better information on the durability and reparability of certain products to consumers and stepping up the protection of consumers against unfair commercial practices by preventing: greenwashing, early obsolescence practices, use of unreliable and non-transparent sustainability labels and information tools. The co-legislator adopted this Directive on 20 February 2024.

4.1.2 EU legislation in preparation

Proposal for a targeted amendment of the Waste Framework Directive ([61])

The overall objective of the WFD revision is to reduce environmental and climate impacts, increase environment quality and improve public health associated with textiles waste management in line with the waste hierarchy. The Commission proposal aims to make producers responsible for the full life cycle of textile products and to support the sustainable management of textile waste across the EU. This initiative also aims to accelerate the development of the separate collection, sorting, reuse and recycling sector for textiles in the EU, in line with the EU Strategy for Sustainable and Circular Textiles.

The Commission proposal intends to introduce mandatory and harmonised Extended Producer Responsibility (EPR) schemes for textiles in all EU Member States. According to this Commission proposal, producers will cover the costs of management of textile waste, which will also provide incentives to reduce waste and increase the circularity of textile products, resulting in a better design of products from the start. The proposal envisages that the contribution to EPR schemes will be adjusted based on the environmental performance of textiles (eco-modulation) based on parameters aligned with ecodesign requirements under the ESPR.

Directives 97/7/EC, 98/27/EC and 2002/65/EC of the European Parliament and of the Council and Regulation (EC) No 2006/2004 of the European Parliament and of the Council ('Unfair Commercial Practices Directive') (Text with EEA relevance). Available at this link.

[60] Proposal for a Directive of the European Parliament and of the Council amending Directives 2005/29/EC and 2011/83/EU as regards empowering consumers for the green transition through better protection against unfair practices and better information. COM/2022/143 final. Available at this link.

[61] Proposal for a Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste. COM/2023/420 final. Available at this link.

Proposal for a Directive on substantiation and communication of explicit environmental claims (Green Claims Directive) ([62])

The Commission Green Claims Directive proposal will address greenwashing by tackling false environmental claims made to consumers, and stopping the proliferation of public and private environmental labels. Together with the proposal for a Directive on empowering consumers for the green transition, the proposal establishes a clear regime for environmental claims and labels. Their purpose is to ensure that consumers receive trustworthy information about the environmental credentials of the products they buy.

The proposal targets ‘green claims’ made by businesses that state or imply a positive environmental impact, lesser negative impact, no impact, or improvement over time for their products, services, or organisation. It requires that green claims are substantiated and this substantiation be verified *ex-ante*. This only concerns claims that are not covered by other EU rules, notably the ESPR and the TLR. The proposal also addresses environmental labelling schemes, stopping the proliferation of public and private labels and ensuring the transparency and robustness of labelling schemes.

Proposal on common rules promoting the repair of goods ([63])

The proposal introduces a new ‘right to repair' for consumers, both within and beyond the legal guarantee. It aims to provide consumers savings and support the objectives of the European Green Deal by reducing waste. The proposal will make it easier and more cost-effective for consumers to repair as opposed to replace goods. Additionally, it aims to promote the repair sector, incentivising sustainable business models.

4.2 Legislation and initiatives in EU Member States and non-EU countries

The publication of Directive (EU) 2018/851 ([64]) (the 2018 revision of the WFD) promoted the establishment of **Extended Producer Responsibility (EPR)** schemes for textile products in several Member States. For textile, France ([65]), the Netherlands ([66]) and Hungary (Decree 80/2023) were pioneers in establishing systems where economic operators placing textile products on the market contribute to the collection, sorting, reuse, preparing for reuse and recycling infrastructure for the same products.

Other Member States establishing EPR schemes are Greece (Law 4819/2021), and Spain (Law 7/2022), while Italy ([67]) is not far behind.

Within the national Climate Law, France is establishing the **Eco-Score** ([68]), which is an online tool that provides the consumer with an idea about the environmental impacts of apparel, with specific characteristics (e.g. weight, fibre composition) selected directly by the consumer from a defined list. In the future, it is planned that economic operators will be able to report the environmental performance of their products via the Eco-Score, so that the Eco-Score will work as an environmental labelling tool. Additionally, it is planned to connect the Eco-Score with the EPR scheme to deploy eco-modulation.

The Dutch Government established the **Denim Deal** ([69]), which aims to bolster the use of post-consumer recycled cotton in denim products marketed in the Netherlands. In particular, the signatories of the initiative aim to use 20% post-consumer recycled cotton fibres in 3 million pairs of jeans produced until the end of 2023.

The Luxembourg Ministry of the Economy developed the **Product Circularity Data Sheet (PCDS)** ([70]), which aims to provide basic product information about the several steps of the supply chain. Information is gathered

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[62] Green Claim Directive. Proposal for a Directive of the European Parliament and of the Council on substantiation and communication of explicit environmental claims (Green Claims Directive). COM/2023/166 final. Available at this link.

[63] Proposal for a Directive of the European Parliament and of the Council on common rules promoting the repair of goods and amending Regulation (EU) 2017/2394, Directives (EU) 2019/771 and (EU) 2020/1828. COM/2023/155 final. Available at this link.

[64] Directive (EU) 2018/851 of the European Parliament and of the Council of 30 May 2018 amending Directive 2008/98/EC on waste (Text with EEA relevance). Available at this link.

[65] French Anti-Waste law for a circular economy. AGEC- Law nº2020-105, 10 February 2020. Available at this link. Code de l'environnement L.541-10-27. Code de l'environnement R.543-214 to R.541-219. Last accessed on 17 December 2023.

[66] Dutch Decree on extended producer responsibility for textiles. Available at this link. Last accessed on 17 December 2023.

[67] Announcement of the Italian EPR scheme. Available at this link. Last accessed on 17 December 2023.

[68] Eco-Score. Available at this link. Last accessed on 17 December 2023.

[69] The Demin Deal. Available at this link. Last accessed on 17 December 2023.

[70] Product Circularity Datasheet. Available at this link. Last accessed on 17 December 2023.

in five areas: general information, composition, design for better use, design for disassembly, and design for reuse.

In February 2023, the State of **California** (USA) introduced the **Responsible Textile Recovery Act ([71])** with Senate Bill 707 (SB-707), which aims to establish an Extended Producer Responsibility scheme for textile products. The bill is currently under scrutiny before its implementation. The bill introduces the concept of a programme operator to oversee the implementation of a stewardship programme. Additionally, the bill would also establish a Textile Stewardship Recovery fund which would receive fees paid by programme operators. This fund will cover the costs associated with programme implementation and enforcement.

4.3 Strategies of the United Nations

The United Nations Environment Programme (UNEP) offers strategic guidance and promotes collaboration across sectors to foster a fair shift towards a sustainable and circular textile value chain. To this end, UNEP promotes numerous activities and publishes studies on its website ([72]).

In particular, UNEP proposes a roadmap with collective actions focusing on nine points (UNEP, 2023a):

1. Adopt globally sustainable and circular business models.
2. Contrast overconsumption and overproduction.
3. Design sustainable and circular textile products.
4. Improve product care and durability.
5. Reduce the emissions into the environment during the production stages.
6. Address social issues along the value chain.
7. Use of sustainable or recycled materials.
8. Improve the shared infrastructure of the value chain.
9. Develop a suitable textile waste management system that avoids landfilling and incineration of textile products.

UNEP promotes the engagement of all stakeholders in the value chain to focus on the nine points of the roadmap (UNEP, 2023a).

4.4 Tests and standards

Textile standards in Europe are coordinated by CEN-CENELEC ([73]). Several working groups are related to the textile industry, mainly CEN/TC248 TEXTILES AND TEXTILE PRODUCTS. **Table 66** in Section 10.3 reports details of technical working groups and scientific committees. On the other hand, ISO/TC 38 TEXTILES encompasses several working groups that deal with international standards for textile properties, testing methods, and quality control. **Table 67** in Section 10.3 includes the technical working groups in ISO/TC 38 that focus on aspects of the textile industry.

The knowledge of the available standards in the textile sector is crucial in the development of the PS, because it provides an overview of the technical aspects/parameters of a textile product that can currently be measured via a commonly recognised test/method/tool. Specific standards could potentially be used to propose and/or verify ecodesign requirements, when the PS addresses tasks 6 and 7 of the MEErP.

Numerous standards used in the textile industry were classified and some of them were related to the product aspects reported in Article 5 of the ESPR (see Section 10.3):

- Standards directly related to the intrinsic durability of the textile product, which could address abrasion, pilling, colourfastness, dimensional stability, seam slippage, tear strength, etc. (**Table 68**). Specific textile frameworks already use some of these standards to address

[71] SB-707 Responsible Textile Recovery Act of 2023. Available at this link. Last accessed on 17 December 2023.
[72] United Nations environment programme. Building Sustainability and Circularity in the Textile Value Chain. Available at this link. Last accessed on 17 December 2023.
[73] CenCenelec website. Available at this link. Last accessed on 17 December.

durability aspects of textile products. **Table 69** compares how durability parameters for textile products are tested by PEFCR A&F, EU Ecolabel criteria, Blue Angel criteria, and Nordic Swan Ecolabel criteria (see Section 4.5 for information about ecolabels and other environmental labels).

- Standards related to the functionality of the textile products, such as antifungal activity, antiviral activity, oil stain repellency, resistance to chlorinated water, resistance to insects, resistance to surface wetting, stain repellency, water repellency, water resistance after aging, wicking (**Table 70**).
- Standards used for textile characterisation, such as identification of dyestuff and fibres, thickness, mass per unit area and composition (**Table 71**), which could be a reference for characterising and referring to specific textile products.
- Standards for the identification of specific substances, such as alkylphenol ethoxylates (APEO), formaldehyde, and other chemicals (**Table 72**), which are of environmental concern as reported in Section 3.1.3.
- Standards related to the loss of fragmented fibres (**Table 73**), which are of environmental concern as reported in Section 3.1.3.
- Standards potentially related to circularity and environmental aspects. Almost all of these standards are still under development (**Table 74**).
- Standards related to potential information on the care of textile products, because they describe and report labelling symbols (**Table 75**). Apparel properly maintained is more likely to have a longer lifespan (see Section 6).

Some of the standards available for the textile industry measure a specific parameter using different methods (e.g. Determination of the abrasion resistance on coated fabrics. Part 1 using taber abrader and Part 2 using martindale abrader). The selection of the method depends mainly on the laboratory equipment used for testing.

Only one standard was found addressing non-woven technology to measure the tensile strength and elongation; all the other standards focused on woven and knitted technologies.

The analysis did not reveal any standard capable of recognising whether a fibre is of virgin or recycled origin, or of identifying the type of fibres being mechanically recycled. Specific methods to verify this type of information will be investigated in the following milestone, when the PS addresses task 6.

In addition to the investigated standards, the textile industry widely deploys a multitude of other standards that are tailored to specific industrial sectors or regional contexts. Notably, several standards are of relevance, including those promulgated by organisations such as the AATCC (American Association of Textile Chemists and Colorists), ASTM (American Society for Testing and Materials), British Standards Institution, JIS (Japanese Industrial Standards), and the GB standards (National Standards of the People's Republic of China), and many more. By adhering to such comprehensive and recognised frameworks, the textile industry can foster consistency, reliability, and quality assurance throughout its global operations.

4.5 Voluntary environmental labels

In general, there are many types of labels, addressing single or multiple environmental issues and covering different sectors and regions. See Section 10.4.1 for more information. Three ISO standards classify voluntary environmental labels as follows:

— **ISO Type I environmental labels** (ISO 14024:2018) ([74]), known as **Ecolabels**, are defined as *'voluntary, multi-criteria-based and third party-verified labels that indicate an overall environmental preference in a life cycle perspective of a product or service within a specific product category'*.

[74] ISO 14024:2018. Environmental labels and declarations. Type I environmental labelling. Principles and procedures. Available at [this link.](#) Last accessed on 12 January 2024.

— **ISO Type II environmental labels** (ISO 14021:2016) ([75]), known as **Self-declared Environmental Claims**, are neither third-party verified nor based on a Life Cycle Thinking approach. Many self-declared environmental claims on the EU market do not necessarily follow ISO 14021:2016.

— **ISO Type III environmental labels** (ISO 14025:2016) ([76]), known as **Environmental Declarations**, are labels presenting '*quantified environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function*'. The establishment of Product Category Rules ensures that the life-cycle assessment is performed with specific rules aiming to foster transparency and facilitate comparisons between different Environmental Declarations.

Global environmental labels used in the textile industry were recently analysed (Ranasinghe and Jayasooriya, 2021) via an investigation including bibliographic research, the Ecolabel Index ([77]), and the Global Ecolabelling Network ([78]). Ranasinghe and Jayasooriya (2021) report that on 20 March 2021 there were 107 environmental labels for textiles in the world: 55 used in Europe, 54 used in the USA, 41 used in Asia, 18 used in Latin America, 19 used in Oceania, and 12 used in Africa. When looking for the same information on 7 February 2024, the ITC Standard Map ([79]) provided 73 environmental labels for textiles used globally: 58 used in Europe, 50 used in USA, 54 used in Asia, 42 used in Latin America, 48 used in Oceania, and 45 used in Africa.

Table 10 reports the topics that were addressed the most by environmental labels for textiles globally in 2021. The majority of the concerns focused on the use of harmful chemicals and toxic substances, as well as natural resources. Additionally, specific global regions used environmental labels addressing specific topics: such as Europe with 'Pesticides/herbicides/fungicides', and Latin America with 'Carbon/GHG offsets'.

Table 10. Top topics addressed by environmental labels for textiles globally in 2021

Topic	Europe	USA	Asia	Latin America	Oceania	Africa
Toxics	X	X	X	X	X	X
Harmful chemicals	X	X		X	X	X
Natural resources	X	X	X		X	X
Pesticides/herbicides/fungicides	X					
Material use	X	X	X			
Waste		X	X	X	X	X
Energy use/efficiency			X	X	X	X
Carbon/GHG offsets				X		

N.B. The topic 'Toxics' addresses harmful substances that are already prohibited or regulated; whereas the topic 'Harmful chemicals' addresses substances that are known to be harmful to health, but are not officially banned. The authors of the referenced study use the term 'Chemicals' when referring to 'Harmful chemicals'.

The authors of the referenced study do not specify if the topic 'Waste' addresses any kind of waste generated along the value chain, or waste generated at a specific stage. No further explanation/specification is provided for other topics.

Source: Ranasinghe and Jayasooriya (2021)

Figure 2 shows the topics addressed by environmental labels used for textiles in 2021 in Europe and their number. These environmental labels addressed most of the environmental impacts described in Section 3.3.2.

The analysis showed that the textile industry largely relies on environmental labels, but most of the time actors do not state which ISO type standard they follow – if they follow any. This situation causes confusion for the consumers, who cannot identify governance, reliability, environmental scope and level of environmental ambition of all environmental labels. To fill this gap, some voluntary initiatives try to score, compare and describe some environmental labels ([80]). The lack of transparency of the numerous environmental labels could be further analysed in the 3rd milestone, when the PS addresses the content of the Digital Product Passport.

[75] ISO 14021:2016. Environmental labels and declarations. Self-declared environmental claims (Type II environmental labelling). Available at this link. Last accessed on 12 January 2024.

[76] ISO 14025:2006. Environmental labels and declarations. Type III environmental declarations. Principles and procedures. Available at this link. Last accessed on 12 January 2024.

[77] Ecolabel Index. Website available at this link. Last accessed on 12 January 2024.

[78] Global Ecolabelling Network. Website available at this link. Last accessed on 12 January 2024.

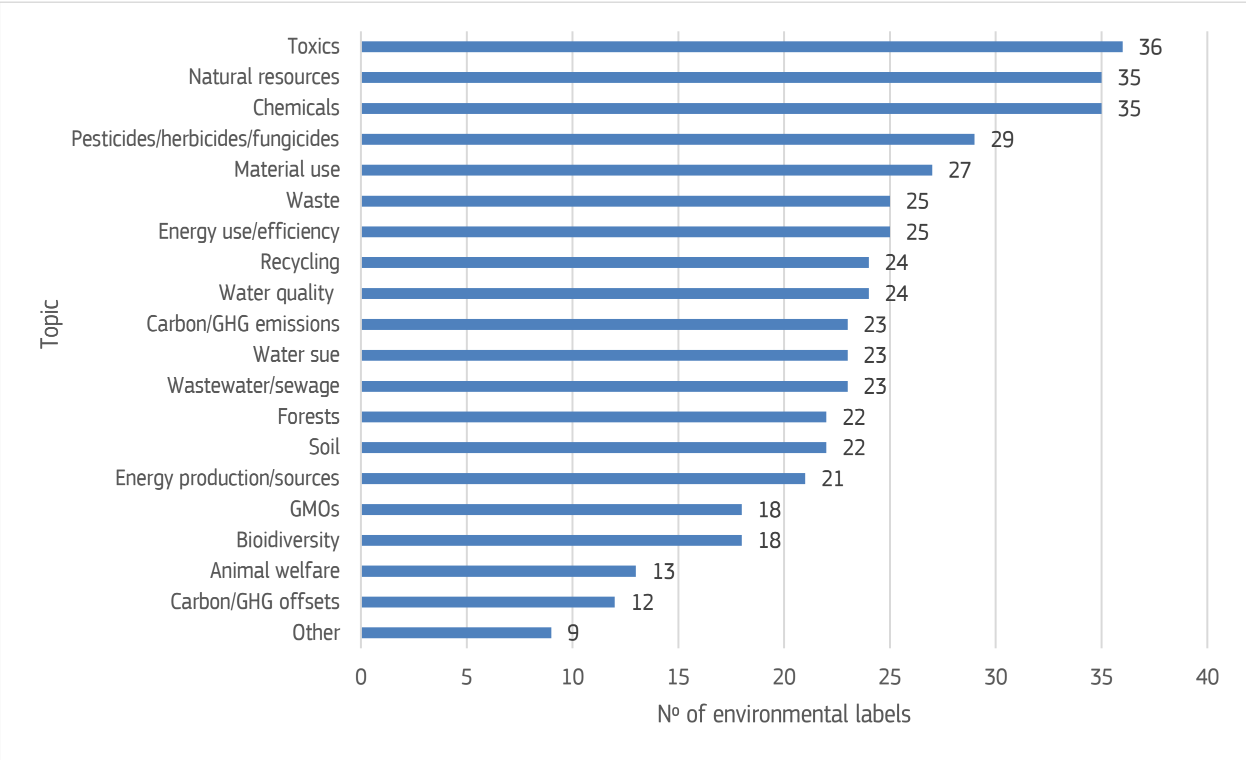
[79] ITC Standards Map App, selecting sectors of clothing and textiles. Available at this link. Last accessed on 7 February 2024.

[80] ITC Standards Map App. Available at this link. Last accessed on 7 February 2024.

Section 7 assesses in detail the EU Ecolabel criteria for textile products in light of their revision process, as described in Section 1. As established by Article 6(3.f) of the EU Ecolabel Regulation, the analysis performed considers other ecolabels used in the EU (Blue Angel ([81]) and Nordic Swan Ecolabel ([82])) to enhance synergies.

Further information about voluntary environmental labels used in Europe is reported in **Table 76** in Section 10.4.2.

Figure 2. Main topics addressed by environmental labels used in 2021 in Europe



N.B. The topic ‘Toxics’ addresses harmful substances that are already prohibited or regulated, whereas the topic ‘Chemicals’ addresses substances that are known to be harmful to health, but are not officially banned. The authors of the referenced study do not specify if the topic ‘Waste’ addresses any kind of waste generated along the value chain, or waste generated at a specific stage. No further explanation/specification is provided for other topics.

Source: (Ranasinghe and Jayasooriya, 2021)

Label Directory – Siegelklarheit. Available at this link. Last accessed on 7 February 2024.
Labels Environnementaux. Available at this link. Last accessed on 7 February 2024.

[81] Blue Angel – The German Ecolabel. Available at this link. Last accessed on 7 February 2024.

[82] Nordic Swan Ecolabel. Available at this link. Last accessed on 7 February 2024.

5 Market analysis

This section analyses the market of the products included in the scope of the PS, addressing many aspects. The information collected at this stage will feed into the following tasks of the MEErP, in particular task 4 (Section 9) to task 7.

The first subsections analyse the market at different scales: global, EU and Member State (Sections 5.1, 5.2 and 5.3). Section 5.4 presents available market information of elements affecting the production and recycling of textile apparel. The market structure and the value chain are analysed in Section 5.5 and Section 5.6, respectively. Section 5.7 analyses the competitiveness at global level, focusing on different environmental compliance costs that companies placed in different countries must face. Section 5.8 analyses the lifespan of the products included in the scope. This information is particularly crucial to build a suitable model for the environmental and economic assessment, as well as the stock analysis (tasks 5 to 7 of the MEErP). The section concludes with a brief comment about the penetration in the market of the environmental labels used in the textile sector (Section 5.9).

5.1 The global market

Historical overview

In 1947, the Grant Agreement on Tariffs and Trade (GATT) was signed by 23 countries to promote free movement of goods among signing countries. The GATT set the bases for the future institution of the World Trade Organization (WTO) in 1994 ([83]).

From 1974 to 1994, under a special regime outside the GATT framework, the Multifibre Arrangement (MFA) set rules for international trade of textile products. The MFA was a framework for bilateral agreements or unilateral actions that established quotas ([84]) limiting imports into countries whose domestic industries could be damaged by a quick rise of imports ([85]). The MFA applied only to trade between developed and developing countries, but not to trade among developed countries. Although the MFA did not comply with the principle of non-discrimination established in the GATT, developed countries used it to protect their textile industry (Stephen MacDonald, 2006).

In 1995, within the establishment of the WTO and the revised GATT, the MFA was substituted by the Agreement on Textiles and Clothing (ATC), which represented the 10-year-long transition towards an international textile market without quotas ([86]). The ATC applied to all the WTO members ([87]). Between 1995 and the end of 2004, quotas were gradually removed ([88]).

Since 1 January 2005, the trade of textile products among WTO members has been free of quotas.

In June 2005, the European Commission signed a Memorandum of Understanding with China to keep the imports of specific textile products ([89]) below some thresholds until the end of 2007. This action was intended to prevent distortion of the European textile sector ([90]).

Since 2005, the European textile market has been completely open to imports of any product coming from any country belonging to the WTO.

In 2005, the removal of quotas from the global textile market caused an increase in production and employment in Asian countries, such as China, India, Türkiye, Hong Kong, Bangladesh, and Indonesia (Hildegunn Kyvik Nordås, 2004). Already in the 1970s, textile production had started moving from Europe and North America mainly to

[83] The General Agreement on Tariffs and Trade (GATT 1947) – the legal text available on this World Trade Organization webpage, last accessed on 29 September 2023.

[84] A quota is a government-imposed trade restriction that limits the number or monetary value of goods that a country can import or export during a particular period (Adam Barone, 2022)

[85] Textiles: back in the mainstream – World Trade Organization webpage, last visited on 29 September 2023.

[86] Textiles Monitoring Body (TMB) The Agreement on Textiles and Clothing – World Trade Organization website, last accessed on 29 September 2023. Marrakesh Agreement Establishing the World Trade Organization – World Trade Organization website, last accessed on 29 September 2023.

[87] The list of WTO members and dates of membership are available here: https://www.wto.org/english/res_e/booksp_e/sli_e/4wtomembers.pdf

[88] Textiles: back in the mainstream – World Trade organization webpage, last visited on 29 September 2023.

[89] Ten types of products were included in the Memorandum of Understanding between EU and China: pullovers, men's trousers, blouses, t-shirts, dresses, bras, flax yarn, cotton fabrics, bed linen, table and kitchen linen.

[90] EU – China textile agreement 10 June 2005. Available at this link. Last accessed on 29 September 2023.

Asia and other developing regions of the world ([91]). In 1996, Asia was the predominant global exporter of apparel products, contributing to more than 32% of the world's apparel exports (ILO News, 1996). However, the general lack of transparency of the textile supply chain until the 2010s does not allow a description over time of EU textile outsourcing ([92]).

In September 2008, the financial crisis that originated in the USA rapidly affected major economies due to their interconnections. The EU experienced the Great Recession between 2008 and 2009. Following a brief period of recovery, many Member States subsequently became vulnerable to the sovereign debt crisis (Szczepanski, 2019). This global crisis significantly impacted the European textile industry which had already been hit by offshoring and the increased competitiveness of the Chinese industry after 2005 (Maya Forstater, 2010).

In 2020, the outbreak of the COVID-19 pandemic led to international economic and social disruptions, including the most significant global recession since the time of the Great Depression in the 1930s (Gita Gopinath, 2020). The main effects of the pandemic on the European textile industry were: (a) a decrease in production, (b) the conversion of traditional production, for some companies, into the manufacture of sanitary products or face masks, and (c) an extraordinary growth in sales via online channels (Vet et al., 2021).

In 2022, two main factors negatively affected the competitiveness of the European textile industry. First, the increase of the energy price in Europe which was over six times that in the USA, China, and other Asian countries. In this context, numerous textiles and apparel companies either operated with a net loss or ceased their production activities (EURATEX, 2022b). Second, countries strongly supported their domestic textile industries, despite being minimally affected by the energy crisis (EURATEX, 2022b).

Table 11 sums up the historical events and international agreements affecting the European apparel sector.

Table 11. Main historical events and international agreements affecting the European apparel sector

Year	Event
1974 to 1994	The Multifibre Arrangement (MFA), with the establishment of import quotas, protected the domestic market of developed countries from products produced in developing countries.
1995 to 2004	The Agreement on Textiles and Clothing (ATC) established a progressive removal of import quotas set with the MFA.
2005 onwards	Among members of the World Trade Organization (WTO), any trade of textile products were free of barriers – all import quotas were removed.
2005 to 2007	The Memorandum of Understanding between the EU and China allowed the monitoring of specific types of textile products imported from China. It aimed to prevent market distortions in the European textile sector.
2008	The Great Recession impacted the European textile sector.
2020	The COVID-19 pandemic led to global recession.
2022	The price of energy strongly increased in EU.

Source: own elaboration based on World Trade Organization website

Global figures

Globally, the apparel sector includes two thirds of the textile industry (EURATEX, 2020; EURATEX, 2022a). It is part of one of the largest industries in the world, if teamed up with the footwear sector in the fashion industry (McKinsey & Company and BOF, 2016). **Table 12** reports the effects of the COVID-19 pandemic on the size of the fashion market from 2019 to 2021. The fashion market shrank about 4% and 21% at global and European scale, respectively. **Table 13** lists the largest global exporters and importers of apparel in 2019 in terms of value as reported by the World Trade Organization. A more detailed description of producing countries at specific phases of the apparel value chain is provided by a study published by the United Nations Environmental Programme (**Figure 3** and **Figure 4**) ([93]).

— The apparel export market is dominated by China and the EU, followed by Bangladesh, Vietnam, India and Türkiye.

[91] Globalization Changes the Face of Textile, Clothing and Footwear Industries. Available at this link. Last accessed on 29 September 2023.

[92] Follow the Thread - The Need for Supply Chain Transparency in the Garment and Footwear Industry. Available at this link. Last accessed on 29 September 2023.

[93] It is not clear to the authors which parameter, e.g. value, mass or any other, was used to develop the percentages reported in **Figure 4**, which is Figure 5 on page 16 of UNEP, (2020).

- The apparel import market is dominated by the EU and the USA, followed by Japan, the UK, Hong Kong, Canada and the Republic of Korea.
- The role of China is prominent in all production phases of the value chain.
- The role of the EU is prominent both in terms of exports and imports.

Table 12. Market data of the apparel and apparel & footwear industries at global and European scale

Industry	Market	Economic parameter	Year	Reported value	Value (bn EUR) [a]	Source
Apparel and footwear	Global	Retail Sale Price	2019	USD 1 773 bn	1 644.3	(b)
			2021	USD 1 717 bn	1 592.3	
Apparel	European	Turnover	2019	EUR 72.8 bn	72.8 bn	(c)
			2021	EUR 65.3 bn	65.3 bn	(d)

N.B. The retail sale price is the price declared by the producer or importer of the goods after deducting any tax included in that price.
The turnover refers to the totals invoiced by the unit, and it corresponds to market sales of goods.
[a] 1 USD = 0.92739 EUR Feb 08, 2024 10:12 UTC.

Source: (b) Fashion United, based on Euromonitor ([94]), (c) EURATEX (2020), (d) EURATEX (2022)

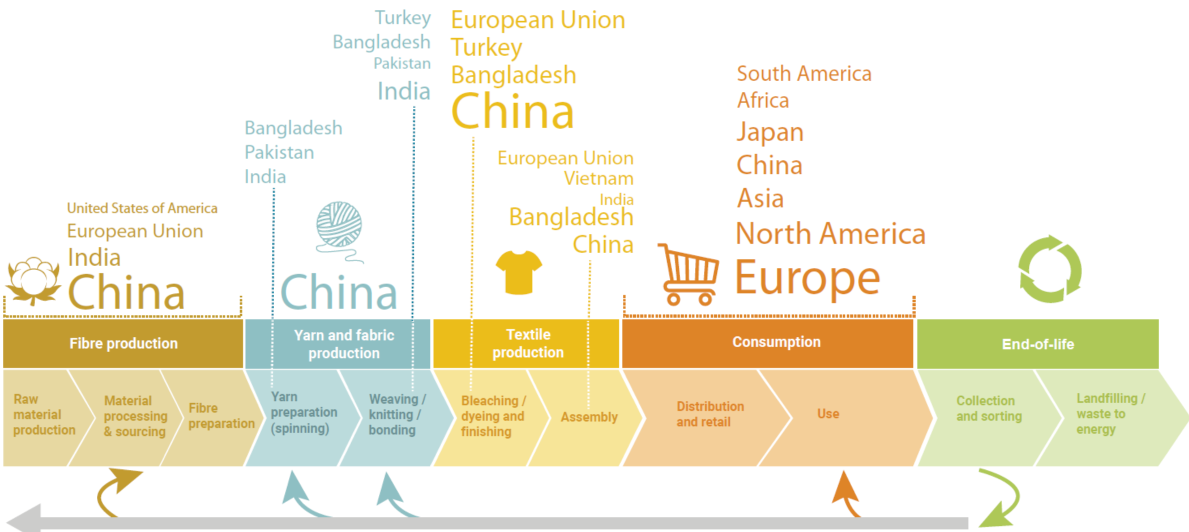
Table 13. Top global exporters and importers of apparel in 2019

Rank	Exports			Imports		
	Country	Value (bn EUR)	Share in world exports (%)	Country	Value (bn EUR)	Share in world imports (%)
1	China [a]	141.0	30.8	EU	88.1	18.1
2	EU	39.9	8.8	USA	88.1	18.2
3	Bangladesh [b]	31.5	6.8	Japan	27.8	5.7
4	Vietnam [b]	28.7	6.2	United Kingdom	24.1	5.0
5	India	15.8	3.5	Hong Kong, China	10.2	NA
6	Türkiye	14.8	3.2	Canada [c]	10.2	2.1
7	Hong Kong, China	11.1	NA	Republic of Korea	10.2	2.1
8	United Kingdom	8.3	1.8	China [a]	8.3	1.7
9	Indonesia	8.3	1.7	Russian Federation [c]	7.4	1.5
10	Cambodia [b]	8.3	1.7	Switzerland	7.4	1.5

[a] Includes significant shipments through processing zones. [b] Estimates of WTO. [c] Imports are valued free on board.
1 USD = 0.92739 EUR Feb 08, 2024 10:12 UTC.
Source: (WTO, 2020)

[94] Information collected from the website Fashion United, Global Fashion Industry Statistics, available here, Euromonitor International, a market research provider, last accessed on 24 October 2023.

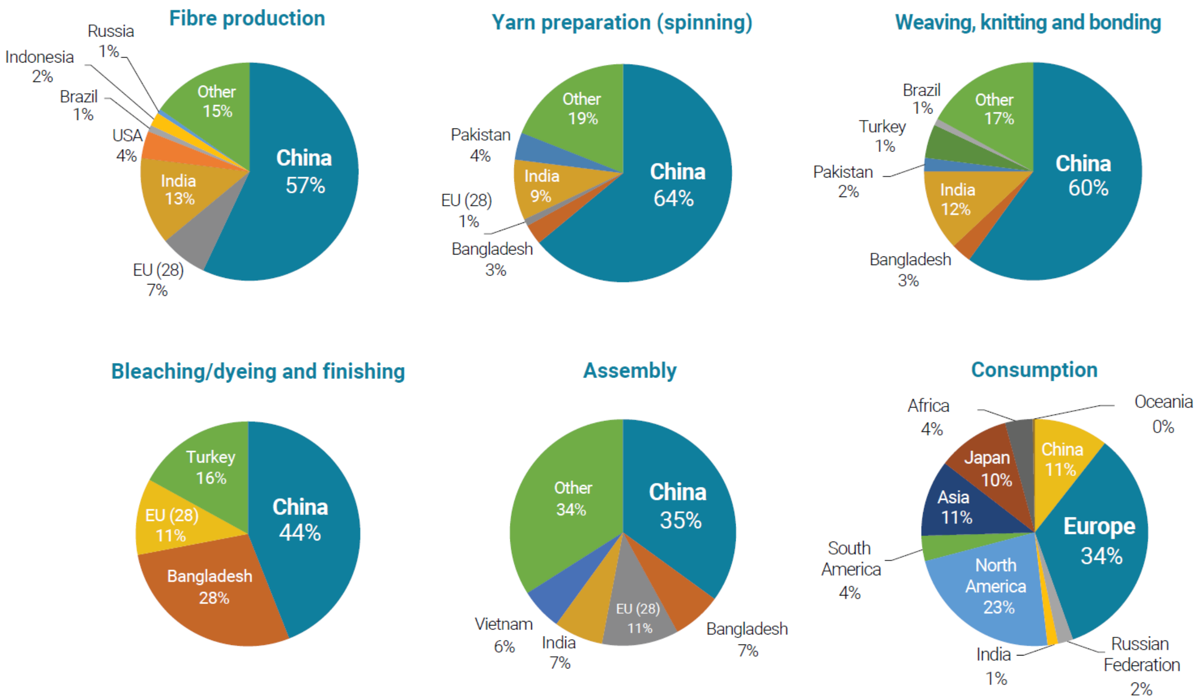
Figure 3. Geographical breakdown of global apparel production and consumption – representation A



N.B. The European Union is different to Europe.

Source: (UNEP, 2020)

Figure 4. Geographical breakdown of global apparel production and consumption – representation B

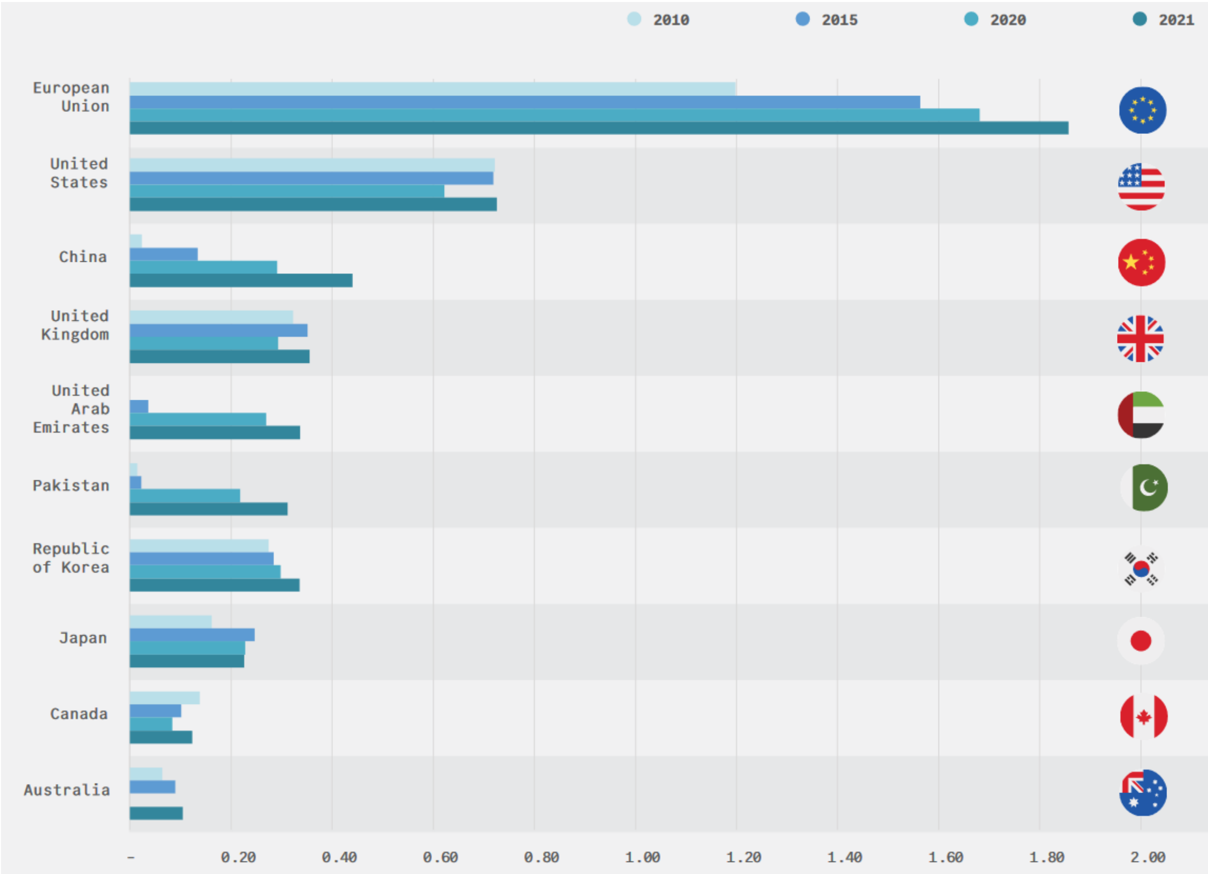


N.B. The EU figures include the United Kingdom. The EU is different to Europe.

Source: (UNEP, 2020)

A global mapping of the textile waste management is currently not available. However, the United Nations and the European Environment Agency investigated the fate of used textile products (Lingås et al., 2023; UNECE and ECLAC, 2024). **Figure 5** and **Figure 6** show the most exporting and importing countries in the world of second-hand apparel in terms of mass. The European Union is the largest exporter, while Pakistan is the largest importer. **Figure 6** shows that the European Union is the second largest importer, most probably because there are five countries ([95]) in EU that export to countries outside EU what is collected locally and what it is imported by other EU countries (Lingås et al., 2023).

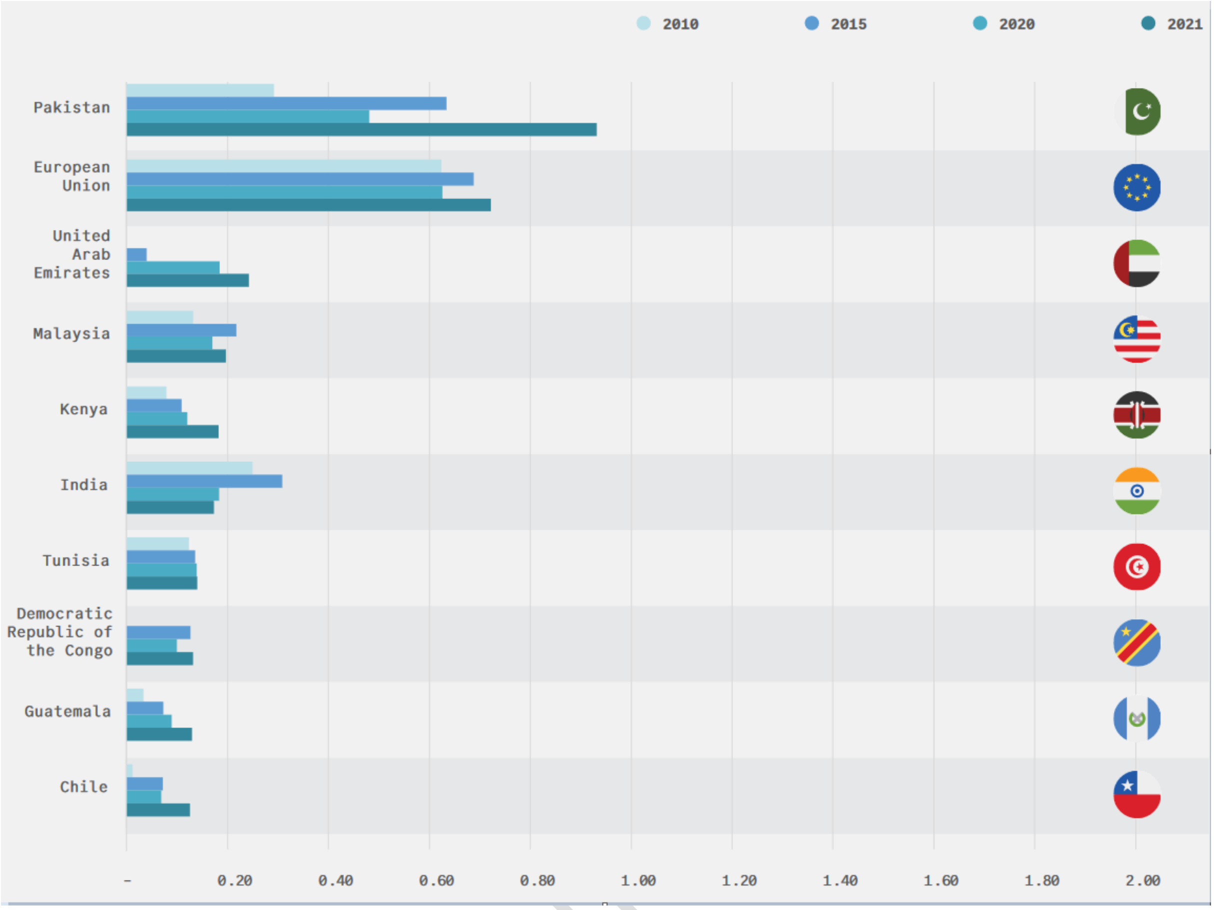
Figure 5. Top ten exporting countries of second-hand apparel by mass (million tonnes)



Source: (UNECE and ECLAC, 2024) based on UN Comtrade - HS Code 6309: Worn Clothing and Other Worn Textile Articles

[95] Overall Belgium, Germany, Italy, the Netherlands, and Poland, are the hubs responsible for most of the exports (Lingås et al., 2023)

Figure 6. Top ten importing countries of second-hand apparel by mass (million tonnes)

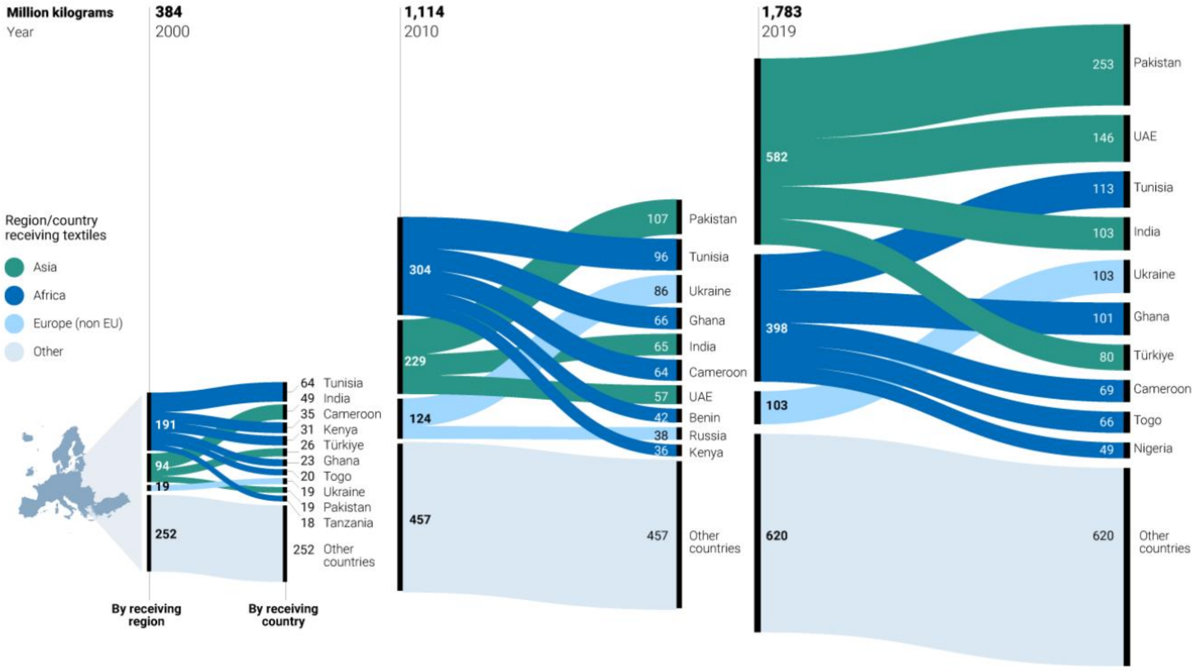


Source: (UNECE and ECLAC, 2024) based on UN Comtrade - HS Code 6309: Worn Clothing and Other Worn Textile Articles

Over the last 20 years, the EU exported an increasing amount of used textile waste:

The export of used textiles from the EU has steadily risen over the last 20 years, from a little more than 384 000 tonnes in 2000, to almost 1.7 million tonnes in 2019 (**Figure 7**). The value of these exports has, however steadily decreased, from EUR 0.76 in 2000, to EUR 0.57 per kilogram in 2019.

Figure 7. EU-27 exports of used textiles



UAE is an acronym for United Arab Emirates

Source: (Lingås et al., 2023) based on UN Comtrade

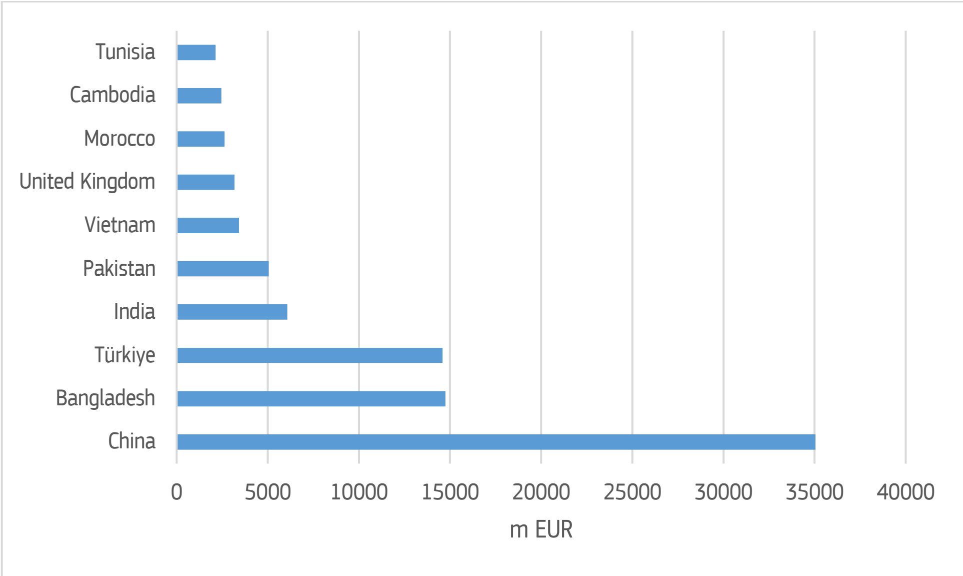
EU global partners

Only a few key partners dominate the EU's trade interactions. In 2021, the top 10 EU suppliers of textiles and apparel made up 84% of all EU imports from non-EU countries. In the same year, the top 10 export partners of the EU purchased 68% of all exports to third countries. (EURATEX, 2022a) ([96]): **Figure 8** and **Figure 9** show the main EU suppliers and customers of textiles and apparel in 2021.

The pivotal role of the EU goes beyond economics due to Europe’s consolidated history and reputation in fashion and design.

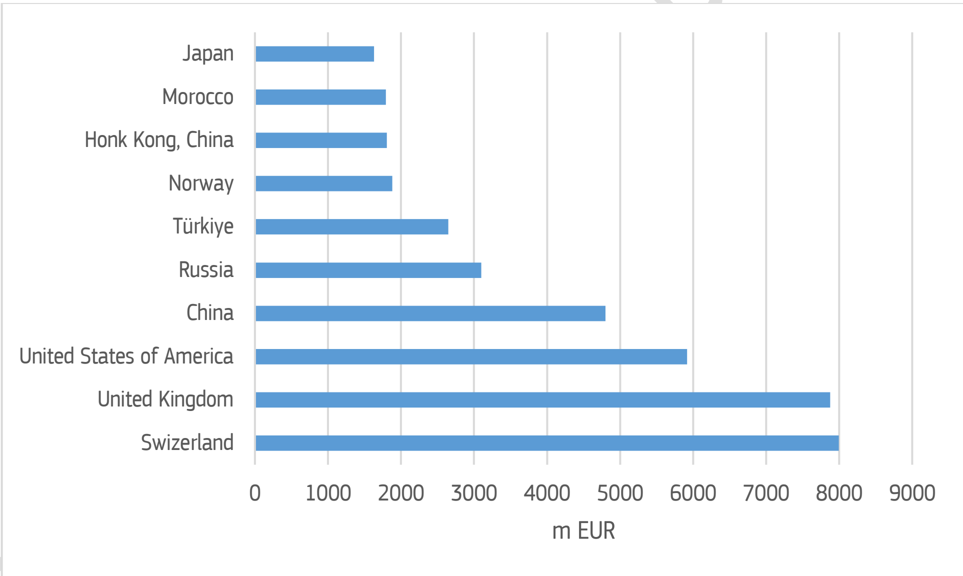
[96] EURATEX (2022) reports data as textile and clothing, which includes the following types of textile products: clothing and accessories, industrial and technical textiles, fabrics, home textiles, knitwear, man-made fibres, yarns, underwear, and workwear.

Figure 8. The EU's main suppliers of textiles and apparel in 2021



Source: EURATEX (2022a)

Figure 9. The EU's main customers of textiles and apparel in 2021



Source: EURATEX (2022a)

Innovation

The European textile industry is an innovation leader worldwide. In 2019, more than 200 000 industrial designs were released by the EU-27, compared to about 50 000 and 20 000 from USA and China, respectively. Additionally, from 2015 to 2019, about 6 600 patents were filed by the EU-27, compared to about 6 000, 5 800, and 3 900, by the Republic of Korea, the USA and China, respectively (EURATEX, 2022a).

5.2 The EU market

The PRODCOM dataset ([28]) collects information about the textile apparel market. This section reports an analysis focusing on the evolution of market indicators of the EU-27 from 1995 to 2022. Details about data used are available in Section 10.1. In particular, **Table 59** describes the codes used for the analysis and their allocation to the specific product categories. Additionally, **Table 60** describes how codes merged or were introduced over the years and specifies potential missing data.

The available data allow an analysis of big trends over time, rather than interpretation of small changes, or differences, in a specific year.

The textile apparel market in the EU-27 was affected by all the historical events reported in Section 5.1. **Figure 10** shows its evolution via four market indicators: production, import, export, and apparent consumption ([29]). These indicators were analysed from the perspective of the mass, the value and the value-to-mass ratio of the textile apparel. The analysis led to the following observations.

Apparent consumption

- Apparent consumption followed the evolution of imports in all analysed perspectives: mass, value and value-to-mass ratio. This means that the market is largely affected by imported products.
- From 2004 to 2005, the apparent consumption increased by 90% if expressed as mass, and 50% if expressed as value. This corresponds to the year when import quotas were removed (**Table 11**).

Production

- From 2003 to 2009, production decreased by about 53% if expressed as mass and about 35% as value, most probably due to the expected import quota removal in 2005 and the subsequent increase in imports. Sector experts revealed that in those years many EU-27 producers relocated their production to third countries.
- From 2009 to 2019, production evolved relatively constantly, fluctuating between 0.7-0.9 billion kg, and EUR 23.9-27.9 billion.

Export

- With the exception of a disruption around 2003-2004, export followed a relatively constant trend in terms of mass, and a slightly increasing trend in terms of value.
- Between 2009 and 2019, while production evolved relatively constantly in terms of mass and value, exports increased by 63% and 110%, in terms of mass and value, respectively. These very different increase rates led export to overtake production in terms of value from 2015 to 2022. These figures are possible because, as reported in Section 10.1.2, PRODCOM accounts for every time a product passes through EU customs. This means that a product could be imported and subsequently exported without undergoing any mass modification, but with an increased value. Most probably, after 2015, export has higher values than production because many EU companies import products that afterwards are exported with a higher value.

Import

- The removal of the import quota established the largest change in the EU market of textile apparel. **Table 14** reports the change that occurred in the apparent consumption when comparing two time intervals: 1995-2004 and 2005-2019, before and after the EU removed the import quota. The apparent consumption of textile apparel in general increased by 86% in mass and 27% in value. This increase was mainly driven by product categories like t-shirts (236% in mass and 133% in value), pants and shorts (194% in mass and 58% in value), jackets and coats (129% in mass and 14% in value), and shirts and blouses (110% in mass and 38% in value) (**Table 14**). For the majority of the product categories, the increase in mass is very much larger than the increase in value. This could flag the purchase every year of more products at lower prices. More details are reported in **Table 61** in Section 10.1.5.

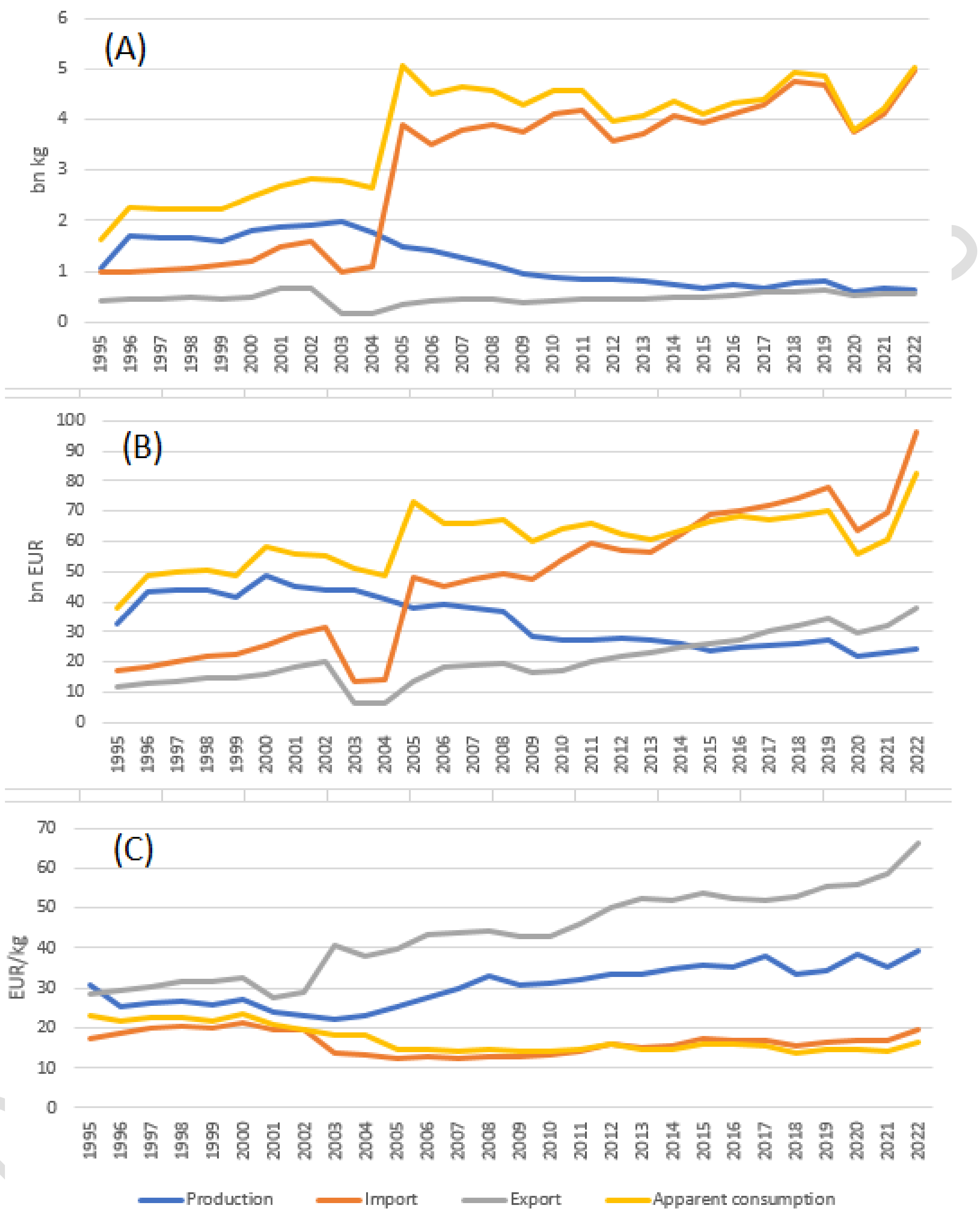
Additional observations

- From 1996 to 2022, the value-to-mass ratio of export, production and import always had the highest, middle and lowest value each year, respectively. Before 2000, the gap among these market indicators was limited, but after 2002 the gap progressively increased.
- In 2020, the COVID-19 pandemic strongly impacted the market: production, import and export decreased by 27%, 20% and 16%, respectively.

The same market indicators were normalised by number of EU-27 citizens over the years to investigate the possible impact of the change in the EU population. Nevertheless, the analysis provided the same trends over the years (**Figure 29**).

All textile apparel categories were further investigated. The results of this analysis are reported in Section 10.1.5.

Figure 10. Market indicators for textile apparel in the EU-27



(A) Total mass; (B) Total value; (C) Value-to-mass ratio

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Table 14. Change of apparent consumption between the time intervals 1995-2004 and 2005-2019

Product category or subgroup	Change in mass (%)	Change in value (%)
1.T-shirts	236	133
2. Shirts and blouses	110	38
3. Sweaters and mid-layers	86	12
4. Jackets and coats	129	14
5. Pants and shorts	194	58
6. Dresses, Skirts and jumpsuits	33	20
7. Leggings, Stockings, Tights and socks	-33	-13
8. Underwear	15	-13
9. Swimwear	100	13
10. Accessories	11	20
Textile apparel	86	27

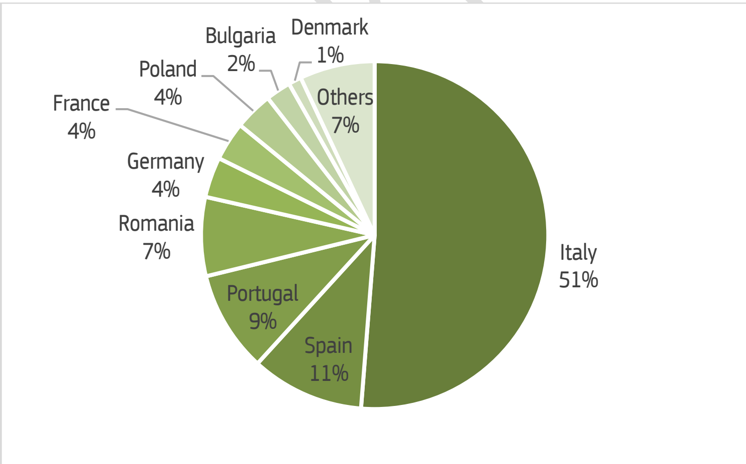
N.B. The change is calculated by comparing the average mass and the average value in the two time intervals.
More details are reported in **Table 61** in Section 10.1.5.

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

5.3 Role of the EU Member States

The PRODCOM database was investigated to understand which Member States play a more relevant role in the textile apparel market. **Figure 11** and **Figure 12** show the largest producers and exporters, respectively. The analysis focuses on 2019, because this is the last year without market disruptions. Italy accounted for half of the EU-27 production, followed by Spain, Portugal and Romania, which covered 11%, 9%, and 7% of the total, respectively. The most relevant exporters in 2019 were Italy, Germany, Spain and the Netherlands, with 19%, 18%, 12%, and 10% of the total, respectively.

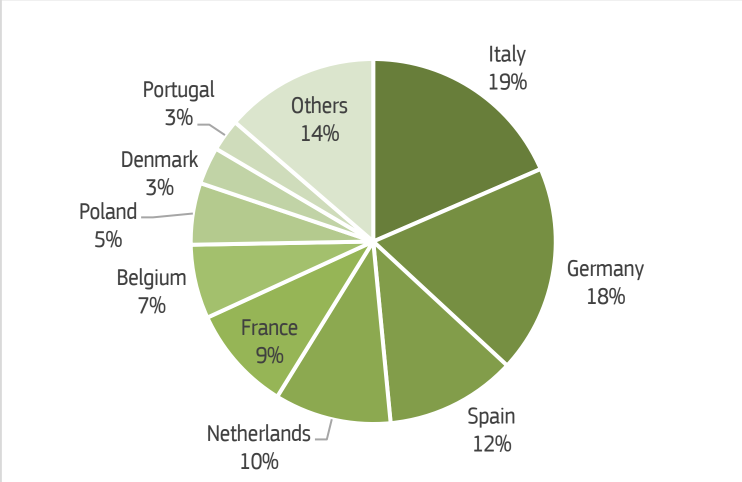
Figure 11. Member States producing textile apparel in 2019



Composition based on value

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 12. Member States exporting textile apparel in 2019



Composition based on value

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

The relevance of these countries is confirmed over the years. A recent study published by the EC recognises Italy, Germany, France and Spain as the most prominent Member States in the textile ecosystem (DG GROW, 2021a). These countries have the largest number of companies and generate the highest value in terms of production and turnover. Additionally, most of the EU companies operating in the textile ecosystem have their headquarters in Italy, Germany, France and Spain. central and eastern European Member States focus on more labour-intensive activities and generate a smaller share of turnover. Nonetheless, the main EU companies often locate certain production facilities in central and eastern Europe.

The European Apparel and Textile Confederation (EURATEX) confirmed in their last report on key facts and figures that Italy is recognised as the largest contributor to the textile and clothing industry in the EU. Other important countries are Germany, France, Spain, the Netherlands and Portugal. These are also the countries that invest the most in innovation (EURATEX, 2022a).

5.4 Main elements affecting the production of textile apparel

Section 3.3 describes the life-cycle stages of textile apparel, reporting all the main elements that are crucial for production. This section analyses the market characteristics of these elements, which are fibres, chemicals, energy and water.

5.4.1 Fibres

In recent years, the estimates of textile fibre production followed an increasing trend going from 104-111 million tonnes in 2019 to 116-124 million tonnes in 2022 (Textile Exchange, 2020; Textile Exchange, 2023). About 54% of these fibres are polyester, about 23% cotton, about 6% man-made cellulosic fibres and 5% polyamide. In 2021 and 2022, the production of viscose was equal to 5.8 million tonnes. **Table 15** reports the estimates of textile fibre production for 3 recent years, showing that about 70% are chemical fibres, while about 30% have a natural origin.

Table 15. Estimates of global production of textile fibres and group of fibres

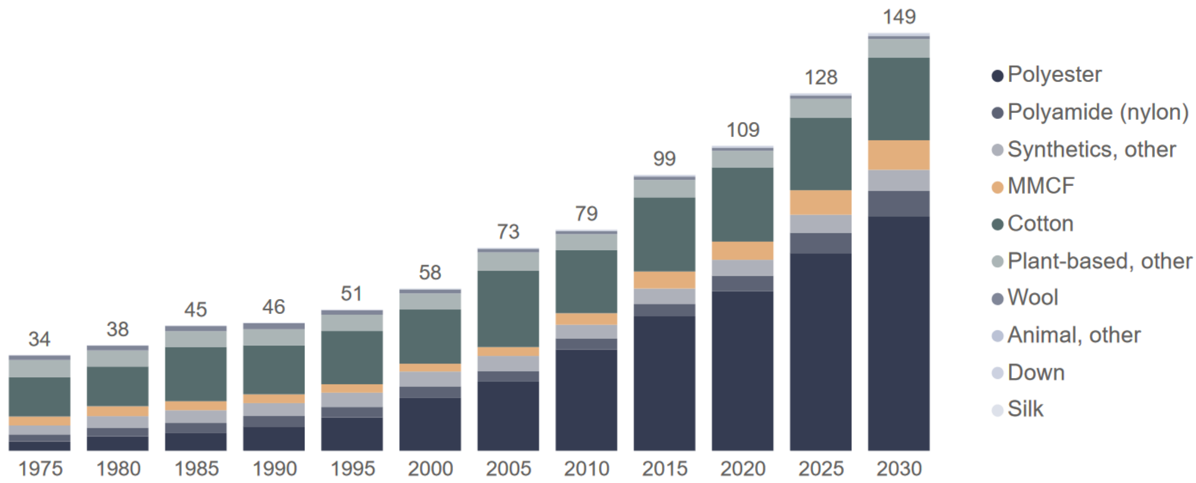
Rank	2019 [a]			2021 [b]			2022 [c]		
	Fibre	Mass (m tonnes)	Share of the total (%)	Fibre	Mass (m tonnes)	Share of the total (%)	Fibre	Mass (m tonnes)	Share of the total (%)
1	Polyester	57.70	52	Polyester	60.50	51	Polyester	63.30	56
2	Cotton	25.70	23	Cotton	24.40	20	Cotton	25.50	23
3	MMCFs	7.10	6	MMCFs	7.20	6	MMCFs	7.30	6
4	Other plant based	6.50	6	Other plant based	6.70	6	Polyamide	6.20	5
5	Polyamide	5.60	5	Polyamide	5.90	5	Other plant based	6.03	5
6	Wool-sheep	1.00	<1	Viscose	5.80	5	Viscose	5.80	5
7	Down	0.27	<1	Polypropylene	3.00		Polypropylene	3.10	3
8	Other animal-based	0.05	<1	Acrylics	1.7		Acrylics	1.60	1
9	Silk	0.16	<1	Elastane	1.20	1	Elastane	1.20	1
10	Acetate	NA	NA	Wool-sheep	1.00	<1	Wool-sheep	1.10	1
11	Acrylics	NA	NA	Acetate	0.90	<1	Acetate	0.90	<1
12	Cupro	NA	NA	Down	0.57	<1	Down	0.61	<1
13	Elastane	NA	NA	Lyocell	0.30	<1	Flax	0.38	<1
14	Flax	NA	NA	Modal	0.20	<1	Hemp	0.30	<1
15	Hemp	NA	NA	Silk	0.17	<1	Lyocell	0.30	<1
16	Lyocell	NA	NA	Other animal based	0.05	<1	Modal	0.20	<1
17	Modal	NA	NA	Cupro	0.02	<1	Silk	0.09	<1
18	Polypropylene	NA	NA	Flax	NA	NA	Other animal based	0.05	<1
19	Viscose	NA	NA	Hemp	NA	NA	Cupro	0.01	<1

N.B. Estimates of total production were between: 104 m and 111 m tonnes in 2019; 113 m and 115 m tonnes in 2021; 116 m and 124 m tonnes in 2022.

MMCF: man-made cellulosic fibres; NA: Not available.

Source: adapted from [a] Textile Exchange (2020), [b] Textile Exchange (2022), [c] Textile Exchange (2023)

Figure 13. Global fibre production: historical data and future projections (millions of tonnes)



Source: Textile Exchange (2022)

Figure 13 shows the evolution of the production of specific fibres from 1975 to 2020, and it foresees quantities for 2025 and 2030. In the first 25 years (from 1975 to 2000), the total production increased by 49% (from 39 million to 58 million tonnes), whereas in the second 20 years (from 2000 to 2020), the total production increased by 88% (from 58 million to 109 million tonnes). Future projections foresee a further increase up to 149 million tonnes in 2030. The evolution of fibre production is mainly driven by the increase in production of polyester.

Most of the fibres produced globally are of unknown origin, due to the difficulties of tracing information (see Section 5.6). Nevertheless, the available information shows the global dimension of fibre production, with China and India producing most of the fibres, and many more countries from all continents producing specific fibres (from **Table 16** to **Table 20**).

Table 16. Location of production for specific textile fibres

Polyester (PES)	MMCF	Polyamide (PA)	Wool	Other animal fibres
Unknown 70% China 13% Others 10% Türkiye 7%	Unknown 58% China 18% Others 16% India 5% Indonesia 3%	Unknown 81% China 15% Taiwan 3% USA 1%	Unknown 55% Australia 17% South Africa 15% New Zealand 10% Others 3%	China 88% Unknown 9% Hungary 2% Poland 1%

N.B. MMCF: man-made cellulosic fibres.

Source: adapted from (Textile Exchange, 2022a)

Table 17. Production of cotton lint in the season 2021-22

Rank	Country	Mass (1 000 tonnes)	Share of the total (%)
1	India	5 900	22.6
2	China	5 730	21.9
3	USA	3 963	15.2
4	Brazil	2 678	10.2
5	Pakistan	981	3.8
6	Uzbekistan	940	3.6
7	Türkiye	833	3.2

World production was estimated equal to 26 134 000 tonnes

Source: International Cotton Advisory Committee website, available at this link. Last visited on 13 December 2024

Table 18. Import of cotton lint in the season 2021-22

Rank	Country	Mass (1 000 tonnes)	Share of the total (%)
1	China	2 520	24.8
2	Bangladesh	1 688	16.6
3	Vietnam	1 576	15.5
4	Pakistan	1 200	11.8
5	Türkiye	1 170	11.5
6	Indonesia	539	5.3
7	Mexico	178	1.8

World import was estimated equal to 10 153 000 tonnes.

Source: International Cotton Advisory Committee website, available at this link. Last visited on 13 December 2024

Table 19. Export of cotton lint in the season 2021-22

Rank	Country	Mass (1 000 tonnes)	Share of the total (%)
1	USA	3 375	33.2
2	Brazil	2 064	20.3
3	India	816	8.0
4	Australia	749	7.4
5	Benin	321	3.2
6	Greece	299	2.9
7	Mali	283	2.8

World export was estimated equal to 10 153 000 tonnes.

Source: International Cotton Advisory Committee website, available at this link. Last visited on 13 December 2024

Table 20. Consumption of cotton lint in the season 2021-22

Rank	Country	Mass (1 000 tonnes)	Share of the total (%)
1	China	8 200	31.4
2	India	5 698	21.8

Rank	Country	Mass (1 000 tonnes)	Share of the total (%)
3	Pakistan	2 152	8.2
4	Bangladesh	1 660	6.4
5	Türkiye	1 617	6.2
6	Vietnam	1 541	5.9
7	Uzbekistan	836	3.2

World production was estimated equal to 25 629 000 tonnes

Source: International Cotton Advisory Committee website, available at this link. Last visited on 13 December 2024

As mentioned in Section 3.1.1, the ESPR establishes two product aspects that address recycled material: recycled content and possibility of recycling. Within this framework, information about current recycled material and recycling plants is crucial for the potential future development of requirements within these two product aspects.

The current global availability of recycled fibres is very limited (**Table 21**). The highest share of recycled material is available for polyester (15%) and wool (6%) fibres. However, almost all recycled polyester fibres come from recycling of plastic bottles, which are made of a specific type of polyester that is called polyethylene terephthalate (PET) (Textile Exchange, 2022a). From 2020 to 2023 the estimates of recycled fibres were relatively constant (**Table 21**).

Table 21. Estimated percentages (%) of recycled fibres in recent years

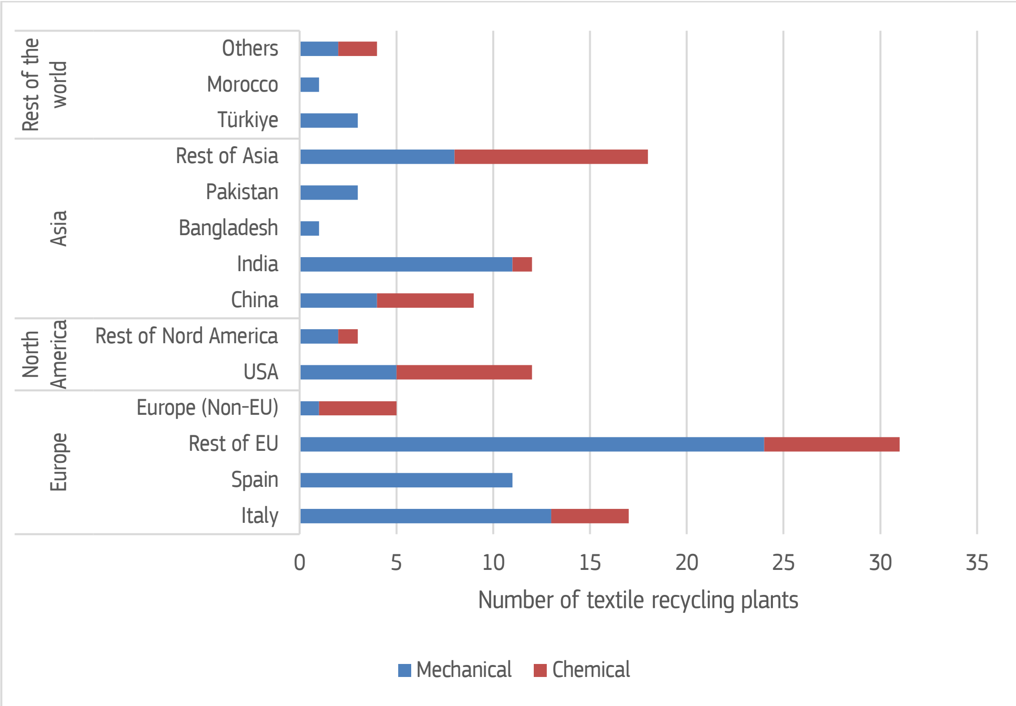
Fibre	2019	2020	2021	2022
Polyester (PES)	14	15	15	14
Wool	NA	6	6	7
Polyamide (PA)	NA	2	2	2
Cotton	NA	0.96	1	1
MMCF	NA	0.4	0.5	0.5

N.B. Approximately 99% of the polyester recycled fibres come from plastic bottles made of polyethylene terephthalate (PET).

Source: Own elaboration based on Textile Exchange (2020(, DG GROW (2021b), Textile Exchange (2021), Textile Exchange (2022), Textile Exchange (2023)

The current availability of textile recycling plants was investigated in terms of location, technologies, possible input fibres and scale of the plants (pilot or full scale). **Figure 14** shows the location of these 130 recycling plants, highlighting consuming and producing countries (see Sections 5.1 and 5.3). Europe and North America, which are the largest consumers, host about 50% and 11% of the global textile recycling plants, respectively. Europe hosts mainly mechanical recycling plants, whereas North America mostly has chemical recycling plants. Italy and Spain are the largest EU producers and the countries with the largest number of textile recycling plants. Asia, which is the continent producing the most global apparel, has 33% of the textile recycling plants. In particular, China and India, the world's largest producers, host only 7% and 9% of the global textile recycling plants. **Figure 14** shows that there are currently more textile recycling plants in countries that consume the most apparel.

Figure 14. Current number of textile recycling plants classified by location

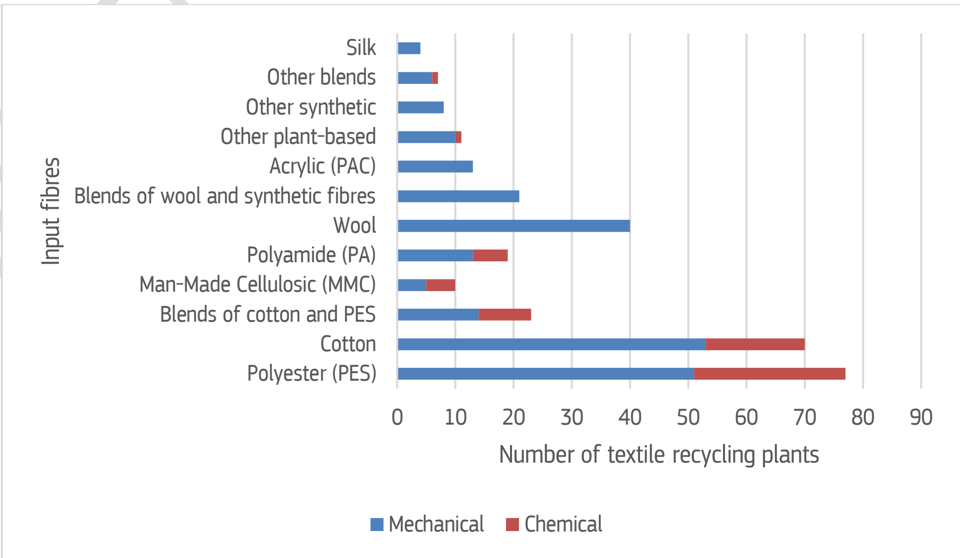


Source: own elaboration based on Airtable - Sorting for Circularity - Recyclers Database ([97]), (Jørgensen et al., 2022; Textile Exchange, 2022a)

Figure 15 shows that some recycling plants are already capable of processing textile products made of many textile fibres. **Figure 15** shows that most of the investigated recycling plants are capable of processing polyester and cotton fibres, as well as wool fibres. Additionally, **Figure 16** shows that most of the recycling plants are full-scale facilities. This is in line with the availability of recycled fibres reported in **Table 21.**

More detailed data about current textile recycling plants is available in Section 10.5.1.

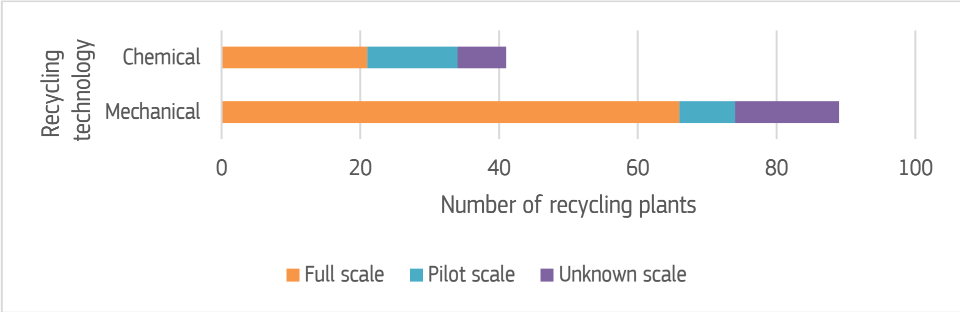
Figure 15. Current number of textile recycling plants classified by input fibre



[97] Airtable - Sorting for Circularity - Recyclers Database. Available at this link. Last accessed on 31 January 2024.

Source: own elaboration based on Airtable - Sorting for Circularity - Recyclers Database ([98]), (Jørgensen et al., 2022; Textile Exchange, 2022a)

Figure 16. Scale of current textile recycling plants



Source: own elaboration based on Airtable - Sorting for Circularity - Recyclers Database ([99]), (Jørgensen et al., 2022; Textile Exchange, 2022a)

A recent study of the Joint Research Centre of the European Commission estimated that in the EU approximately 30% of the used and sorted textiles (0.55-0.60 Mt yr^{-1}) are sent for recycling. The resulting recycled fibres are mainly used for cleaning wipes, non-woven material and insulation material, due to the fact that the most abundant resulting recycled material is represented by non-spinnable fibres. In the EU, recycled material comes from post-industrial waste, which represents only 11% of all textile waste (Huygens et al., 2023).

Table 22 reports the current fibre composition of EU textile waste, which is mainly made up of cotton and polyester. **Figure 17** shows the composition of single textile products, which are mainly made of blends of two or more fibres. The current EU recycling capacity is estimated to be equal to 0.7-0.85 Mt yr-1; whereas the future projection for 2030-2035 is for it to reach 1.2 - 2.7 Mt yr-1, based on the assumption that the textile industry is expected to generate more waste despite the future regulations in place. Based on the future projections for 2030-2035, a 30% increase in textile waste is expected, along with more sorting capacities, increased energy recovery and a reduction in landfilling. The majority of the future textile recycling capacity it is estimated to be based on mechanical recycling, while lower volumes are claimed by operators using chemical recycling (Huygens et al., 2023).

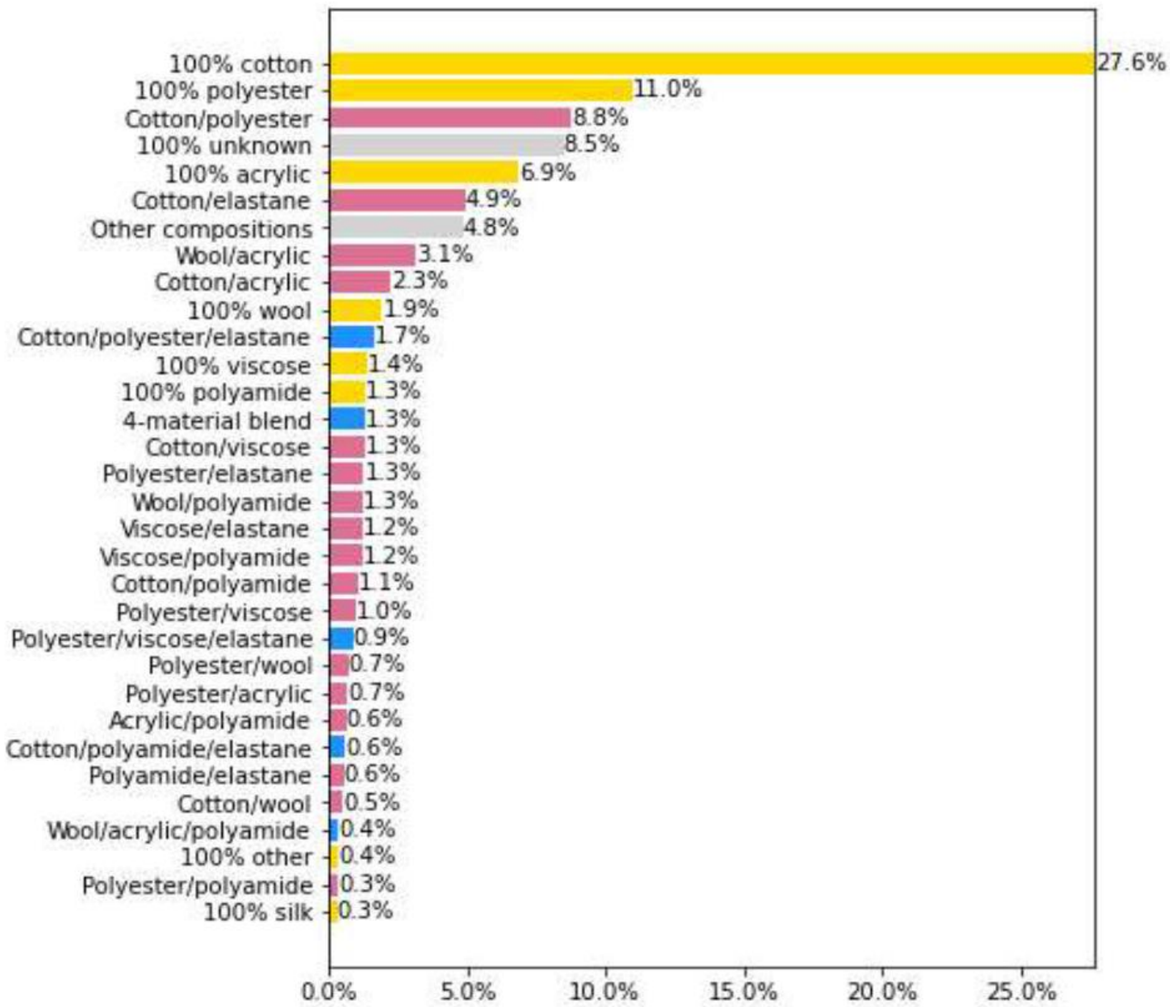
Table 22. Material composition of EU post-consumer textile waste

Material	Percentage in the waste fraction (%)
Cotton	34
Polyester	29
Polyamide	7
Wool, polypropylene, acrylic	30
Non-textile	11

Source: Huygens et al. (2023)

[98] Airtable - Sorting for Circularity - Recyclers Database. Available at [this link](). Last accessed on 31 January 2024.
[99] Airtable - Sorting for Circularity - Recyclers Database. Available at [this link](). Last accessed on 31 January 2024.

Figure 17. Composition of textile products



Analysis of textile products incoming to sorting facilities. The sample was composed of about 73% of apparel, 9% of home/interior textiles, 9% of footwear, and 9% of unclassified items. The colour code marks with yellow mono-fibre products, pink the blends of two fibres, and blue the blends with two or more fibres.

Source: (Refashion, 2023)

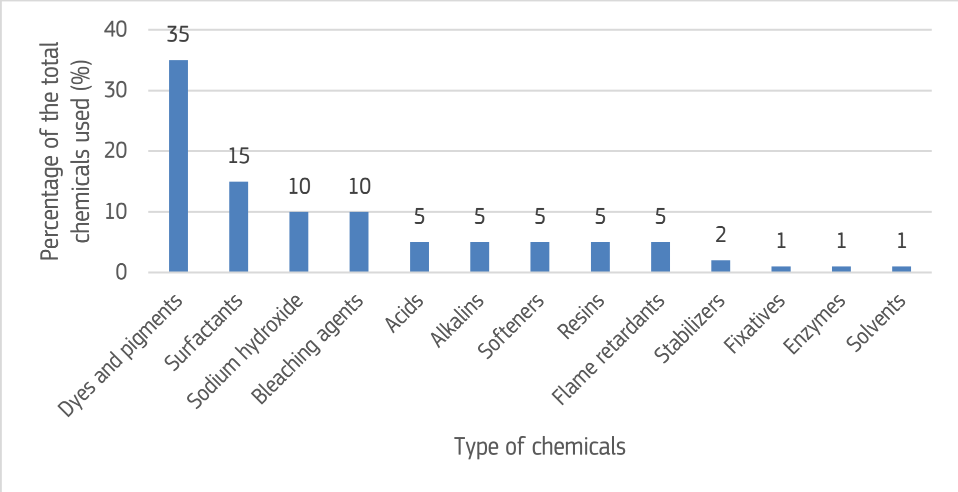
5.4.2 Chemicals

The chemical demand of the textile industry is estimated to use about 25% of the global chemical production, which in 2021 was equal to 9.3 million tonnes (Prasannamedha and Senthilkumar, 2021; Raj et al., 2022).

The Ellen MacArthur Foundation estimated that the textile industry uses approximately 43 million tonnes of chemicals per year. In particular, the production of 1 kg of cotton requires 0.35–1.5 kg of chemicals, and the production of 1 kg of synthetic fibre requires 0.11-0.82 kg of chemicals, besides the polymers making the fibre itself (Ellen MacArthur Foundation, 2017). In general, the manufacturing of 1 kg of apparel usually requires 1–4 kg of chemicals. This range is relatively large because it depends on the type of apparel, the efficiency of the supply chain, and the processes used for production (Muthu, 2020).

Figure 18 shows the chemicals most commonly used by the textile industry. Dyes and pigments, surfactants, caustic soda, and bleaching agents represent 35%, 15%, 10% and 10% of the total consumption, respectively. These four types of chemicals represent about 70% of the total chemicals used (Rahman et al., 2023).

Figure 18. Share of the most commonly used chemicals in the textile industry



N.B. Sodium hydroxide is the caustic soda. Resins are formaldehyde-based.

Source: Own elaboration based on (Rahman et al., 2023)

According to the UN COMTRADE database ([100]) and the Observatory of Economic Complexity (OEC) database ([101]), the largest global exporters of dyes, identified with HS 32 ([102]) of the Harmonized System, are Germany, China and the USA, representing about 15%, 10% and 9% of the global exports (**Table 23**).

Table 23. Largest exporters of dyes in 2019

Reporter country	Trade value (m USD)	Share of the global market (%)
Germany	13 036.6	15.6
China	7 719.9	10.2
USA	7 548.3	9.22
Japan	4 624.0	5.92
Netherlands	4 474.6	4.91
India	3 504.3	4.52
United Kingdom	3 450.8	4.14
Italy	3 430.6	4.08
Spain	2 995.8	3.71
Belgium	2 631.8	3.38
Republic of Korea	2 352.4	2.88
Other Asia	1 409.9	1.72

Dyes are identifies with the harmonised Standard code HS 32.

Source: elaboration based on UN COMTRADE database ([100]) and OEC database ([101])

5.4.3 Energy

In 2004, the energy consumption in the global textile industry was estimated to be equal to 2% of the global energy consumption. Additionally, the production of 1 kg of generic textile product was estimated to require about 126 MJ (about 35 kWh) of energy (Muthu, 2015).

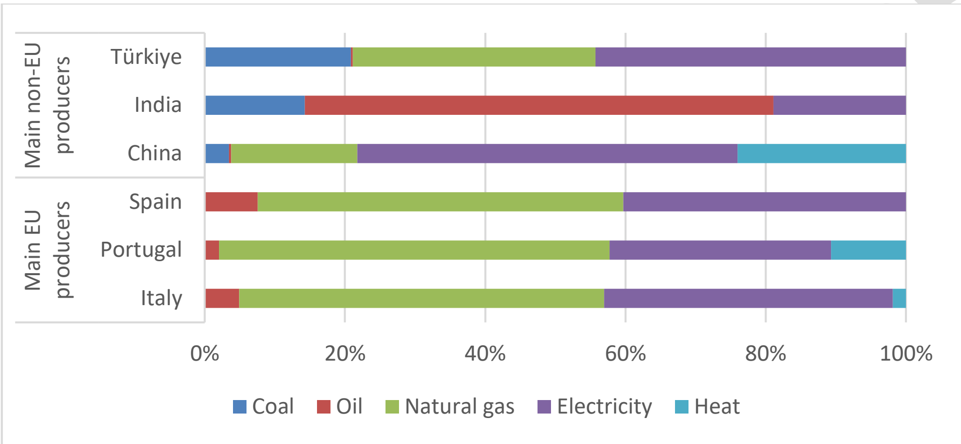
Table 8 in Section 3.3.1 reports that almost all the stages of the textile value chain require the use of energy. Nevertheless, the manufacturing stages cover about 70-80% of the total life-cycle energy consumption (Sandin, Roos, Spak, et al., 2019; Quantis, 2021).

[100] UN COMTRADE database. Available at this link. Last accessed on 12 January 2024.
[101] Observatory of Economic Complexity (OEC) database. Available at this link. Last accessed on 12 January 2024.
[102] HS 32: ´tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints, varnishes; putty, other mastics; inks´

The energy consumption largely varies according to the country where the textile production process occurs, and its impacts depend on the energy source used (Hasanbeigi and Price, 2012; Muthu, 2020). Figure 19 reports the energy balance of the textile and leather industries of the main producers inside and outside the EU. Meanwhile, **Figure 20** shows the electricity generation by source of the same countries. Both figures show that the energy used in the EU has a very different composition to the energy used outside the EU. The energy used in China and India is mainly generated with coal and oil, which are known to be more polluting than natural gas and other sources of energy.

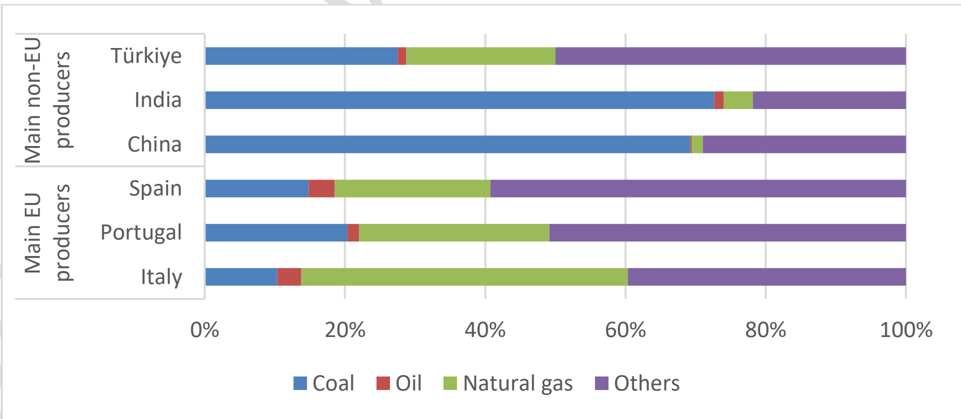
Specific stages of textile production consume different amounts of energy (Muthu, 2015; Muthu, 2020; Roth et al., 2023). These aspects will be detailed in the following milestone, when the PS addresses tasks 4 (Section 9) and task 5 of the MEErP.

Figure 19. Energy balance of the textile and leather industries in 2021



Source: own elaboration based on IEA World Energy Statistics and Balances ([103])

Figure 20. Electricity generation by source



N.B. The group 'Others' includes nuclear power, hydropower and renewable sources.

Source: own elaboration based on IEA (2019)

In the manufacture of apparel, the cost of energy also plays an important role. As already mentioned in Section 5.1, the increase of the cost of energy in the EU in 2022 negatively affected the Union's textile production. **Table 24** reports the price of electricity for the countries where most of the production and consumption occurs. The data gathered report that the electricity price at industrial scale is more expensive in the EU than in China and India.

[103] IEA World Energy Statistics and Balances (database). Available at this link. Last accessed on 10 February 2024.

Table 24. Electricity prices for selected countries for the base year 2019

Country	Residential - Electricity price (USD/MWh)		Industrial - Electricity price (USD/MWh)	
	2012	**2022**	**2010**	**2022**
China	NA	82.32	NA	88*
India	69.66	NA	105.51	NA
Türkiye	184.14	89.52	150.92	204.51
EU-27*	227.1	NA	160.38	NA
USA	115.77	150.89	67.89	83.69
Japan	243.76	NA	162.11	NA
Republic of Korea	101.73	106.81	75.65	104.81

N.B. NA: Not available.

*Source: UN COMTRADE database ([104]) and * Global petrol prices ([105])*

5.4.4 Water

Table 8 in Section 3.3.1 reports that many stages of the textile value chain require the use of water.

The water demand of the textile industry was estimated to be equal to about 79 billion m^3 per year. Most of this water is attributed to cotton production. In general, the manufacture of 1 tonne of textiles is associated with the consumption of 200 tonnes of fresh water (Niinimäki et al., 2020).

Cotton and hemp are the most water-demanding among the textile fibres; whereas polyester and polypropylene need the least water for their production (**Table 25**). Among the manufacturing processes, the finishing processes are the most demanding, requiring between 40 l kg^{-1} and 80 l kg^{-1} of fabric (Roth et al., 2023). More details will be provided in the following milestone, when the PS addresses tasks 4 (Section 9) and task 5 of the MEErP.

Table 25 Water consumption of fibres

Fibre	Water consumption (l/kg of fibre)
Cotton	1 559
Wool	530
Man-made cellulosic fibres	92
Hemp	89
Polyester	51 – 71
Nylon (known as polyamide)	185 – 633
Polyethylene and polypropylene (PP)	47 – 32
Acrylic	210
Viscose rayon	640

Source: Muthu (2015), Muthu (2020), Niinimäki et al. (2020)

Due to the large water demand of the finishing processes, the cost of water at industrial scale is a factor affecting its manufacture.

Table 26 reports the tap water price in several apparel-producing and -consuming countries. Assuming that the price difference between industrial and tap water has the same ratio worldwide, **Table 26** reports that the manufacturing of apparel in China and India can be performed with a lower water price than in Europe.

Table 26. Tap water price for selected countries

Country (city)	Tap water price (EUR/m^3)
China (Shanghai and Beijing)	0.36-0.68
India (Bangalore)	0.24
Turkey (Istanbul)	0.85
Europe (cities from 24 countries)	2.80
USA (30 cities)	2.23
Japan (Tokyo)	1.58
Republic of Korea (Seoul)	0.77

[104] UN COMTRADE database available at this link. Last accessed on 15 December 2023.
[105] Global Petrol Prices, available at this link. Last accessed on 15 December 2023.

N.B. Reference year 2019, with the latest updates in 2021.

Source: Tap water price index ([106]) and Eur Eau (2020)

5.5 Market structure and business models

Composition

EU companies in the textile value chain are mostly microenterprises, covering all manufacturing stages (**Table 27)**. However, medium and large enterprises generate most of the total turnover (**Table 28**).

After the manufacturing stages, textile apparel go through wholesalers and subsequently retailers ([107]), enabling their placing on the market and their making available on the market for the first time. In the textile and apparel sector, wholesalers are understood as companies that sell products to other companies in large quantities and at low prices, whereas retailers are companies that sell in small quantities and generally with higher prices than wholesalers. In the EU, retailers in the apparel sector are constituted by a bigger number of enterprises, generate higher turnover, higher production value, and employ more people than wholesalers of apparel and footwear together (**Table 29**). Among the top 120 players of the EU textile ecosystem, 50 are retailers of fashion products and about 38 are wholesalers and agents for fashion products (DG GROW, 2021a).

Table 27. Share of the number of EU-27 enterprises per NACE group in 2021

Size of enterprises	Economic activity			
	Preparation and spinning of textile fibres [C131] (%)	Weaving of textiles [C132] & finishing of textiles [C133] (%)	Manufacture of other textiles [C139] (%)	Manufacture of wearing apparel, except fur apparel [C141] & Manufacture of knitted and crocheted apparel [C143] (%)
Microenterprises (from 0 to 9 employees)	80 (p)	85 (p)	92 (p)	95 (p)
Small enterprises (from 10 to 49 employees)	13 (ep)	9 (p)	6 (p)	3 (p)
Medium enterprises (from 50 to 249 employees)	6 (p)	6 (p)	2 (p)	2 (p)
Large enterprises (more than 250 employees)	: (c)	2 (pu)	0.3 (p)	0.2 (pu)

N.B. Data from relevant countries like Italy is missing in all the indicators.

p: provisional; ep: estimated, provisional; c: confidential; pu: provisional, unreliable or uncertain data with estimation error from ±1% to ±5%; ":" not available.

Source: own elaboration based on EUROSTAT SBS_SC_OVW ([108])

[106] Water Price Index. Available at this link. Last accessed on 11 February 2024. Water Price Index examines and interprets the prices of tap water and bottled water in 120 cities globally. It presents the actual average expenditure for usage and the percent difference of the price from the median value of the dataset in each respective location. The factor 'Tap Water Price (EUR/m^3)' refers to the monthly cost for 1 cubic metre of tap water, as indicated by the most recent applicable rate from the database of the International Benchmarking Network for Water and Sanitation Utilities (IBNET), which is available at this link (last accessed on 11 February 2024).

[107] According to the Cambridge dictionary: (1) a wholesaler is a buyer and seller of goods in large amounts to shops and businesses; (2) retailer is a person, shop, or business that sells goods to the public.

[108] Enterprise statistics by size class and NACE Rev. 2 activity (from 2021 onwards). Available at this link.

Table 28. Share of the turnover of EU-27 enterprises per NACE group in 2021

Size of enterprises	Economic activity			
	Preparation and spinning of textile fibres [C131] (%)	Weaving of textiles [C132] & finishing of textiles [C133] (%)	Manufacture of other textiles [C139] (%)	Manufacture of wearing apparel, except fur apparel [C141] & Manufacture of knitted and crocheted apparel [C143] (%)
Microenterprises (from 0 to 9 employees)	10 (p)	7 (p)	13 (p)	19 (p)
Small enterprises (from 10 to 49 employees)	15 (p)	8 (p)	10 (p)	15 (p)
Medium enterprises (from 50 to 249 employees)	48 (p)	41 (p)	44 (p)	28 (p)
Large enterprises (more than 250 employees)	27 (p)	45 (p)	33 (p)	38 (p)

N.B. Data from relevant countries like Italy is missing in all the indicators. Italy is the EU country with the highest turnover and employment share compared with other MS in 2021 (EURATEX, 2022a). In this context, the data presented are indicative but not precise data.
p: provisional.
Source: own elaboration based on EUROSTAT SBS_SC_OVW ([108])

Table 29. Description of wholesalers and retailers in 2020, according to NACE classes

Economic parameter	Economic activity	
	Wholesale of clothing and footwear [G4642]	Retail sale of clothing in specialised stores [G4771]
Number of enterprises	52 212	262 403
Turnover (m EUR)	120 758.3	139 012.2
Production value (m EUR)	46 047.5	65 744.7
Number of employees	294 255	1 155 453

Source: own elaboration based on data from EUROSTAT SBS_NA_DT_R2 ([109]).

Besides numerous SMEs, the fashion industry includes large companies, which are usually active in many subsectors of the textile ecosystem, as a consequence of acquisitions and mergers, as well as subcontracting and outsourcing. The largest groups in the fashion industry include several brands, which supply diverse end markets or propose different product lines that go beyond apparel and footwear. Other companies function under a single brand, but still with a variety of products (DG GROW, 2021a).

Some large companies are vertically integrated, meaning made up of large groups that design, manufacture and sell a variety of products. Nevertheless, acquisitions, mergers, subcontracting and outsourcing strongly define the textile apparel market in a global value chain. The majority of the most important EU companies are also world players that manufacture, innovate and sell across the globe and acquire (and are acquired by) other world players (DG GROW, 2021a).

Drawing the boundaries of the EU textile apparel market is not possible because it fully operates in the global market and value chains. Some important EU companies play a role in distribution, but they are not manufacturers in the EU. Many of them own hundreds (and in a few cases thousands) of subsidiaries outside the EU, which are responsible for production and/or retail. At the same time, subsidiaries of non-European companies are also frequently considered important players in the EU (DG GROW, 2021a).

A recent analysis of the top 120 main players in the EU textile ecosystem identified four broad classes of companies (DG GROW, 2021a):

- high-end luxury brands;
- manufacturers and retailers producing mid- and low-end products;
- manufacturers of intermediate textile products;

[109] Annual detailed enterprise statistics for trade (NACE Rev. 2 G). Available at this link.

— companies specialised in the manufacturing of specific goods.

General business models

Companies in the fashion industry follow different models in relation to the intangible value of the product and the management of its supply chain. As described in Section 3.1.1, textile apparel are products with physical and symbolic functionalities. Besides the tangible quality of the manufacturing process, textile apparel must meet symbolic and aesthetic values, known as intangibles. Since these intangibles change rapidly, companies working in the textile apparel industry try to gain value via the supply chain, reacting efficiently to the unpredictable changes in consumer tastes and demands. Within this context, textile apparel companies inevitably rely on outsourcing to compete in the rapidly changing market (DG GROW, 2021a). The reasons of the rapid change of consumer taste and demand are further investigated in (Section 9), where business models and user behaviour are analysed in the context of all relevant product aspects reported in Article 5 of the ESPR.

Regarding the integration of manufacturing and intangibles, two main models can be identified in the textile apparel industry (DG GROW, 2021a):

- **Consumer-led operation model**, where the requests of the consumer are the centre of the business model. There is a huge effort to collect customer feedback, and produce what is desired by the market. In this model, consumers dictate the terms of production and affect the whole supply chain.
- **Brand-led operation model**, where the brand dictates the design and manufacture. There is a huge effort in strategies and programmes to promote the interest in the brand.

Two other main models can be identified regarding the approaches to the supply chain (DG GROW, 2021a):

- **Integrated approach**, where the production is entrusted to internal suppliers and the logistics aims to quickly react to customer's demands.
- **Centralised approach**, where the production is mostly outsourced, and supported by audit and quality control programmes, which could eventually change contractors.

Companies also apply hybrid forms of these models.

Distribution, retailing and e-commerce

According to McKinsey & Company ([110]), the distribution and retailing channels in the fashion industry are mainly controlled by fashion brands and retailers. **Table 30** describes the main distribution and retail models of companies selling textile apparel.

Table 30. Distribution and retail models of apparel companies

Brand		Retailer	
Only direct to consumer: Fashion brands that cover various stages within the fashion value chain, beyond being solely an apparel brand. This includes managing their own retail operations and potentially establishing their own e-commerce presence, all while avoiding wholesale distribution. (Vertically integrated apparel player)	Mix wholesale/direct to consumer: Apparel brand that sells both directly to consumers (in physical stores and/or e-commerce) and to other retailers. (Hybrid apparel player)	On- and offline: multi-brand retailer with its own brands, typically with a physical store and an online store. (Multibrand retailer)	Only online: Online retailer offering a variety of brands, including its own. (Multibrand pure e-commerce retailer)

Source: Reported from McKinsey & Company ([110]).

In the last few years, e-commerce has been rapidly increasing, especially for online market places and multi-brand retailers (DG GROW, 2021a). In particular, the EEA used the EUROSTAT database to report a steady increase in the percentage of individuals purchasing online apparel and footwear between 2020 and 2022 (Duhoux et al., 2024). In 2009, the percentage of textile and apparel turnover generated by e-sales was equal to 5% of the total. In the following years, it gradually increased up to 11% in 2020 (EURATEX, 2022a).

[110] McKinsey & Company webpage on Retail. – Measuring the fashion world. Achim Berg, Miriam Lobis, Elizabeth Hunter, Felix Rölkens, Patrick Simon, and Hannah Yankelevich. Available at this link. Last accessed on 10 December 2023.

Second-hand and rental markets

Second-hand and rental of textile apparel are experiencing fast growth, but are still at the very first stages of development. Their future success requires the adoption of business models based on collaborative consumption practices, e.g. utility-based non-ownership, and redistributed ownership of textile apparel. The lack of consumer awareness is seen as a barrier to the development of these two markets. For the second-hand market, other barriers are the limited durability of clothes and the need for traceability and guarantee of authenticity (DG GROW, 2021a).

Figures about the second-hand market are limited. According to RREUSE ([111]), in 2022, about 17 of their members were involved in the collection, sorting, and reuse of used and waste textiles. Members of RREUSE collect 360 000 tonnes of textiles annually, of which about 15% is reused locally. RREUSE estimates that a social enterprise employs between 20 and 35 people per 1 000 tonnes of textile waste collected. The same organization counts about 2 400 second-hand stores across the EU and beyond.

5.6 Characteristics of the value chain

The value chain of textile apparel is defined as global, long, complex, fragmented and opaque (Cai and Choi, 2020; UNECE and UNTRADE, 2020; Brondino, 2022).

The nodes of the value chain could be divided into two parts:

(a) a first part including the life-cycle stages from raw material for fibre production until retailing, when the product is placed on the market and it is made available on the market for the first time,

(b) a second part including use phase and waste management.

The first part of the value chain is composed of at least 15 nodes, i.e. the production of an item of textile apparel involves at least 15 economic operators via the production of raw materials, manufacturing and retailing operations. Companies placing products on the market do not know the full story behind their products – they do not know which were the economic operators involved over the whole supply chain and the processes and material/chemicals used. Most of the companies in the value chain can get information from their immediate suppliers, but usually information is lost about suppliers further upstream (UNECE and UNTRADE, 2020). This part of the value chain is highly interconnected with nodes spread worldwide at all stages (UNEP, 2020) ([112]). Although there are specific countries producing specific fibres, most fibres can be supplied from many parts of the world and mixed together (Textile Exchange, 2022a). Fibre processing as well as yarn spinning and fabric manufacturing occur in several countries and use resources, e.g. chemicals, which are produced in third countries. This was also shown in **Figure 3** and **Figure 4** in Section 5.1.

This description of the first part of the value chain shows that the manufacturing origin of textile apparel should not refer to just one country, but it should refer to the many countries where the main production stages occurred.

Usually, the textile apparel market mainly includes multinational companies based in developed countries that act as retailers or as producers and retailers. These multinational companies generally outsource production in developing countries due to the lower production costs (Brondino, 2022). For the first four stages of the product's life cycle (see **Figure 1** and **Table 8**), developing countries offer the possibility to produce textile apparel facing lower environmental compliance costs than in developed countries (see Section 5.7). Similar conditions occur for the confectioning stage, which is very labour-intensive: developing countries offer cheaper labour costs than developed countries (UNECE and UNTRADE, 2020).

Some studies envisage the possibility of reshoring and/or nearshoring production to developed countries, brought about by increased automation. However, this process is expected to happen only in the long term and subject to the sector investing strongly in this direction (Brondino, 2022).

[111] RREUSE website. Available at this link. Last accessed on 13 December 2025. Reported figures were shared during consultation with stakeholders.

[112] An exchange with a large global economic actor revealed that a retailer/producer could have more than 1 700 suppliers, which may have more than 8 200 factories located in 50 supply markets.

The textile apparel industry has always operated according to seasons, which are associated with the release of new collections. Over the last decades, the number of seasons has been drastically increasing from two per year to almost one per week ([113]). This seasonality largely affects the supply chain, from procurement to manufacturing capacity, planning and inventory management.

Within this framework, the first part of the value chain evolves among global dynamics, consumer demands and the strategies of big retailers (Ellen MacArthur Foundation, 2017; UNECE and UNTRADE, 2020; Brondino, 2022)

In order to increase transparency in the textile apparel value chain, in 2019 the United Nations Economic Commission for Europe (UNECE) launched a project for an international framework initiative to enhance transparency and traceability for sustainable value chains in the garment and footwear industry ([114]).

The second part of the value chain is mainly constituted by the post-consumer textile waste treatment market and by the second-hand market (reuse). The European Environment Agency and the United Nations provide figures about used textiles, mainly textile apparel, exported outside the EU (Lingås et al., 2023; UNECE and ECLAC, 2024). Used textile apparel is part of a specialised and traded global value chain. Over the last two decades, the export of used textiles from the EU has tripled from about 550 000 tonnes in 2000 to almost 1 700 000 tonnes in 2019. These products can have several fates. Usually, what is exported to Africa is first screened in local markets and subsequently most is dumped via informal waste streams. Used textiles reaching Asia are usually down-cycled into industrial rags or filling, or re-exported for recycling in other Asian countries or are further sent to Africa for reuse. Products that cannot be recycled or re-exported are likely to end up in Asian landfills (Lingås et al., 2023; UNECE and ECLAC, 2024).

5.7 Competitiveness and environmental compliance costs

The global value chain of textile apparel produces most of its environmental impacts in the production stages (**Table 9**). Usually, the production stages occur in Asian countries (**Figure 4**). This implies that most of the negative emissions to the environment occur outside the EU (**Table 6**), in particular in countries that allow production at lower costs due to poor labour conditions and less stringent measures about environmental protection (UNECE and UN TRADE, 2020).

A recent analysis performed by the OECD investigated the requirements set by several frameworks establishing Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution (OECD, 2022). This publication aimed to gather information on existing BAT reference documents (BREFs) that could stimulate more countries to implement specific requirements in their territories. **Table 31** reports the comparison of environmental aspects that are addressed by several BREFs implemented around the world. The analysis showed the following:

- Comparison is made difficult by the different approaches used by each BREF, in terms of key environmental indicators and stages of production.
- The EU has the most ambitious mandatory system, covering almost all the environmental aspects (7 out of 8).
- Among the largest global producers, the BREFs applied in China and India were analysed ([115]). Both China and India set limits for fewer environmental aspects than the original EU BREF. In particular, India addresses only emissions to water, with less stringent thresholds than the EU BREF. The Chinese BREF addresses more environmental aspects than India (4 out of 8), but it sets less stringent values for emissions to water compared to the EU BREF (**Table 79** in Section 10.5.1). Comparison with values related to emissions to air was not possible due to the different practices and key environmental indicators used by the several schemes.

[113] Numerous fashion websites report this information. Some of them are: (1) Digitally Empowering Fashion, (2) InStyle, and (3) techfashionista. All websites were last visited on 7 December 2023. The exchange with a large global retailer revealed that this company updates their collections every week to satisfy the requests of their customers.

[114] UNECE - Traceability for Sustainable Garment and Footwear. Available at this link. Last accessed on 7 December 2023.

[115] Information about the Minimum National Standard (MINAS) from India was included in the analysis provided by OECD (2022). Meanwhile, the analysis of the Chinese BREF was performed thanks to a machine translation of the document found on the internet.

In this context, it is evident that companies producing textile apparel, or their intermediate products, in the EU must face higher costs than companies producing in China and India due to prevention/reduction of emissions into the environment set by the EU BREF, within the framework of the EU Industrial Emissions Directive ([116]).

Table 31. Environmental aspects covered by the Best Available Techniques (BAT) reference documents (BREFs) for preventing and controlling industrial pollution around the world

Country/organisation Environmental aspects	European Union (EU BREF)	China	India (MINAS)	South Korea	United States (US EPA)	World Bank (EHS Guideline)
Emissions to air	Yes	Yes	No	Yes	Yes ([a])	No
Emissions to water	Yes	Yes	Yes	Yes	Yes	Yes
Consumption of energy	Yes	No	No	No	No	Yes
Water usage	Yes	No	No	Yes	No	No
Waste generation	Yes	Yes	No	No	No	Yes
Usage and management of chemicals	Yes	No	No	No	No	No
Energy efficiency	Yes	No	No	Yes	No	No
Noise emission	No	Yes	No	Yes	No	No

N.B. MINAS: Minimal National Standard; US EPA: United States Environmental protection Agency; EHS Guideline: World Bank Group Environmental, Health, and Safety Guidelines.
([a]) Covered by the Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAP) (OECD, 2022).
Source: (Ministry of Ecology and Environment, China, 2021; OECD, 2022).

China implemented its scheme on available pollution prevention and control techniques for the textile industry ([117]) in 2021, but it was not included in the analysis of OECD (2022).

Besides the above-mentioned aspects, the current competitiveness in the global textile value chain is also influenced by the cost of energy, water and chemicals, as assessed in Section 5.4.3 and Section 5.4.4. Besides the Industrial Emission Directive, EU industries must comply with requirements established by REACH (Section 4.1.1).

5.8 Lifespan of textile apparel

The apparent consumption in the EU-27 of textile apparel (**Figure 10** in Section 5.2) focuses on yearly market data, which provide a good understanding of the amount of textile apparel traded over the years. Future steps of the PS will focus on the economic and environmental assessment of textile apparel in the Union. This assessment will take into account the use phase and therefore the lifespan of the products, which affects their demand.

The lifespan of a product can be measured according to different descriptors (Murakami et al., 2010). Table 32 lists the different lifespan descriptors used for textile apparel.

Table 32. Types of lifespans

Type	Definition
Total lifespan	The period during which an item of textile apparel retains its original form, irrespective of its functional condition.
Service lifespan	The time an item of textile apparel remains functional and usable, considering its use by both the initial and subsequent owners. This timeframe initiates upon the product's acquisition by the first owner and concludes when the last owner disposes of it.
Possession span	The period of time in which an item of textile apparel is held by a specific owner. This timeframe does not discriminate whether the item of textile apparel is used subsequently by another person or it is disposed of.
Duration in use	The period of time a single owner utilises the item of textile apparel, considering only the use time (i.e. the time it is worn).
Physical lifespan	The period of time an item of textile apparel can be worn before it exhibits a level of wear beyond what is deemed acceptable.

[116] Industrial Emission Directive. Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast) (Text with EEA relevance). Available at this link.
[117] Chinese guidelines on available pollution prevention and control techniques for the textile industry. Available at this link. Last accessed on 11 December 2023.

Source: adapted from Murakami et al. (2010)

The lifespan of textile apparel is affected by many factors related to the specific type of textile apparel, the intrinsic physical properties of the product, and the behaviour of the users. Textile apparel is worn and cleaned with different frequencies according to their specific use, material composition and user choices. This is because specific textile apparel has seasonal use, or are related to specific activities, like sports. Additionally, many textile apparel remain stored and not in use in wardrobes. More investigation about factors related to user behaviour are addressed in Section 6.

The PS will focus on the service lifespan, which considers the time period from the purchase of the new item to its disposal, disregarding the number of users. Currently, there is no established system that allows the direct measurement of the service lifespan of textile apparel. The information available in the literature focuses on the possession span, which refers to the time a single user keeps the item, and the duration in use, which refers to how much time the owner uses the item (Table 32). This information is collected via surveys where users are asked to provide their estimates.

The possession span of textile apparel is often expressed as number of years. The duration in use is expressed as 'days of wear'. **Table 33** and **Table 34** report data gathered from the literature, using both metrics for most of the textile apparel categories. **Table 81** in Section 10.5.3 reports a brief description of the investigated studies.

The figures obtained from the analysis show a relatively large range of values, a consequence of the many factors affecting this parameter. The analysis addressed only specific products belonging to specific product categories. Section 10.5.3 provides additional, more granular information on the collected data.

Users and experts perceive that over the last 20 years the service lifespan of textile apparel has decreased. Some experts estimated that it decreased by 36% (Ellen MacArthur Foundation, 2017). The lack of a direct measurement method does not allow the provision of a better understanding of this important parameter. Nevertheless, educated assumptions will be made to be used in the stock model that will be produced in the following milestone, when the PS addresses task 7 of the MEErP.

Table 33. Possession span of textile apparel expressed in years

Textile apparel category	Gray et al. (2022)	Laitala and Klepp (2020)	Laitala et al. (2018)	WRAP (2017a)	Drycleaning Institute (2015)
1. T-shirts	4	4.6	3.3-6.8	4.5	NA
2. Shirts and blouses	4.1	4.8	3.3-7.2	5 (Shirts)	2-3
3. Sweaters and mid layers	4.4 (Sweatshirts and hoodies)	6	3.7-10.8	NA	3-4
4. Jackets and coats	6.2 (Non-padded) 5.4 (Padded)	7 (Coats) 6.8 (Jackets)	4-11.6 (Coats) 4-11.5 (Jackets)	NA	2-4
5. Pants and shorts	4.8 (Shorts) 4.3 (Trousers) 4.1 (Jeans)	4.7 (Pants) 3.5 (Jeans)	2.5-6.2 (Pants) 2.5-4.3 (Jeans)	4 (Jeans)	2-4
6. Dresses, skirts and jumpsuits	4.9 (Skirts) 4.6 (Dresses)	7.1 (Dresses) 6.9 (Skirts)	4.1-15.2 (Dresses and skirts)	NA	1-3 (Dresses) 2-4 (Skirts)
7. Leggings, stockings, tights and socks	3.8 (Leggings) 2.9 (Socks and hosiery)	2.6 (Socks)	1.8-3.6 (Socks)	2.5 (Socks)	1 (Socks)
8. Underwear	2.7	3.5 (Bras) 3.1 (Underpants)	2.4-4.4	NA	1-2
9. Swimwear	NA	NA	NA	NA	2
10. Accessories	NA	NA	NA	NA	1-2

N.B. NA: Not available.
Beton et al. (2014) reports that apparel has a lifespan between 1 and 3 years, based on expert opinions.
Knitwear products were reported to have a possession span of 4.8 years (Gray et al., 2022) and 5 years (WRAP, 2017a).
All investigated studies address specific products belonging to specific textile apparel categories.

Source: own production

Table 34. Duration in use of textile apparel expressed in days of wear

Textile apparel category	Roos et al. (2015)	WRAP (2017a)	Klepp et al. (2020)	PEFCR (2022)
1. T-shirts	22	112.5	90.5	45
2. Shirts and blouses	NA	80 (Shirts)	90.5	40
3. Sweaters and mid layers	NA	NA	90.5	85
4. Jackets and coats	100 (Jackets)	NA	90.5	100
5. Pants and shorts	200 (Jeans)	300 (Jeans)	90.5	70 (Jeans)
6. Dresses, skirts and jumpsuits	10 (Dresses)	NA	90.5	70
7. Leggings, stockings, tights and socks	NA	125 (Socks)	90.5	50 (Socks) 70 (Leggings/tights) 50 (Hosiery)
8. Underwear	NA	NA	90.5	60
9. Swimwear	NA	NA	NA	30
10. Accessories	NA	NA	NA	100

N.B. NA: Not available.
Days of wear of knitwear products were reported to be equal to 150 (WRAP, 2017a) and 90.5 Klepp et al. (2020).
All investigated studies address specific products belonging to specific textile apparel categories.

Source: own production

5.9 Market penetration of environmental labels

Although numerous environmental labels are used in the textile sector, currently there is no direct method to quantify their market penetration. Therefore, it not possible to understand the real success of these labels and the specific reasons behind their success.

Such information could be helpful for the revision of the EU Ecolabel criteria for textile products. The following milestone of the PS will address the potential inclusion of information requirements for products awarded with one or more environmental labels. The required information could also include a description of the specific environmental label in the Digital Product Passport.

6 User behaviour

6.1 Introduction

The aim of this section is to present and analyse information available in the literature regarding behavioural trends among users with regards to apparel.

The methodology used in the user behaviour analysis is twofold. First, a comprehensive screening and literature review of scientific papers and other studies on user behaviour related to apparel was conducted. The main goal of the systematic literature review was to identify the topics usually covered by studies on user behaviour regarding apparel. As a second step, several questions related to the most common aspects explored by user behaviour studies were prepared. These questions were included in the first stakeholder consultation through an online questionnaire ([118]). Stakeholder references to additional scientific papers, consumer surveys and other relevant documents were analysed in order to complement the literature review carried out in the first step.

The information was analysed considering its potential use when modelling the user phase in the environmental and economic analysis taking place at a later stage of the preparatory study (task 5 of the MEErP), and also its connection with potential **ecodesign requirements** to be developed within the aspects listed in Article 5(1) of the ESPR as well as with potential **EU Ecolabel** and **GPP criteria**.

The user behaviour chapter covers aspects such as the way users choose to buy apparel, their habits during the use phase, and why they decide to dispose of. It distinguishes user behaviour aspects at pre-purchase (section 6.2.), post-purchase (section 6.3.) and disposal stages (section 6.4.).

The table below indicates the main aspects related to user behaviour that will inform the modelling phase and the development of potential ecodesign requirements. Knowledge of user behaviour can help to identify barriers and restrictions to possible ecodesign measures resulting from social or cultural factors. Having information about how frequently consumers buy apparel, the temperature of washing or whether softeners are used or not, is important for the modelling. Equally, knowing whether consumers can assess the quality of apparel, what are their priorities when purchasing, whether users follow care labels, reasons for disposal and if consumers are willing to repair the apparel or not, are relevant considerations for the development of ecodesign requirements. The table below indicates the main user behaviour aspects that will serve as relevant input in the modelling of the environmental impacts and the life cycle costs of apparel, and for the development of potential ecodesign requirements.

[118] Initial questionnaire. Preparatory Study on textiles for product policy instruments – the initial questionnaire. Available at this link.

Table 35. Potential application of user behaviour aspects in the next steps of the preparatory study

ID	Aspect	Information used for	Comments
1	Reasons for purchasing	Potential ecodesign requirements	Reasons for purchasing showcase the triggers for new apparel purchases and can shape the development of ecodesign requirements.
2	Criteria used when purchasing	Potential ecodesign requirements	The criteria used when purchasing could give an indication of which aspects of the apparel are more relevant to users, e.g. durability.
3	Quality assessment of apparel	Potential ecodesign requirements	Quality and longer apparel lifespans are important to consumers. This supports the focus on durability ecodesign requirements.
4	Attitude towards second-hand purchases	Potential ecodesign requirements	Supports the development of potential durability requirements.
5	Attitudes towards chemicals in apparel	Potential ecodesign requirements	Supports the development of requirements on substances of concern. Provides relevant input for the EU Ecolabel potential criteria on chemicals.
6	Attitudes towards the purchase of apparel made with recycled materials	Potential ecodesign requirements	Supports the development of requirements on recycled content. Provides relevant input for the EU Ecolabel and/or EU GPP potential criteria on recycled content.
7	Laundering practices [a]	Modelling and potential ecodesign requirements	Different washing temperatures, washing frequencies and sorting practices among users can be modelled to show the way they affect the durability and quality of apparel. Potentially relevant input for the assessment of the environmental impact and the life cycle costs.
8	Care labels	Potential ecodesign requirements	The user behaviour informs how care labels are used by users and what aspects may be missing from them ([119]), supporting the drafting of information requirements and the development of the Digital Product Passport.
9	Reparability	Potential ecodesign requirements	Potential reparability and durability ecodesign requirements can be shaped by user behaviour data on reparability e.g. the link between the apparel item and accessories such as buttons that tend to fail sooner.
10	Long-term apparel storage	Potential ecodesign requirements	The user storage of apparel could affect its lifespan, thus it may be considered in the LCA modelling phase.
11	Reasons for disposal ([120]) and product-person attachment	Potential ecodesign requirements	The early disposal of apparel by users could trigger the need for the development of durability ecodesign requirements. Reasons for apparel disposal include loss of functionality and quality. These are aspects that create product-person attachment which translates into apparel being kept in the system for longer. This supports the focus on design for durability requirements.
12	Reasons for returning apparel	Potential ecodesign requirements	The lack of quality of ordered apparel is among the main reasons for returning products ordered online. This supports potential inclusion of durability ecodesign requirements.

[a] It includes sorting before washing, washing temperature and frequency, choice of detergent and softener, drying, ironing, and storing after washing and drying

Source: own production

[119] The ongoing review of the Textile Labelling Regulation is also assessing this same issue.

[120] In this study the term 'disposal' used to refer to the generic action of getting rid of a product, regardless of whether the product becomes waste or it simply changes ownership as a product. The general use of the term 'disposal' in this Preparatory Study should not be understood to imply 'disposal operations' described in Annex I of the Directive 2008/98/EC on waste and repealing certain Directives Available at this link.

Note: The following sections provide a summary of the main learnings and observations derived from an extensive literature search carried out on user behaviour with regards to apparel. **A more detailed review of literature corresponding to pre-purchase, post-purchase and disposal aspects is provided in the annex, Section 10.6.**

6.2 Pre-purchase aspects

6.2.1 Reasons for purchasing apparel

Consumer behaviour in the apparel industry is influenced by various factors, including individual perspectives on purchasing and the prevalence of spontaneous buying behaviour. Understanding the motivations behind consumer purchases, whether driven by functionality or self-representation, shows what qualities in apparel users consider to be important for them.

- **Diverse consumer perspectives and reasons for purchasing:** There are two primary consumer approaches towards apparel - those viewing it as purely functional and those seeing it as self-representational. These perspectives significantly influence consumer priorities during the purchase process (McNeill and Moore 2015). Research suggests that the primary purchase motivations include looking good, replacing old items (Ribeiro et al., 2023), buying essential wear, staying on-trend, and preparing for special occasions (D&B, 2020).
- **Spontaneous buying behaviour:** Apparel purchases often occur spontaneously, with a considerable proportion in the 40-70 age group engaging in frequent spontaneous buying. This trend indicates that a majority of consumers may not thoroughly inform themselves before making apparel purchases and act on impulse (Kleinhückelkotten et al., 2018a). Discount offers, including global phenomena like New Year sales, influence impulsive purchases, leading to more frequent buying and increased monthly spending on apparel (D&B, 2020a; Djafarova and Bowes, 2021; Heiny and Schneide, 2021; Amasawa and Kimita, 2023).
- **Digital vs. physical shopping dynamics:** While visual aids on social media attempt to replicate physical store experiences (Djafarova and Bowes, 2021), impulse purchases are more closely associated with physical stores, particularly affecting the younger population (Cook and Yurchisin, 2017). However, malicious interface design strategies, such as dark patterns, are prevalent in online shopping sites (Yada et al., 2022) where they mislead users into making purchases that may not align with their best interests, including unnecessary spending (Schäfer et al., 2023). An example of a dark pattern frequently observed in apparel purchases is the 'low-stock message,' which falsely claims that a product is nearly sold out to induce a sense of urgency and prompt quicker buying decisions (Schäfer et al., 2023).

The level of information provided by surveys on reasons for purchasing apparel is sufficient to get an idea of the different consumer preferences. It should be noted that the literature does not provide an order of importance or a priority list for the reasons for purchase mentioned by consumers.

The reasons users have for purchasing apparel are diverse and highly dependent on personal preferences. However, some seem to be linked to the need to replace apparel that is old, worn out or broken to a certain extent. In these cases, information requirements on reparability and disposal could guide the user concerning ways to repair the product to ensure optimum durability.

In the cases in which impulse purchases are involved, information requirements on the product itself regarding the life-cycle environmental impacts of the apparel item in question, would allow consumers to be more aware of the impact of their purchase and make evidence-based decisions.

6.2.2 Criteria used when buying apparel

When it comes to purchasing apparel, consumers navigate a complex landscape of decision-making criteria that encompass various factors influencing their choices. These criteria often include considerations such as product quality, price affordability, brand significance, durability, ease of care, and alignment with personal values and preferences. Additionally, age-related preferences and sustainability concerns further shape the decision-making process, highlighting the diverse range of factors at play in the apparel market.

- **Main apparel purchase decision attributes**:
    - Quality and price are paramount factors influencing consumers' apparel purchasing decisions, with 97% emphasising the importance of product quality and 94% expressing a similar sentiment

towards price in a survey run among 26 635 European citizens (European Commission. Directorate General for Environment, 2023). Similarly, price is for 68% of 11 483 consumers from ten European countries the most important factor when purchasing clothes, followed by quality (61%) and fit (56%) (YouGov, 2021).

- The brand's significance has less importance when purchasing apparel compared to quality and price (YouGov, 2021; European Commission. Directorate General for Environment., 2023).
- Other studies indicate that the perceived value of an apparel item by a specific user is also a significant driver of purchasing behaviour, with quality and functionality following closely behind (AK Wienn and Greenpeace, 2023a; Mishra et al., 2023; Thredup, 2023).
- Durability and ease of care seem not to be explicitly considered by users during apparel purchases but are associated with perceived quality according to De Klerk and Lubbe (2008) and Wakes et al. (2020). However, other studies highlight durability in the top three main aspects to influence the decision to purchase apparel items such as coats or jackets (Consumers, Health, Agriculture and Food Executive Agency et al., 2018) and is also the fourth most important aspect when purchasing apparel for 30% of 11 483 consumers from ten European countries (YouGov, 2021).
- According to a Cotton Incorporated (2014) survey, the top pre-purchase drivers for sportswear among consumers are comfort (77%), fit (69%), washes clean (65%), quality (64%), and durability (62%).

— **Age-related purchase preferences**:

- Fashion trends hold greater significance for younger consumers, as they see them as a sign of success (AK Wienn and Greenpeace, 2023a; Spaepen et al., 2021).
- Older generations prioritize new items, comfort, country of origin, textile material, and brand knowledge (Spaepen et al., 2021).

— **Sustainability considerations**:

- Some sources highlight that across all Member States, a majority of respondents reply that the environmental impact of a product is 'very' or 'rather important' in their purchasing decisions (European Commission. Directorate General for Environment, 2023). In fact, in an EU-wide survey involving 27 498 respondents, three-quarters express the view that apparel should be crafted from materials that are recyclable (European Commission, 2019). Moreover, around 54% of 2 500 Spanish consumers would appreciate having more information on the recyclability of the apparel item they purchase (Asociación para la Gestión del Residuo Textil y el Calzado, 2024).
- Other sources indicate that sustainability and social standards rank lower in importance compared to price or quality considerations when purchasing (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018; AK Wienn and Greenpeace, 2023a). In fact, approximately 32% of the 27 498 EU survey respondents express agreement with the notion that they are not concerned about the environmentally-friendliness of their apparel (European Commission, 2019) while only 15% of 11 483 consumers from ten European countries consider important the environmental impact of the apparel item when purchasing (YouGov, 2021). Moreover, approximately half of the 27 498 respondents indicate that apparel should be offered at the lowest possible price, irrespective of the environmental impact or working conditions during its production, with a similar proportion of respondents in disagreement with this statement (European Commission, 2019).
- Approximately 82% of 27 498 survey respondents believe that there is insufficient information available regarding environmental aspects and working conditions associated with apparel (European Commission, 2019).
- The willingness of having more information on the sustainability of products in the category of ‘textiles, clothing/footwear’ seems relatively high. In particular, 71% out of 26 635 survey respondents in the EU-27 Member States express a desire to find more of the above-mentioned products carrying the EU Ecolabel. This sentiment is prevalent in all countries, to varying degrees (from 54% in Czechia to 83% in Portugal and Romania) (European Commission. Directorate General for Environment, 2023).
- Research by consumer organizations indicates that people are becoming increasingly aware of the environmental issues related to the textile sector and are willing to adjust their behaviours as a result (BEUC, 2023). For example, national-level surveys, particularly in Spain (OCU, 2018), Germany (VZBV, 2022), and Austria (AK Wienn and Greenpeace, 2023a), have highlighted that a significant majority of consumers prefer long-lasting clothing and are inclined to avoid purchasing new items to support climate protection.

In summary, purchase decisions are very much influenced by the perception of quality and price, but there are other factors (trends, sustainability, comfort, perceived value), which are of varying importance to different population segments (based on their age, education level). Given the analysed information provided by surveys, there is no doubt that quality in apparel is very important for consumers. As apparel quality is closely linked to its durability, developing ecodesign requirements for this product aspect deserves further consideration.

Moreover, the fact that a high number of consumers believes that environmental information about apparel is not sufficient is relevant for consideration of possible information requirements on environmental impacts of apparel.

Equally important is the certainty that consumers would like to find more apparel holding the EU Ecolabel, which supports the revision of requirements set by this label.

Criteria applied by consumers when buying apparel can support the inclusion and prioritization of ecodesign requirements on certain product sustainability aspects (e.g. durability) and the setting of classes of performance, as appropriate.

6.2.3 User quality assessment of apparel: key insights

Understanding how users assess the quality of apparel involves examining various phases and factors that influence their perceptions. This assessment is influenced by intrinsic attributes like material and fit, as well as extrinsic factors such as brand reputation and manufacturing location. Additionally, experienced features and personal values play a significant role in shaping perceptions of quality. Consumers also tend to associate durability and ease of care with higher quality apparel, with a strong expectation for long-lasting products. Despite the role of price in influencing perceptions of quality and longevity expectations, studies suggest that cheaper apparel is not necessarily synonymous with lower quality, indicating a complex relationship between price and perceived value.

- **Phases of quality assessment by users**:
  - Consumer evaluates the quality in apparel in three phases: at the point of purchase, during use, and upon disposal (Piippo et al., 2022a).
- **Factors influencing the perception of quality**:
  - Intrinsic attributes (material, fit), extrinsic factors (brand, manufacturing location), experienced features, and values influence the perception of quality in apparel (Niinimäki, 2011; Koszewska, 2016; Henninger et al., 2017).
- **Interlinkages between durability and quality in apparel:**
  - Durability and ease of care are associated with perceived quality (De Klerk and Lubbe, 2008; Wakes et al., 2020a).
  - Consumers expect high-quality apparel to be durable (Yuille, 2015). In fact, 43% of survey respondents declared that long-lasting products are generally better quality (Consumers, Health, Agriculture and Food Executive Agency et al., 2018).
  - In 2019, nine in ten respondents (88 % out of 27 498 EU-27 citizens) indicated that apparel should be made to last longer (European Commission, 2019). Among the reasons, over 45% of respondents of another survey indicated that they will save money if apparel items such as coats or jackets last longer (Consumers, Health, Agriculture and Food Executive Agency et al., 2018).
- **Role of price in apparel quality perception and longevity expectations:**
  - Consumer expectations of apparel longevity are linked to the price, particularly for younger generations (Monitor, Cotton Incorporated Lifestyle, 2018; Wakes et al., 2020a).
  - Price may not always accurately reflect quality and durability (Ghaani Farashahi et al., 2018a; Wakes et al., 2020a). In fact, some studies indicate that cheaper apparel is not always synonymous with lower quality (Wakes et al., 2020a; Badgett, 2017).
  - 43% of Austrian survey participants express a willingness to buy long-lasting apparel despite the price, with 30% already practising this behaviour (AK Wienn and Greenpeace, 2023a) while 55% out of 1 000 German consumers would be willing to pay more for their apparel if being certain about increased durability (VZBV, 2022).
  - For coats or jackets, over 60% of 1 001 respondents' observations indicated that it is hard to tell how long a product will last (Consumers, Health, Agriculture and Food Executive Agency et al., 2018).

Overall, the references analysed provide consistent views on the fact that the assessment of quality by users is multifactorial and somewhat subjective because, inter alia, it is largely based on tactile experience with the apparel.

In the previous section, apparel quality has been highlighted as a key aspect users deem to be important in the apparel they purchase. However, how consumers assess quality is not always clear as this can be very subjective. For this reason, information on the performance of the product could provide consumers with additional, objective quality parameters for the apparel. Information requirements on product aspects linked to durability, and even reliability, could enable consumers to better understand and assess the quality of apparel.

In order to facilitate the user's assessment of the quality of apparel, performance requirements based on product durability, reliability and reusability aspects could, as appropriate, include minimum levels. Another possibility could be to define requirements connected to the functional performance of apparel. Information requirements related to the above-mentioned product parameters could serve as metrics to guide users' assessment of quality in apparel.

6.2.4 Consumer behaviour towards labels on apparel

Consumer behaviour towards labels on apparel plays a pivotal role in shaping purchasing decisions and influencing perceptions of product quality and sustainability. Expectations regarding label information vary, with consumers expressing preferences for receiving details about durability and/or reparability either via official EU labels, product descriptions, or retailers. Offering such information on labels has the potential to impact the relative importance of price in purchasing decisions, highlighting the growing interest in transparency and sustainability among consumers. This interest extends to EU Ecolabel products, with a substantial proportion of survey respondents expressing a desire for more environmentally friendly options in apparel.

- **Consumer attention to labels in general:**
  - There is limited information regarding the level of consumer attention to apparel labels generally speaking, except for care labels (Section 6.3.2).
- **Expectations regarding label information:**
  - Around 18% of over 4 880 user responses indicate that consumers expect to receive information regarding the durability of coats or jackets via an EU official label while the majority prefers to receive such information via product descriptions (39.9%) or via the retailer (36%) (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018).
  - Offering details about durability on labels could alter the relative importance of price when making purchasing decisions (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018).
  - A significant 74% of 1 000 Italian consumers expressed a strong need for clearer and more transparent information about the sustainability of apparel and the production processes involved (Altroconsumo and IPSOS, 2024).
  - In the case of reparability information, 14% of survey respondents expect to have such information via an EU official label while the majority would opt to have it via the retailer (35.6%) and via product descriptions (33.6%) (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018).
- **Growing interest in EU Ecolabel products:**
  - There is increasing interest in EU Ecolabel textile products. A total of 71% of 26 635 EU survey respondents express a desire for more EU Ecolabel textile products. There is a consistent level of interest across countries, ranging from 54% in Czechia to 83% in Portugal and Romania (European Commission. Directorate General for Environment, 2023).

Understanding the way and extent to which consumers respond to information contained on labels can support the development of information requirements, for instance related to the environmental impacts of a product and its performance on specific product sustainability aspects.

6.2.5 Attitudes towards second-hand apparel purchase

There is a growing interest in second-hand apparel reflected in consumer attitudes. Evidence suggests a significant portion of consumers are open to purchasing second-hand items. While concerns about hygiene and a preference for new items persist among some, the appeal of financial savings and eco-friendly practices drives many to incorporate second-hand pieces into their wardrobe. Additionally, emotional attachment to clothing items further boosts positive attitudes towards second-hand shopping, highlighting a nuanced approach to fashion consumption.

- **Consumer inclination towards second-hand apparel:**
  - There is a certain interest among consumers towards second-hand apparel, as indicated by 34% of the 26 595 respondents showing a readiness to buy second-hand apparel (European Commission. Directorate General for Environment, 2014).
  - Over 70% of 27 498 respondents in the EU agree that the promotion of second-hand apparel should be increased (European Commission, 2019).
  - About 37.4% of the population actively engages in buying second-hand apparel, while concerns about hygiene and a preference for new items are primary reasons for non-participation (D&B, 2020a).
  - Those incorporating second-hand apparel tend to purchase fewer new items, with financial savings, sustainability, and a preference for unique pieces being primary drivers (D&B, 2020a).
  - The emotional value users have for apparel items significantly boosts positive attitudes towards second-hand clothing (Rulikova, 2020; Amini et al., 2021; Koay et al., 2022).
- **Marketing strategies in second-hand apparel:**

- Preliminary observations from Turunen and Gossen (2024) suggest that current second-hand business models often employ consumption-promoting marketing strategies and include a rise in unworn or lightly used items on second-hand platforms. Additionally, subscription models may lead to shorter apparel lifespans, and self-service flea markets, with their low prices, can attract shoppers more interested in the experience than in making responsible purchases (Turunen and Gossen, 2024).

— **The concept of replacement rates and second-hand apparel:**
  - The 'replacement rate' refers to the extent to which purchasing second-hand apparel substitutes the need for new items (Nørup et al., 2019; Trzepacz et al., 2023). Studies show that second-hand purchases generally reduce the need for new apparel, potentially extending the lifespan of existing clothing (Nørup et al., 2019; Trzepacz et al., 2023). For example, a survey indicated that 39% of second-hand buyers would have otherwise bought a new product (Vinted, 2021). However, replacement rates vary, and factors such as the quality of second-hand items can influence their environmental benefits (Farrant et al., 2010; Sandin and Peters, 2018; Trzepacz et al., 2023).

— **Gender and age dynamics:**
  - Women show a higher inclination to purchase second-hand apparel, with approximately 40% embracing this trend compared to just over 25% of men (European Commission. Directorate General for Environment, 2014; D&B, 2020a).
  - The younger population, especially those aged 18-25, lead in the adoption of second-hand apparel, while participation decreases in the 26-40 age group (D&B, 2020a).

The willingness of users to purchase previously used apparel (second-hand) can be relevant in view of the potential definition of ecodesign requirements on reusability.

6.2.6 Attitudes towards the purchase of apparel made without harmful chemicals

Consumer attitudes towards chemicals in apparel encompass a spectrum of perceptions shaped by factors such as fabric type, geographical location and evolving consumer preferences. Insights from surveys and analyses offer valuable perspectives on the perceived risks associated with chemicals in apparel fabrics, highlighting varying degrees of concern and priorities among consumers.

— **Chemical perception in apparel:**
  - In a survey spanning 27 EU Member States, 60% of 26 718 respondents perceive chemicals in apparel fabrics as minimally risky, with most not seeing them as a threat to people (European Commission, 2009). However, more recent evidence shows that consumers are increasingly concerned about the use of hazardous chemicals in apparel (Evaluation report of the Textile Labelling Regulation, under development). In a survey of over 2 000 Spanish consumers, around 61% identified restricting hazardous chemicals in clothing as the second most important action for policymakers (CECU, 2023).
  - Synthetics are perceived as posing the highest risk among fabric types, with only 22% categorising them as significantly risky (European Commission, 2009).

— **Country-level variances in risk considerations:**
  - A country-level analysis reveals that environmental and health risks are deemed very important by about two-thirds of respondents in Germany and Slovakia. In contrast, more than six in ten respondents in Denmark and the United Kingdom consider this aspect unimportant (European Commission, 2009).
  - Data from the Fashion Revolution (2020) survey, covering 5 000 consumers across the United Kingdom, France, Germany, Italy, and Spain, indicates that an average of 37% considers it important to buy apparel produced without harmful chemicals. Similarly, 36% of 11 483 consumers from ten European countries consider important that there are less or no chemicals in the apparel they are buying (YouGov, 2021).The surveys do not provide detailed information about the types of chemicals.

The user perception towards chemicals in apparel, especially as regards substances that pose a risk to human health or to the environment, could support the establishment of information requirements on the presence of substances of concern. This in turn can inform possible actions that could be addressed in specific legislation on the safe use of chemicals such as REACH (e.g. via prioritisation in the REACH restrictions “roadmap” which is subject to periodic review by the Commission).

6.2.7 Attitudes towards the purchase of apparel made with recycled materials

Knowledge of consumer attitudes towards apparel containing recycled material (recycled content) is relevant for the analysis of technologies reported in Section 9.

— **Consumer preference for recycled materials:**
  - According to the Fashion Revolution (2020) survey of 5 000 consumers in the United Kingdom, France, Germany, Italy, and Spain, an average of 11% emphasize the importance of their apparel containing recycled materials.
    Nearly 60% of the 2 500 Spanish consumers surveyed expressed a desire to purchase textiles and/or footwear made from recycled materials, while around 25% reported that they have already made such purchases (Asociación para la Gestión del Residuo Textil y el Calzado, 2024).

— **Age group differences:**
  - Younger respondents (12-24 years old) give it greater importance, with 14% indicating a preference for apparel containing recycled materials, compared to only 7% in the 55-75 age group (Fashion Revolution, 2020).

6.3 Post-purchase aspects

6.3.1 User behaviour during use: laundering practices

User laundering practices include sorting before washing, use of a certain washing temperature, washing frequency, choice of softeners and detergents, drying methods, ironing, and storage. Consumer behaviour related to apparel laundering practices influences the environmental impact during the life of the product and constitutes relevant input for the assessment of the environmental impact and the life cycle costs of an apparel product.
Moreover, research indicates that consumer behaviour during the use and care of apparel may significantly impact the lifespan of apparel too. It could therefore be a good idea for apparel items to be accompanied by information for consumers and other end users on how to maintain the product to ensure a longer lifespan.

— **Sorting before washing:**
  - Sorting practices vary based on factors like washing temperature, colour, fibre type, and care labelling (Laitala et al., 2012).
  - Sorting based on washing temperature is more common among consumers compared to washing everything together (Laitala et al., 2012).

— **Washing temperature and washing frequency:**
  - The average European washing temperature is 42.4 °C (A.I.S.E, 2020).
  - Differences in washing habits (i.e. washing temperature used, choice of detergent and softeners, etc.) are observed across countries. Factors like age, location and societal norms contribute.
  - Sportswear often features distinct fibres and fabrics that can quickly absorb sweat and may lead to unpleasant odours, necessitating more frequent laundering compared to everyday casual wear (Wei et al., 2020; Chang and Wang, 2023) typically after a single use (Brice and Thorpe, 2021).
  - User beliefs about hygiene and convenience may impact the apparel washing frequency (D&B, 2020a).

— **Choice of softeners and detergents:**
  - Users often dose detergent arbitrarily; overdosing is common (A.I.S.E, 2020).
  - Fabric softeners are used in approximately 55% of washing cycles in Europe (Stamminger, 2016 as cited in Klepp and Laitala, 2023a).
  - Economic factors play a substantial role in users' choices of laundry products.

— **Consumer awareness on microplastics release during washing cycles:**
  - A survey of 411 Belgian citizens revealed that while 68% are aware of plastic pollution, only 37% are aware of microfiber pollution and its connection to the issue. Awareness of synthetic fibre pollution is lowest among individuals under 25 (29%) and highest among those aged 41 to 60 and over 60, though still less than half in these groups are informed (43%) (Herweyers et al., 2020).

— **Drying and ironing:**
  - Analysing domestic apparel ironing and drying phases is challenging due to the limited availability of data (Munasinghe et al., 2021).

- Diverse drying methods include air-drying, electric dryers and dedicated drying spaces. Survey data provide insights into specific drying methods where line-dried outdoors (natural drying) is one of the most commonly used drying methods for apparel (Laitala et al., 2020; GINETEX, 2017a).
- Ironing practices have decreased over the years; habits vary across countries and demographics. The frequency of ironing is influenced by gender and age; men and younger respondents tend to iron less (Klepp and Laitala, 2023b).

— **Storage after washing and drying**

- The folding and storage of apparel after washing and drying may influence the lifespan of apparel. However, no studies have been found on post-washing, drying and storage behaviours.

Sufficient information is available on commonly used washing temperatures among users as well as washing frequency. When it comes to sorting before washing, drying and ironing practices, the literature is more limited. Additionally, the surveys analysed on choice of softeners and detergents provide valuable information for the LCA modelling phase given that softeners could be a source of substances of concern to be taken into consideration.

6.3.2 Following apparel care label instructions

Apparel care labels provide instructions on washing temperature, cycles, detergents, etc. Surveys and studies shed light on consumer attitudes and behaviours regarding care label instructions, revealing insights into adherence rates, preferences for accessing instructions, and associations with care label symbols.

— **Attitudes towards care label instructions**:

- Surveys indicate that a significant percentage of users follow care instructions on apparel labels (GINETEX, 2017a; GINETEX, 2019).
- Users' adherence to care labels diminishes after the initial wash (McLaren et al., 2015).
- Some users cut out care labels, affecting the resale potential of apparel (GINETEX 2017).
- Some users prefer new ways to access the apparel care instructions, such as QR codes on smartphones (COFREET, 2023; Ribeiro et al., 2023).

— **Association with care label symbols:**

- Surveys show consistent understanding of symbols like ironing and washing (AB-REOC and BV-OECO, 2019; GINETEX, 2017a).
- Users' poorer understanding of symbols for bleaching, drying, and professional cleaning may be due to them being less intuitive (AB-REOC and BV-OECO, 2019; GINETEX, 2017a).

Relevant information can be extracted from the available surveys on user interaction with care labels, especially when it comes to the extent to which users follow care labels in Europe. For other user behaviour patterns in relation to care labels, information is available only from one survey, and so not allowing the comparison of information from different sources. Nonetheless, all the surveys related to user behaviour and apparel care labels have an ample respondent base, making the results valuable for the preparatory study at hand.

Additionally, the user behaviour analysis provides insights on apparel maintenance aspects that may either be missing or need further clarification on care labels. This is valuable data for the development of information requirements for consumers on how to use and maintain the product in order to minimise its impact on the environment and to allow for optimal duration.
Finally, consumer opinions about care label instructions and their level of adherence to them can guide the manner in which the information could be provided (e.g. in the Digital Product Passport or directly on a label as referred to in Article 14 of the ESPR final compromise text).

6.3.3 Reparability

The consumer relationship with apparel often exhibits a transient nature, characterised by the disposal of items before they reach the end of their lifecycle. This disposability stems from factors such as overconsumption and the convenience of replacing rather than repairing apparel. Moreover, diminishing sewing skills and limited access to repair services further impact consumers' decisions regarding garment maintenance and repair.

— **Transitory relationship with apparel:**

- Consumers have a transient relationship with apparel, often disposing of items before they are worn out or broken (Harris et al., 2016).

- Reasons for this behaviour include overconsumption and the convenience of replacing unwanted items rather than repairing them. A lack of emotional attachment to the product is observed (Terzioğlu, 2021; EEA, 2022a).
- Most survey respondents rated reparability as unimportant when purchasing apparel items such as coats or jackets while only about 11% considered reparability to be important (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018).

— **User decisions and repair capabilities:**

- Sewing skills for apparel repair are diminishing, attributed to a lack of dedicated teaching in schools and at home and a scarcity of time and repair equipment (Finnish Ministry of the Environment, 2023a).
- Trust in one's own skills is a significant motivator for engaging in sewing and repairs (Finnish Ministry of the Environment, 2023a).
- Users decide to mend apparel based on sewing skills; some can sew a button, but fewer can replace zippers (Laitala and Boks, 2012).

— **The apparel repair sector in the EU:**

- Repair in Europe is common, but the total cost is influenced by high labour costs, equipment, and materials (EEA, 2022a).
- On average, the share of survey respondents rating the availability of repair services as having a lot of influence on their purchasing decision was relatively low (Consumers, Health, Agriculture and Food Executive Agency et al., 2018).
- Difficulties accessing repair services notably diminished the appeal of repair (Consumers, Health, Agriculture and Food Executive Agency et al., 2018).
- Lack of information about, trust in, and satisfaction with repair services hinder consumer engagement (EEA, 2022a).
- Research by Laitala et al., (2023) emphasizes the need for clear guidelines on what constitutes unacceptable wear versus normal use.

The user behaviour analysis identifies a series of common apparel repairs that users generally carry out. These apparel repairs are generally limited to simple ones, such as substituting a button, and only a limited fraction of the population is skilled enough to engage in more demanding repairs such as changing a zipper. Performance requirements for reparability could be considered to ensure the availability of replacement components that, according to users, tend to break or wear out most frequently. Moreover, information on the period of availability of spare parts (e.g. buttons and other accessories) and the possibilities of repairing may also contribute to further user engagement in repair activities whether privately or by visiting repair shops.

It could also be envisaged that information requirements would provide instructions or 'use cues' in the product to guide the correct repair or replacement of the above-mentioned apparel components. This could facilitate the ease of self-repair by the user but also guide tailors when repairing apparel, guaranteeing that a certain level of quality in the apparel repair is achieved. Some of this information could be included in the Digital Product Passport.

6.3.4 Storage of apparel

User behaviour regarding storage of apparel is linked to aspects described in Section 6.2 and Section 6.4.3. The storage of apparel items, whether temporary or permanent, appears to be strongly connected to the emotional attachment individuals have to their apparel. Increasing the emotional durability could potentially make users keep their items for longer, avoiding disposal and potentially increasing the number of uses. However, such storage does not prevent users from continuing to buy more apparel.

— **Types of apparel storage:**

- Apparel storage can be classified into two categories: active and inactive. Active apparel storage involves placing regularly worn items inside wardrobes or easily accessible spaces. Inactive apparel storage refers to keeping items at home without use for an extended period. Inactive storage constitutes over 30% of apparel in European closets (European Parliamentary Research Service, 2019).

— **Reasons for inactive apparel storage:**

- Inactive apparel may include items that no longer fit, stored with the hope they will fit again, and as a means of monitoring weight (Bye and McKinney, 2007).

— **Temporary storage practices:**

- Temporary storage occurs when users are contemplating disposal methods, waiting for apparel to come back into fashion, repairing, or determining if there are still ways to utilise the apparel (Cluver, 2008a).

— **Storage of basic apparel:**
  - Essential but outdated or worn-out basic apparel is stored until substitutes are purchased (Cluver, 2008a).

Information requirements related to the end-of-use options (e.g. reusability) for apparel that is no longer wanted could encourage users to opt to give a second life to their apparel, for instance via donation. This would avoid the storage of apparel users no longer wish to wear or to keep in their closets.

6.4 User behaviour related to the disposal of apparel

6.4.1 Reasons for the disposal of apparel

Disposal ([120]) of apparel happens when a user transfers its ownership to another person or entity (Cluver, 2008a).

The main reasons for apparel disposal seem to be due to certain product characteristics changing over time, damage or simply for reasons related to consumer preferences.

— **Factors influencing disposal decisions:**
  - Individual characteristics, habits, demographics, product traits, and quality influence the decision to dispose of an apparel products (Cluver, 2008; Goworek et al., 2012, as cited in Harris et al., 2016; Sandin et al., 2019).
  - Perceived quality is crucial; low quality may lead to early disposal, and owning new apparel frequently shortens usage time (Aakko and Niinimäki, 2022).
  - Loss of symbolic perceived value also contributes to early disposal (Gwozdz et al., 2017a).

— **Reasons for apparel disposal:**
  - A review by Laitala and Klepp, (2022) of 17 consumer studies involving around 20 000 participants identified the most common reasons for apparel disposal as intrinsic quality (34%), perceived value (31.4%), and fit issues (25.8%). These findings are consistent with the results summarized in **Table 36**, which also highlight these factors as the primary reasons for apparel disposal. While quality-related concerns are the leading cause, perceived value and fit issues are almost equally significant.
  - Price influences disposal frequency, with consumers valuing higher-priced items and disposing of cheaper apparel more frequently (Morgan and Birtwistle, 2009; Joy et al., 2012).

— **Intrinsic durability and user perceptions:**
  - Intrinsic durability, defined during product design, influences the ability of apparel to withstand wear without compromising functionality and aesthetics (Alliance of Commerce and Deloitte, 2022).
  - Physical issues like abrasion, colour changes, and broken zippers contribute to the perceived loss of intrinsic durability (Laitala and Boks, 2012).

— **Disposed apparel problems:**
  - Predominant problems of disposed apparel: colour fading and fabric-related issues.
  - Other issues: pilling, fabric breakdown, accidental damage, loss of dimensional stability, logo failure, discoloration, holes in seams, and trim failure (Cooper and Claxton, 2022b).

The combined dataset in **Table 36** from various studies (detailed in Section **10.6.3.1**) provides a comprehensive view of global apparel disposal trends. Survey participants across countries commonly cite intrinsic quality and fit as reasons for disposal of apparel.

Perceived value, taste-related factors, situational reasons, and fashion trends also play a role in apparel disposal. Overall, there is a complex interplay of individual factors contributing to disposal decisions.

Table 36. Main reasons for apparel disposal

Publication	Country	Main reasons for the disposal (expressed in % of respondents)				
		Intrinsic quality (e.g worn-out items)	Fit issues	Perceived value (e.g. taste-related unsuitability)	Fashion changes	Other (e.g. Situational reasons, functional shortcomings)
Greenpeace, (2015)	Germany	92	72	64	40	NA
Ungerth and Carlsson, (2011)	Sweden	60	9	21	NA	4
Laitala and Boks, (2012))	Norway	49	19	11	NA	19
Laitala and Klepp (2020)	China, Germany, Japan, United Kingdom, and USA	44	13	35	NA	9
WRAP (2017b)	United Kingdom	18	42	33	NA	NA
Lang, Armstrong, and Brannon (2013)	USA	30	31	39	NA	NA
Morell-Delgado et al., (2024)	Spain	NA	44	21.5	NA	2.5
YouGov, (2019)	Italy	60	47	16	12	2
Accenture, (2022)	Poland	38	21	7	6	21

N.B. NA: Not Available

Source: Own elaboration based on data provided in the indicated publications.

Changes in the product's characteristics may relate to apparel quality issues that can shed light on which types of performance and information requirements could be prioritised extend the duration of use of apparel products. For instance, in order to enhance technical durability for an extended usage period, it is crucial to understand the reasons behind consumer apparel disposal. Gaining such insights should aid in assessing possible ecodesign requirements that foster the durability of the apparel, while also addressing practices associated with premature disposal of apparel which have an overall negative impact on the environment.

Moreover, the reasons for disposal can focus on certain aspects of the product's performance.

6.4.2 Disposal channels

Users may dispose of apparel directly in the residual waste, donate it for reuse or pass on to family and friends.

— **Disposal trends:**

- The person-product type of attachment plays a key role in how apparel may be disposed of. Sharing within social circles is consistent behaviour when there are positive associations with the user's apparel. Negative associations with the apparel may result in donation, swapping, or disposal in the waste bin (Joung and Park-Poaps, 2013; Lewis, 2015). At the same time, throwing away usable apparel is generally perceived negatively and as socially reproachable behaviour.
- The overarching observation made by the European Commission. Directorate General Joint Research Centre (2021) study regarding the quality of apparel found in residual waste is that there exists a correlation between the proportion of apparel collected separately and the average quality and value of apparel discarded in residual waste. According to the above-mentioned study, this relationship is partly attributable to households' discerning decisions regarding the perceived monetary value of apparel, determining which items merit donation or resale for reuse, and which have minimal reuse potential. Supporting this notion, a 2018 study conducted in Denmark (Watson et al., 2018) lends credence to this theory. It suggests that the 42 000 tonnes of apparel disposed of in Danish residual waste for incineration in 2017 held an estimated value of 12-15 million euros prior to disposal. In contrast, the 36 000 tonnes of apparel separately collected were sold

on reuse markets for an estimated 65 million euros, signifying a value per tonne that is four to five times higher.

The way users dispose of their apparel provides valuable data that can help shape information requirements related to end-of-life behaviour. For instance, information requirements may guide consumers and public authorities towards more sustainable choices when disposing of apparel, which could also contribute to enhanced separate apparel collection rates as prescribed by the Waste Framework Directive by Member States given the significant reuse potential of apparel.

6.4.3 Person-product attachment

The emotional attachment formed between the apparel and the consumer is generally referred to as 'person–product attachment'. This type of connection between a user and an apparel item has an influence on how long consumers own certain apparel and how often they make use of it. This person-product attachment is usually embedded in the term 'emotional durability', which goes beyond just functionality. The Ellen MacArthur Foundation report (Ellen MacArthur Foundation, 2021) defines emotional durability as: 'the product's relevance and desirability to a user, or multiple users, over time'.

- **Ownership categories:**
  - Ownership categories include 'active' (daily use), 'seldom' (several times a year), and 'inactive/in storage' (rarely or never used) (Niinimäki and Armstrong, 2013).
  - A survey by Niinimäki and Armstrong (2013) identified elements fostering person-product attachment:
    - Functionality: Comfort, good fit, multi-function, ease of matching, easy to put on.
    - Memory: Memories, received from a special person, family ties.
    - Emotional satisfaction: Looking/feeling good, receiving compliments, love for the brand.
    - Design and style: Good design, in style.
    - Fabric and material: Nice colour, pleasant touch, aesthetic, flexible.
    - Personal values, quality, effort invested, and financial value: Uniqueness, feeling relaxed, durability, high quality, hand-made, reward for self, price (Niinimäki and Armstrong, 2013).
- **Value of new apparel and barriers to reuse:**
  - Newly purchased apparel holds the highest emotional attachment due to its perceived intrinsic value (Forbrugerrådet Tænk, 2022).
  - New apparel is used more frequently than older apparel; second-hand apparel is used 30% less (Forbrugerrådet Tænk, 2022).
  - Reuse may extend the possession span but does not necessarily increase apparel usage (Laitala and Klepp, 2021).
- **Emotional durability as a forward-looking issue:**
  - Emotional durability, linked to consumer perceptions, is challenging to measure, relying on social science concepts (Alliance of Commerce and Deloitte, 2022).
- **Quality as a key factor in prolonged use:**
  - Quality is a significant factor in incentivising prolonged apparel use. In fact, consumers express willingness to wear apparel longer if it is of better quality, maintains shape and colour, and has a bonding effect (Kleinhückelkotten et al., 2019; Laitala et al., 2021a).
- **Role of designers in increasing emotional attachment:**
  - Strategies to promote the product-person attachment include designing for long-term needs, incorporating added value, and creating adaptable, modular, or timeless products (Niinimäki and Armstrong, 2013; Alliance of Commerce and Deloitte, 2022).

6.4.4 Returns of apparel

The dynamics of online shopping and returns encompass various facets that influence consumer behaviour and preferences. Convenience emerges as a primary driver for the proliferation of online purchases, while return policies and processes significantly shape the shopping experience. This overview delves into return rates, underlying reasons for returns, and the factors influencing return behaviour, shedding light on the complexities of the retail returns landscape.

- **Online shopping and returns:**
  - Convenience is a key reason for online shopping (AK Wienn and Greenpeace, 2023a).

    - Long return periods encourage more apparel orders, while inconvenient return processes lead to items being stored rather than returned (Forbrugerrådet Tænk, 2022).
- **Return rates and demographics:**
    - Casual dresses, jackets and jeans have high return rates, with expensive products more likely to be returned (EEA, 2024).
    - Women tend to return more online purchases than men (AK Wienn and Greenpeace, 2023a; British Fashion Council's Institute of Positive and Roland Berger, 2023).
    - Young consumers, more active in online shopping, tend to return apparel more frequently, ordering multiple sizes (AK Wienn and Greenpeace, 2023a).
- **Reasons for returns:**
    - **Fit issues:** Fit issues is the main reason for returns, followed by taste-related unsuitability (including shape, material, colour, or pattern dislike), quality and faulty items (Foresight Factory, 2021; Zimmermann et al., 2021).
    - **Mis-buying:** Common issue with online shopping, driven by fitting problems and consumer dislikes (Forbrugerrådet Tænk, 2022).
    - **Quality concerns:** Low quality, lack of durability, and buyer's remorse also contribute to returns (Bernon et al., 2011).
- **Factors influencing returns:**
    - **Sizing issues:** Difficulty interpreting sizing scales and inconsistent sizing contribute to fitting problems (Vladimirova et al., 2022).
    - **Return policies:** Consumers often check return policies before purchasing, and their return experience influences repeat purchases (Asdecker and Sucky, 2019).
    - **Assumptions about returns:** Many consumers assume returned items are always resold, impacting their return behaviour (Makov, 2023).

Similarly to the reasons for apparel disposal, the causes for apparel returns may shed light on the product aspects that are important for users, e.g. quality. This could support the potential inclusion of durability ecodesign requirements.

7 Current EU Ecolabel criteria for textile products

This section analyses the current EU Ecolabel criteria for textile products ([121]) in light of their revision. Section 7.1 reports the facts and figures of the criteria, whereas Section 7.2 provides the main suggestions for the criteria revision received via the initial questionnaire (see Table 1 in Section 1). Section 7.3 describes the relationship between the new mandatory ecodesign framework (ESPR) and the revision of the EU Ecolabel criteria for textile products. Finally, Section 7.4 provides a detailed comparison of the criteria for textile products set by the EU Ecolabel, Blue Angel and Nordic Swan. This analysis set the bases to address Article 6(f) of the EU Ecolabel Regulation which promotes synergy with other officially recognised ISO Type I environmental labels (Ecolabels).

7.1 Facts and figures

In recent years, the number of licences and products awarded the EU Ecolabel for textile products has continuously increased (**Figure 58** in Section 10.7.1). In September 2023, the EU Ecolabel for textile products counted 86 licences and 9 250 products. The most licences were awarded by Denmark, Italy and Norway, representing 28%, 21% and 13% of the total, respectively. The most products were awarded by Portugal, Italy and Denmark, representing 42%, 36% and 14% of the total, respectively. More details are available in **Table 100** in Section 10.7.1.

Table 37 reports the figures published in September 2023 according to the type of products. Most licences and products awarded were textile apparel: 76% and 32% of the total products and licences, respectively. Home/interior textiles were 8% and 18% of the total products and licences, respectively. Cleaning products were 11% and 16% of the total products and licences, respectively. Intermediate products represent a significant percentage in terms of licences but less in products.

Table 37. Figures of types of products awarded the EU Ecolabel for textile products in September 2023

Type of product	Licences		Products	
	Number	Percentage of the total (%)	Number	Percentage of the total (%)
Textile apparel	27	32	6 947	76
Home/interior textiles	15	18	688	8
Textile cleaning products	14	16	1 012	11
Intermediate products, such as textile fibres, yarns, fabrics and knitted panels	27	32	512	6
Intermediate products, such as non-fibre elements	2	2	4	<1

N.B. The number of licences and products is affected by the reporting methods used by competent bodies. This results in small discrepancies compared to the total statistics.

Source: own elaboration based on data provided by EU Ecolabel Helpdesk

7.2 Suggestions for the revision of EU Ecolabel criteria

When voting on the final draft of the current EU Ecolabel criteria, in November 2013, the Commission and the Member States identified some aspects to potentially be assessed during the subsequent revision process of the EU Ecolabel criteria. The proposal suggested investigating the extension of the scope to silk, bamboo fibres, man-made fibres, as well as the use of additional recycled materials and potential alternatives to the use of fluorinated membranes.

The initial questionnaire (see **Table 1** in Section 1) allowed the collection of respondents' opinions on the current EU Ecolabel criteria and on the potential topics to investigate during the revision process. Out of 34 respondents, 10 belonged to the manufacturing industry and 6 to governmental institutions (4 competent bodies of the EU Ecolabel), 29% and 18% of the total, respectively. More details about the types of respondents are provided in **Table 101** in Section 10.7.2.

[121] EU Ecolabel criteria for textile products. Commission Decision of 5 June 2014 establishing the ecological criteria for the award of the EU Ecolabel for textile products. Commission Decision (2014/350/EU). Available at this link.

In general, current EU Ecolabel criteria are perceived to be too complex, and the application process cumbersome and bureaucratic, with most of the costs and difficulties being related to the involvement of suppliers, tests and certifications.

In particular, two competent bodies declared that applicants usually need clarifications/guidance on which products are included in the scope, and which are the corresponding criteria that these specific products must meet. A couple of competent bodies reported that some applicants gave up with the application, because they lacked data and information on their supply chain. This is further confirmation of the features of the supply chain discussed in Section 5.6.

Respondents had different general perceptions about the interest in the EU Ecolabel criteria: 32% think that consumers look for textile products with the EU Ecolabel, 52% think that consumers do not look for products with the EU Ecolabel, and 16% have no opinion.

Respondents to the initial questionnaire gave specific suggestions on the requirements of the current EU Ecolabel criteria for textile products, reported in Section 10.7.2, **Table 102** to **Table 106**.

General suggestions on how to improve the EU Ecolabel criteria included:

- simplification of the application process;
- harmonisation of the requirements with the ones of other Type I ecolabels;
- use of more third-party certifications to prove compliance with the criteria (e.g. on chemicals) to streamline the verification process;
- facilitating the retrieval of information from the supply chain actors outside the EU;
- inclusion of criteria addressing product recyclability and packaging;
- alignment with ecodesign requirements developed in the framework of the ESPR.

7.3 Revision of EU Ecolabel criteria within the ESPR framework

The establishment of the ESPR brings a change in the revision of the EU Ecolabel criteria for products addressed by a delegated act of the ESPR. This is the case of the EU Ecolabel criteria for textile products. As mentioned in Section 1, Article 34(3) of the ESPR establishes synergies between the mandatory ecodesign legislative framework and the EU Ecolabel, as the EU Ecolabel could be used as proof of compliance to Ecodesign requirements when ESPR and EU Ecolabel cover the same product groups. The ESPR and EU Ecolabel requirements must therefore be coherent and synergic to guarantee that products awarded the EU Ecolabel comply with the ESPR requirements set in the relevant delegated act. Therefore, the revision of the EU Ecolabel criteria for textile products remains regulated by the EU Ecolabel Regulation, but it should also follow the framework of the ESPR.

In particular, this means that the EU Ecolabel criteria should complement ecodesign requirements, increasing the ambition level set by the ESPR, complying with the specificities of the EU Ecolabel Regulation. For instance, the EU Ecolabel criteria could restrict hazardous chemicals and consider ethical and social aspects where appropriate, as well as they could forbid or restrict the use of specific chemicals and substances.

The EU Ecolabel criteria for textile products set the product environmental performance at fibre, fabric and product level:

- specific fibres must meet requirements on sourcing and emissions at their production stage;
- fabrics must demonstrate that they satisfy specific physical durability parameters;
- the product, as well as its components, must meet specific requirements regarding chemical content.

These EU Ecolabel criteria disregard the final function of the product, e.g. there is no distinction as to whether a fabric is used as component of a T-shirt, a winter jacket, or a sofa. As explained in Section 3.2, the same approach cannot be used in the PS because ecodesign requirements must include aspects like durability and recycled content, which are closely related to the function and use of the textile product. A preliminary exchange with the textile industry and associations provided important information on this subject. First, a fabric must be designed considering its final use because it undergoes different wear and tear according to the function and use of the textile product. Second, the fact that mechanically recycled natural fibres are shorter than virgin natural fibres significantly affects the physical characteristics of the yarn and consequently of the fabric. The longer the fibre, the thinner the manufactured yarn can be. Specific yarns are used to produce specific fabrics. In general, a T-shirt, which requires thin yarns, can contain less mechanically recycled natural fibre than a coat, which can be manufactured with thicker yarns. This means that the possibility to use a specific quantity of recycled natural fibres in a textile product depends on the function performed by the textile product. Additionally, the characteristics of the yarn affect the aesthetic and it influences the comfort provided to the user.

7.4 Looking for synergies with other Ecolabels used in the EU

Article 6(f) of the EU Ecolabel Regulation promotes synergy with other officially recognised ISO Type I environmental labels (**Ecolabels**). In the EU, besides the EU Ecolabel for textile products, there are the following:

- Blue Angel – The German Ecolabel: criteria are set by DE-UZ 154 Basic Award Criteria. Edition January 2023, version 2 ([122]).
- Nordic Swan Ecolabel: criteria are set by 'Textiles, hides/skins, and leather'. Version 5.4 ([123]).

Table 38 reports the scope of these Ecolabels according to the classification adopted in this PS. Besides some differences, the three Ecolabels include in their scope apparel, home/interior textiles, technical textiles like cleaning textiles (with the exception of Nordic Swan), and intermediate textile products. Nordic Swan is the only Ecolabel addressing hide and leather products.

Section 10.7.3 (from **Table 107** to **Table 113**) describes in parallel the topics addressed by the criteria of the three Ecolabels, which all have the same approach. They set the product environmental performance at fibre, fabric and product level, as described for the EU Ecolabel criteria in Section 7.3.

The three Ecolabels address the same main topics, even if there are differences in terms of ambition level, specific substances and test methods used as verification.

[122] Blue Angel – The German Ecolabel: DE-UZ 154 Basic Award Criteria. Edition January 2023, version 2. Available at this link. Last accessed on 12 January 2024.

[123] Nordic Swan Ecolabel: Textiles, hides/skins, and leather. Version 5.4. Available at this link. Last accessed on 12 January 2024.

Table 38. Scope of the textile Ecolabels used the most in the EU

Type of product	EU Ecolabel ([a])	Blue Angel ([b])	Nordic Swan ([c])
Apparel	Textile clothing and accessories: clothing and accessories consisting of at least 80% by weight of textile fibres in a woven, non-woven or knitted form.	- Textile clothing and textile accessories consisting of at least 90% textile fibres by mass. - Functional clothing in which more than 90% by mass of the material is textile fibres or textile substances that have undergone finishing processes (impregnation, sealing, etc.).	Apparel and accessories, for example trousers, shirts, jackets, workwear, uniforms, underwear, handkerchiefs, scarves.
Home/interior textiles	Interior textiles: textile products for interior use consisting of at least 80% by weight of textile fibres in a woven, non-woven or knitted form.	- Textile products for use inside buildings (house and home textiles incl. uncoated carpets) consisting of at least 90% textile fibres by mass. - Bedding consisting of at least 90% textile fibres by mass.	Furnishing fabrics (for both private and professional use), such as towels, bedding, curtains, tablecloths, pillows, duvets, plus textiles for use in the furnishing of cars/trains/aircraft/boats.
Technical textiles	Cleaning products: woven or non-woven products made from textile fibres and intended for the wet or dry cleaning of surfaces and the drying of kitchenware	- Cleaning textiles: woven or non-woven textiles consisting of at least 90% textile fibres by mass that are designed for the wet or dry cleaning of surfaces or for drying household articles. - Textile products designed for food contact (e.g. waxed cloths).	NA
Intermediate products	Textile fibres, yarn, fabric and knitted panels: intermediate products intended for use in textile clothing and accessories and interior textiles, including upholstery fabric and mattress ticking prior to the application of backings and treatments associated with the final product. Non-fibre elements: intermediate products that are incorporated into textile clothing and accessories and interior textiles, including zips, buttons and other accessories, as well as membranes, coatings and laminates.	- Fibres, yarn, fabric, knitted and crocheted items, non-wovens (including textile composites). - Fibres made of stainless steel and mineral fibres are limited to a maximum of 10% by mass.	- Fibres*, yarn, fabric. * Only the following fibre types can be certified with the Nordic Swan Ecolabel as a certified fibre and only if the relevant fibre requirements of the criteria are met: Organic cotton fibres, wool, and other creatine fibres (either sheep, camel, alpaca, or goat), regenerated cellulose produced by closed loop process, flax (linen), silk, bamboo, sisal and other bast fibres. - Durable non-woven textiles that are to be used for apparel and accessories or in interior furnishings.
Other products	NA	Handbags, bicycle bags, backpacks and school bags consisting of at least 70% textile fibres by mass.	- Purses, wallets, and bags. - Hide and leather products, such as jackets, trousers or bags, and hides/skins and leather as raw materials for clothing or home furnishings (including for cars/trains/aircraft/boats), from the following species of animal: sheep, goat, cow, horse, pig, elk, deer, and reindeer.

[a] EU Ecolabel criteria for textile products. Commission Decision (2014/350/EU).
[b] Blue Angel – The German Ecolabel: DE-UZ 154 Basic Award Criteria. Edition January 2023, version 2.
[c] Nordic Swan Ecolabel: Textiles, hides/skins, and leather. Version 5.4.
N.B. The classification of the type of products follows the classification adopted in this PS, which does not necessarily correspond to the classification given by the specific Ecolabel. NA: Not available.

Source: own production

8 Public procurement and current EU voluntary Green Public Procurement criteria

As mentioned in Section 1, the PS will provide the scientific and technical basis for the future development of the possible mandatory EU GPP requirements for textile products within the framework of the ESPR. To this aim, it is important to assess the current public procurement of apparel in the EU (Section 8.1), and the current status of the voluntary EU GPP criteria, which could provide important learnings for the development of future mandatory criteria (Section 8.2).

8.1 Public procurement in the EU

Public procurement in the EU is regulated by Directive 2014/24/EU ([124]), Directive 2014/23/EU ([125]) and Directive 2014/25/EU ([126]). Monitoring public procurement is currently a challenging task. The first reporting and monitoring exercise (COM(2021) 245 final) ([127]) submitted by Member States showed that all reports contained more qualitative information than quantitative data. Additionally, the incomplete available data limited the analysis at EU level (COM(2021) 245 final). The monitoring exercise showed that Member States follow different methodologies for data collection, and that in several cases there were discrepancies between figures collected at country level and figures reported on Tenders Electronic Daily (TED) ([128]).

TED is the online version of the 'Supplement to the Official Journal' of the EU, which is dedicated to European public procurement. TED gathers information covering public procurement for the European Economic Area, Switzerland, and the Republic of North Macedonia from 1 January 2006 to 31 December 2021. These data include the most important information of the contract notice and contract award notice standard forms, such as who bought what from whom, for how much, and which procedure and award criteria were used. Therefore, TED is the only platform that can currently be used to analyse public procurement in the EU.

Generally, the data reported in TED consist of tenders above the procurement threshold of EUR 139 000. Nevertheless, many public authorities register on TED data of their tenders below this mandatory threshold.

Goods, works, and services that are being procured are classified with Common Procurement Vocabulary (CPV) codes. CPV codes help procurement personnel to classify their contract notices and to help suppliers find the notices which are of interest.

Each CPV code nine digits: the first two digits identify the divisions (XX000000-Y); the first three digits identify the groups (XXX00000-Y); the first four digits identify the classes (XXXX0000-Y); the first five digits identify the categories (XXXXX000-Y). Each of the last three digits gives a greater degree of precision within each category. A ninth digit serves to verify the previous digits.

Table 114 in Section 10.8.1 reports the CPV codes for products in the scope of the PS.

CPV codes related to apparel were investigated in the TED dataset ([129]) for 5 years before the pandemic (2015-2019). This time interval was chosen to investigate the latest evolution of public procurements without considering the market disruption caused by the COVID-19 pandemic in 2020.

The description of CPV codes reported in the Contract Award allowed the analysis of apparel public procurement as reported in **Table 39**. The number of Contract Awards procuring apparel in the EU gradually increased from 556 in 2015 to 1 261 in 2019. Products included in the CPV group of ‘Occupational clothing, special workwear and accessories’ were the most purchased by public authorities in the investigated years, representing between 42% and 46% of the total procured apparel reported in TED.

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[124] Public Procurement Directive. Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC (Text with EEA relevance)Text with EEA relevance. Available at this link.

[125] Award of Concession Contracts Directive. Directive 2014/23/EU of the European Parliament and of the Council of 26 February 2014 on the award of concession contracts (Text with EEA relevance) Text with EEA relevance. Available at this link.

[126] Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC (Text with EEA relevance)Text with EEA relevance. Available at this link.

[127] Report from the Commission - Implementation and best practices of national procurement policies in the Internal Market. COM/2021/245 final. Available at this link.

[128] Tenders Electronic Daily (TED). The online version of the 'Supplement to the Official Journal' of the EU, dedicated to European public procurement. Available at this link. Last visited on 12 January 2024.

[129] Tenders Electronic Daily (TED) (csv subset) – public procurement notices. Available at this link. Last accessed on 12 January 2024.

The analysis showed that the Member States with the highest number of Contract Awards reported in TED were France, Germany, Poland and Czechia. More details about the analysis are available in Section 10.8.2.

Table 39. Number of Contract Awards procuring apparel in the EU

CPV code	2015		2016		2017		2018		2019	
	N	%	N	%	N	%	N	%	N	%
181XXXXX-X Occupational clothing, special workwear and accessories	241	43	285	46	360	43	431	44	533	42
182XXXXX-X Outerwear	61	11	68	11	93	11	93	10	124	10
183XXXXX-X Garments	57	10	60	10	88	11	99	10	138	11
184XXXXX-X Special clothing and accessories	110	20	47	8	97	12	111	11	142	11
351134XX-X Protective and safety clothing	14	3	37	6	50	6	69	7	103	8
3741XXXX-X Sport goods and equipment	7	1	11	2	8	1	10	1	15	1
3581XXXX-X Individual and support equipment	66	12	108	18	133	16	158	16	206	16
Total	556	100	616	100	829	100	971	100	1 261	100

N.B. N: number of Contract Awards. %: Percentage of Contract Awards compared to the total number of contracts related to textile products.

Source: own elaboration based on Tenders Electronic Daily (TED) (csv subset) – public procurement notices ([129]).

8.2 Current voluntary EU Green Public Procurement criteria

As mentioned in Section 1, the PS will provide the scientific and technical basis for the future development of the mandatory EU GPP requirements for textile products within the framework of the ESPR. To this aim, the analysis of current voluntary EU GPP criteria ([130]) could provide some important learnings.

The current voluntary EU GPP criteria are based on the current EU Ecolabel criteria for textile products. In addition to EU Ecolabel criteria, the voluntary EU GPP criteria suggest some requirements about textile services related to laundry operations and take-back systems.

The initial questionnaire (see **Table 1** in Section 1) allowed the collection of respondents' opinions on the status of the current voluntary EU GPP criteria and on the lessons learnt so far. Out of 34 respondents, 12 belonged to the governmental institutions and 6 to the manufacturing industry, 35% and 18% of the total, respectively. More details about the types of respondents are provided in **Table 120** in Section 10.8.3.

The questionnaire showed that although many European countries ([131]) have GPP schemes on textile products, it is not possible to understand the uptake of the EU GPP criteria. This is mainly due to their voluntary nature, and the lack of a framework to collect this kind of data.

In light of possible future mandatory EU GPP criteria, respondents provided the following suggestions:

— Provide a clear and fixed set of requirements, which will allow manufacturers to produce goods that meet the demand.

— Assess administrative obstacles related to the premature disposal of textile products caused by contracting or budget period reasons.

— Facilitate the verification of product characteristics to procurers, who are usually not sustainability experts.

— Establish a framework based on Life Cycle Costing of durable textile products.

[130] EU GPP criteria for textile products and services. Commission Staff Working Document on EU green public procurement criteria for textiles products and services. SWD(2017) 231 final. Available at this link.

[131] These countries are: Austria, Belgium, Czechia, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Malta, the Netherlands, Portugal, Sweden and Norway.

— Establish a framework which considers environmental and social aspects in the whole value chain, possibly promoting the purchase of second-hand products.

— Support public authorities to develop a common strategy in purchasing and disposing of textile products.

The positions expressed by the respondents to the initial questionnaire are complemented by COM(2021) 245 final ([127]). This Communication lists the main aspects hindering the adoption of current voluntary EU GPP criteria:

- the lack of legal obligation;
- the lack of legal certainty on the correct interpretation of the requirement for a 'link to the subject matter of the contract' and the general fear of litigation;
- the lack of data proving the economic benefits of applying GPP criteria;
- the difficulty to monitor their application;
- the lack of specific knowledge and skills of the public servants engaged in tendering procedures;
- the fact that GPP may be perceived as an obstacle to competition, specifically restricting SME participation in public tendering.

9 Technologies

This section addresses the Task 4 of the MEErP providing a **general technical analysis of the products in the scope.** This analysis aims to describe the following types of product technologies:

- The Base Case of technologies (BC), which is the average product on the market.
- The Best Available Technologies (BAT), which have the most ambitious performances available on the market. BAT are implemented at scale.
- The Best Not yet Available Technologies (BNAT), which have the most ambitious performances, but they are not implemented at scale, therefore they are considered not available on the market.

In this context, product technologies are products with defined characteristics related to a specific product aspect reported in Article 5(1) of the ESPR, such as durability, repairability, etc.

Section 9.1 identifies the relevant product aspects for the products in scope, and groups those that can be potentially addressed with the same product parameters via future requirements. This approach aims to streamline the multi-criteria analysis that will be performed in the following Tasks of the PS.

Section 9.2 describes the product technologies for each relevant product aspect, analysing the complexity of their ecosystems.

Section 9.3 reports on the influence that product aspects have upon each other and proposes product categories based on the analysis performed in section 9.2. Information reported in Tasks 1 to 4 will feed the models in Tasks 5 and 6, which will describe the base cases and design options, respectively. Each product category reported in section 9.3 will be described with a representative product, which will be used as reference for all products belonging to the specific category.

The analysis performed in Section 9 goes beyond the directions reported in the MEErP. It aims to address Task 4 of the MEErP in the context of the ESPR.

9.1 Relevant product aspects

Article 5(1) of ESPR establishes that, in order to address environmental impacts of products, the ecodesign requirements in the delegated acts shall improve a specific list of product aspects. This list includes 16 product aspects:

(a) durability

(b) reliability

(c) reusability

(d) upgradability

(e) repairability,

(f) the possibility of maintenance and refurbishment

(g) the presence of substances of concern

(h) energy use and energy efficiency

(i) water use and water efficiency

(j) resource use and resource efficiency

(k) recycled content

(l) the possibility of remanufacturing

(m) recyclability

(n) the possibility of recovery of materials

(o) environmental impacts, including carbon footprint and environmental footprint

(p) expected generation of waste

Article 5 of ESPR also establishes that ecodesign requirements in the delegated acts shall be based on the above product aspects, when they are relevant to the product group concerned. Therefore, this section aims to evaluate the relevance of the 16 product aspects in the context of textile apparel. To this aim, two main actions were performed:

- Discarding product aspects that are not relevant in the context of textile apparel;
- Grouping product aspects that can be addressed together in order to streamline the following steps of the study.

Section 9.1.1 describes in general methodology followed, whereas Section 9.1.2 describes the specific steps involved. Finally, section 9.1.3 describes the proposed grouping of product aspects.

9.1.1 Methodology

The analysis undertaken started from the list of 16 product aspects in Article 5 of ESPR, and aimed to: (a) exclude product aspects which were not relevant for textile apparel, and (b) group product aspects that could be potentially addressed with the same product parameters via future requirements. This approach streamlines the multi-criteria analysis that will be performed in the following tasks of the PS.

Non-relevant product aspects were excluded following three steps:

- Generic description of textile apparel,
- Guiding questions, and
- Qualitative assessment.

First, textile apparel were described considering the following characteristics: final vs intermediate product; complex vs non-complex product; and durable vs consumable product. This description set the understanding of the product characteristics that are crucial for steps 2 and 3. Second, key guiding questions identified product aspects that evidently were not relevant for textile apparel. Third, a qualitative assessment investigated technical, socioeconomic and environmental dimensions. This qualitative assessment was based on information found in the literature and did not aim to perform a comprehensive analysis given this will be performed in the following tasks of the PS. The purpose of the qualitative assessment is to further refine the justification to exclude product aspects that are evidently not relevant for textile apparel, and to serve as a basis for the grouping of product aspects.

Finally, only the relevant product aspects were grouped taking into account the characteristics of each product aspect and the product parameters reported in Annex I to ESPR. This grouping streamlined the following steps of the PS because it allowed the use of the same parameters to address more than one product aspect. Therefore, this grouping decreased the number of relevant product aspects to be investigated in the analysis of technologies (see section 9.2) and Tasks 5 and 6 of the PS.

9.1.2 Exclusion of non-relevant product aspects

This section followed the methodology described in section 9.1.1 and identifies product aspects that are considered not relevant for textile apparel.

Generic description of textile apparel

Textile apparel were screened following three sets of characteristics:

- Intermediate product or final product
- Complex product or non-complex product
- Durable product or consumable product

According to Article 2(3) of the ESPR, an intermediate product is a product that requires further manufacturing or transformation such as mixing, coating or assembling to make it suitable for customers. Conversely, a final product is understood to be a product that is already suitable for users. One of the main differences between intermediate and final products is the lifecycle stages that can be considered. While all lifecycles stages could be evaluated in the assessment of final products, in the case of intermediate products a cradle-to-gate approach is followed, where the use stage is disregarded and the end-of-life stage is only partially assessed. Product aspects that serve to reduce the impacts of use and end-of-life stages would be considered as not relevant for intermediate products. By definition, textile apparel belongs to **final** products, because it is suitable for users.

According to Council Regulation (EC) 6/2002 ([132]), a complex product is a product which is composed of multiple components which can be replaced permitting disassembly and re-assembly of the product. In contrast, non-complex products do not include components or priority parts, thus they do not have components that can be replaced. A product's priority part is functionally important and is likely to fail or to be upgraded. The part will have high priority if it is necessary to deliver either primary (necessary to fulfil the intended use) or secondary functions (necessary to enable, supplement or enhance the primary function) (Cordella, Alfieri, et al., 2019).

Textile apparel belongs to **complex** products, because often it is composed of multiple components which can be replaced permitting disassembly and re-assembly of the product. Additionally, the complexity of textile apparel relies on the numerous fibre types used in blends and processed in several ways along spinning, fabric manufacturing and finishing processes ([133]). Therefore, even textile apparel that is not made of components is considered to be a complex product.

Finally, textile apparel belongs to **durable** products because it is conceived and designed to last. Conversely, once used, consumable products are expected to be consumed or discarded.

Therefore, textile apparel encompasses final, complex and durable products whose relevant product aspects should consider all life-cycle stages, the technological product complexity and its durable function.

Guiding questions

Key guiding questions were used to identify product aspects that evidently are not relevant for textile apparel. These questions addressed only the circularity aspects and did not focus on substances of concern, generic environmental impacts or use and efficiency of water, energy and resources, because these product aspects were considered already relevant based on the analysis performed in Section 3.1.3 and 3.3.

<u>Durability</u>

Is the functionality of the textile apparel expected to be provided for a long lifetime and/or for a high amount of multiple uses?

Yes, it is. Therefore, durability can be considered a relevant product aspect.

<u>Reliability</u>

Can the use of the textile apparel or a part/component thereof cause a limiting event in the product?

Yes, fatigue and or ageing of the product (or of a specific part/component) due to its use can cause a limiting event that prevents its use. Therefore, reliability can be considered a relevant product aspect.

<u>Reusability</u>

Could the reuse of textile apparel potentially entail a health risk?

In general, reuse of textile apparel do not entail health risks for consumers. Therefore, reusability can be considered a relevant product aspect.

<u>Upgradability</u>

Would it be technically feasible to upgrade a priority part that could potentially stop functioning, that is already not allowing textile apparel to perform at its fullest and/or there is potential to redesign the product in a way that can be upgraded?

Yes, it is technically feasible to upgrade a priority part in an item of textile apparel. For instance, reassembling a zipper of better quality. It is also possible to redesign textile apparel in a way that they can be upgraded. For instance, improving their ability for disassembly. Therefore, upgradability can be considered a relevant aspect.

<u>Repairability</u>

[132] Council Regulation (EC) No 6/2002 of 12 December 2001 on Community designs. Available at this link.
[133] A description of this complexity is reported in Section 9.2.1.1.

Would it be technically feasible to repair/replace the no longer functioning priority part and/or there is potential to redesign the product in a way that can be repairable?

Yes, it is. Therefore, repairability can be considered a relevant aspect.

Possibility of maintenance

Will the use and/or storage of textile apparel in specific conditions maintain its expected lifetime or extend it? Would it be possible to postpone a limiting event by performing maintenance activities to any of the parts/components of textile apparel?

Yes, appropriate use and storage of textile apparel can extend their expected lifetime. Moreover, maintenance activities (proper washing, drying and ironing) can postpone limiting events. Therefore, possibility of maintenance can be considered a relevant aspect.

Possibility of refurbishment

Is it technically feasible to refurbish textile apparel by the manufacturer and/or third party operators?

Yes, it is. Therefore, possibility of refurbishment can be considered a relevant aspect.

Recycled content

Is there a waste stream from which material can be recycled and reintroduced in the manufacturing process of textile apparel?

Is the waste stream available for using it in the manufacturing of textile apparel?

Is the waste stream generated within an acceptable distance from the recycling and manufacturing sites?

Can the recycled material be used for the manufacturing of textile apparel with the same or an acceptable minimum quality to keep the properties and function of the product?

Yes, there is a waste stream of textile apparel from which material can be recycled. This material is available for using in the manufacturing of textile apparel. Generally, the waste stream is not generated close to the most common sites for recycling and manufacturing of products. Only post-industrial textile waste is generated at manufacturing facilities. The quality of mechanically recycled fibres is generally lower than that of virgin fibres. Future developments of chemical recycling techniques could produce recycled fibres with the same quality of the virgin fibres. The possibility to incorporate recycled content largely depends on the type of fibre concerned: chemical recycling of cotton waste cannot generate new cotton fibres, but it can generate chemically modified (regenerated) fibres, such as man-made cellulosic fibres (MMCFs). Therefore, recycled content can be considered a relevant aspect.

Possibility of remanufacturing

Would it be technically possible to disassemble textile apparel without damaging those components or parts that could have potential to be used in a new product and/or would be possible to design the product in a way that allows it?

Yes, depending on the specific product and manufacturing process it may be technically possible to disassemble textile apparel so that some parts are used in a new product. It is also possible to redesign textile apparel in a way that they can be remanufactured. Therefore, possibility of remanufacturing can be considered a relevant aspect.

Recyclability

Is textile apparel made of components/parts or materials that can or have potential to be separated and recycled?

Is there available waste derived from the product from which materials can be recovered and recycled?

Is the technology to recycle textile apparel' material available? Is there an existing or potential demand for the recycled material?

Yes, textile apparel is made of materials that can be separated and recycled. There is available waste derived from textile apparel from which materials can be recovered and recycled. Some recycling technologies are already available. There is certain demand for material recycled from textile apparel, although it is limited due to non-competitive prices of recycled fibres. Therefore, recyclability can be considered a relevant aspect.

Possibility of recovery of materials

Besides preparation for re-use and recycling, is there another way to recover materials from the products in the scope?

No, the only way to recover materials from textile apparel is via preparation for re-use and recycling. Therefore, possibility of recovery of materials via any other route can be considered a non-relevant aspect.

The outcome of the qualitative analysis based on key guiding questions is that only the product aspect ‘possibility of recovery of materials’ can be considered as non-relevant at this point of the analysis.

Qualitative assessment

The qualitative assessment investigated technical, socioeconomic and environmental dimensions of the 15 relevant product aspects screened in in the guiding questions. This qualitative assessment used information gathered through literature review and did not include a comprehensive analysis because this is the aim of the following steps of the PS, mostly the analysis of technologies (section 9.2), Task 5 and Task 6.

The qualitative assessment aimed to further refine the exclusion of product aspects that are evidently not relevant for textile apparel, and to serve as a basis for the grouping of product aspects. In this way, the following steps of the PS can exclude their assessment for a streamlined process.

The qualitative assessment included:

- The technical dimension, which addressed product characteristics and/or improvement potential from a technical perspective.
- The socioeconomic dimension, which addressed the economic feasibility, impacts on job loss/creation and user-related aspects.
- The environmental dimension, which addressed environmental impacts caused by the consumption of the product and potential improvements.

The results of the qualitative assessment showed that all screened product aspects had at least one dimension that resulted relevant for textile apparel. Section 10.9.1 in the Annex provides details of the qualitative assessment.

Finally, **Table 40** reports the outcome of the analysis aiming to exclude non-relevant product aspects.

Table 40. Relevance of product aspects for textile apparel

Relevant product aspects	Non-relevant product aspects
Durability Reliability Reusability Upgradability Repairability Possibility of maintenance and refurbishment Presence of substances of concern Energy use and energy efficiency Water use and water efficiency Resource use and resource efficiency Recycled content Possibility of remanufacturing Recyclability Environmental impacts Expected generation of waste	Possibility of recovery of materials

Source: own production

9.1.3 Grouping of relevant product aspects

Grouping of relevant product aspects aimed to streamline the multi-criteria analysis that will be performed in the following tasks of the PS. Each product aspect represents a criterion of the analysis. If the number of these criteria decreases, the analysis is more efficient.

To this aim, **Table 41** reports some of the characteristics typical for specific product aspects, using the results of the qualitative assessment performed in section 9.1.2. Additionally, **Table 42** reports the direct interaction between product aspects and product parameters reported in Annex I to the ESPR. The product aspects that have common characteristics were grouped because they can be addressed via the same product parameters.

Table 41. Product aspects and required characteristics of products

Product aspect	Required characteristics of products (Annex I of ESPR)
Durability	A highly durable item of textile apparel should have, among others, the following characteristics: high resistance to abrasion, tearing, pilling, colour-fastness, soiling, dimensional changes and seam slippage. It should have easily accessible information for repair and maintenance. Moreover, a durable product should be desirable to the user for a long time. If textile apparel is modular, its priority parts should have easy physical access. Additionally, the process, tools and fasteners required for disassembly should be simple.
Reliability	A highly reliable item of textile apparel should have, among others, the following characteristics: high resistance to abrasion, tearing, pilling, colour-fastness, soiling, dimensional changes and seam slippage. Additionally, a reliable product should be desirable to the user for long time.
Reusability	A highly reusable item of textile apparel should have, among others, the following characteristics: high resistance to abrasion, tearing, pilling, colour-fastness, soiling, dimensional changes and seam slippage. It should have easily accessible information for repair and maintenance. Moreover, a durable product should be desirable to the user for a long time. If textile apparel is modular, its priority parts should have easy physical access. Additionally, the process, tools and fasteners required for disassembly should be simple.
Upgradability	A highly upgradable item of textile apparel should have, among others, the following characteristics: it should be highly modular in design, with easy physical access to priority parts. The process, tools and fasteners required for disassembly should be simple.
Repairability	A highly reparable item of textile apparel should have, among others, the following characteristics: it should be highly modular in design, with easy physical access to priority parts. The process, tools and fasteners required for disassembly should be simple. The product should also have access to repair services.
Possibility of maintenance	An item of textile apparel with possibilities for maintenance should have, among others, the following characteristics: it should have easily accessible information for care in terms of cleaning, drying, ironing and storing the product.
Possibility of refurbishment	An item of textile apparel with possibilities for refurbishing should have, among others, the following characteristics: it should be highly modular in design, with easy physical access to priority parts. The process, tools and fasteners required for disassembly should be simple.
Presence of substances of concern	An item of textile apparel with good information on presence of substances of concern is accompanied with a comprehensive list of all the substances of concern that it contains (above specified thresholds, as appropriate). Substances are used in order to give specific characteristics to the product, facilitate the manufacturing process or to help during the treatment of the product when it becomes waste. Consequently, substances of concern could affect durability, recyclability and environmental impacts.
Energy use and energy efficiency	An item of textile apparel with low energy use or high energy efficiency should (1) be manufactured with low energy consumption, (2) use materials which are not energy intensive in their manufacturing stage, (3) allow to reduce the energy consumption during the use phase in laundering, drying and ironing activities, and (4) be treated at its end of life with non-energy intensive techniques.
Water use and water efficiency	An item of textile apparel with low water use or high water efficiency should (1) be manufactured with low water consumption, (2) use materials which are not water intensive in their manufacturing stage, (3) allow to reduce the water consumption during the use phase in laundering activities, and (4) be treated at its end-of-life with non-water intensive techniques.
Resource use and resource efficiency	An item of textile apparel with low resource use or high resource efficiency should, among other things, use materials that throughout its life cycle stages (1) consume raw materials produced in sustainable way, (2) indirectly use land assuring its future use with the same activity, (3) use ecosystems without damaging their biodiversity and general balance.
Recycled content	An item of textile apparel with recycled content should contain recycled materials, in substitution of virgin materials. The recycled material should come from recyclable textile products to meet the fibre-to-fibre recycling objectives identified by the EU Textile Strategy.
Possibility of remanufacturing	An item of textile apparel with possibilities for remanufacturing should have, among others, the following characteristics: it should be highly modular in design, with easy physical access to priority parts. The process, tools and fasteners required for disassembly should be simple. It should have easily accessible information for repair.

Product aspect	Required characteristics of products (Annex I of ESPR)
Recyclability	In order to be recyclable, an item of textile apparel should meet all the following five characteristics when it becomes waste: (1) it can be effectively collected; (2) it can be sorted, i.e. segregated from other waste and sent to the subsequent recycling pathways; (3) it can be prepared for recycling, or can be sent directly recycling without specific preparation; (4) its fibre content can fully be used as feedstock for one or more recycling techniques to produce recycled fibres usable in textile products; (5) it has no elements or substances that disrupt the collection, sorting, preparation for recycling and recycling, or that limit the use of the recycled fibre.
Environmental impacts	An item of textile apparel with low environmental impact should have, among others, the following characteristics: in all life cycle stages it should (1) use a limited quantity of energy and water, (2) release directly and indirectly a limited quantity of pollutants (e.g. SOx, NOx, COD, microplastics) into the environment, use in the product and emit into the environment minimum possible amounts of substances of concern.
Expected generation of waste	An item of textile apparel with low expected generation of waste should have, among others, the following characteristics: (1) in all life cycle stages, it should generate minimal amounts of waste, (2) it should be designed and manufactured to prevent the generation of post-industrial waste, (3) ideally it should be designed to increase emotional attachment to the user to limit the demand for new products, (4) it should be durable to postpone the demand for new products.

Table 42. Interaction between product aspects and product parameters reported in Annex I to ESPR

Product parameters	Durability	Reliability	Reusability	Upgradability	Repairability	Possibility of maintenance	Possibility of refurbishment	Presence of substances of concern	Energy use and energy efficiency	Water use and water efficiency	Resource use and resource efficiency	Recycled content	Possibility of remanufacturing	Recyclability	Environmental impacts	Expected generation of waste
Product's guaranteed lifetime	X	X	X		X											
Technical lifetime	X	X	X													
Mean time between failures	X	X	X													
Indication of real use information on the product	X	X	X			X										
Resistance to stressor ageing mechanisms	X	X	X													
Characteristics, availability, delivery time and affordability of spare parts	X			X	X		X						X			
Modularity	X			X	X		X						X			
Compatibility with commonly available tools and spare parts	X			X	X		X						X			
Availability of repair instructions	X			X	X		X						X			
Availability maintenance instructions	X					X										
Number of materials and components used	X													X		
Use of standard components	Not applicable to textile apparel															

Product parameters	Durability	Reliability	Reusability	Upgradability	Repairability	Possibility of maintenance	Possibility of refurbishment	Presence of substances of concern	Energy use and energy efficiency	Water use and water efficiency	Resource use and resource efficiency	Recycled content	Possibility of remanufacturing	Recyclability	Environmental impacts	Expected generation of waste
Use of component and material coding standards for the identification of components and materials																
Number and complexity of processes and whether specialised tools are needed																
Ease of non-destructive disassembly and reassembly																
Conditions for access to product data	Not applicable to textile apparel															
Conditions for access to or use of hardware and software needed	Not applicable to textile apparel															
Conditions of access to test protocols or not commonly available testing equipment	Not applicable to textile apparel															
Availability of guarantees specific to remanufactured or refurbished products																
Conditions for access to or use of technologies protected by intellectual property rights																
Use of easily recyclable materials																
Safe, easy and non-destructive access to recyclable components and materials																
Material composition and homogeneity																
Possibility for high purity sorting																
Avoidance of technical solutions detrimental to reuse																
Avoidance of technical solutions detrimental to upgrading																
Avoidance of technical solutions detrimental to repair																

Product parameters	Durability	Reliability	Reusability	Upgradability	Repairability	Possibility of maintenance	Possibility of refurbishment	Presence of substances of concern	Energy use and energy efficiency	Water use and water efficiency	Resource use and resource efficiency	Recycled content	Possibility of remanufacturing	Recyclability	Environmental impacts	Expected generation of waste
Avoidance of technical solutions detrimental to maintenance	■					■										
Avoidance of technical solutions detrimental to refurbishment	■						■									
Avoidance of technical solutions detrimental to remanufacturing	■												■			
Avoidance of technical solutions detrimental to recycling														■		
Use of substances, in particular the use of substances of concern	■							■				■		■	■	
Use or consumption of energy, in one or more life cycle stages of the product	■	■							■						■	
Use or consumption of water, in one or more life cycle stages of the product										■					■	
Use or consumption of other resources, in one or more life cycle stages of the product											■				■	
Use or content of recycled materials and recovery of materials												■				
Use or content of sustainable renewable materials											■				■	
Weight and volume of the product and its packaging											■					■
Incorporation of used components											■					■
Quantity, characteristics and availability of consumables needed for proper use						■										
Environmental footprint of product															■	
Carbon footprint of product															■	
Material footprint of product															■	
Microplastic and nanoplastic release															■	
Emissions to air															■	

Product parameters	Durability	Reliability	Reusability	Upgradability	Repairability	Possibility of maintenance	Possibility of refurbishment	Presence of substances of concern	Energy use and energy efficiency	Water use and water efficiency	Resource use and resource efficiency	Recycled content	Possibility of remanufacturing	Recyclability	Environmental impacts	Expected generation of waste
Emissions to water																
Emissions to soil																
Noise																
Amounts of waste generated																
Functional performance																
Reduction of material consumption																
Load and stress optimisation of structures	Not applicable to textile apparel															
Integration of functions within the material or into a single product component	Not applicable to textile apparel															
Use of lower density or high strength materials and hybrid materials																
Waste reduction																

Coloured cells highlight relevant product parameters for specific product aspects.

Source: JRC own elaboration.

In the context of textile apparel, the product aspects of durability, reliability and reusability were grouped because they have common characteristics and have overlapping aims which can be reached with the same actions. A durable product is likely to be reliable and reusable. **Physical durability** is taken as the leading aspect of this group because it focusses on intrinsic measurable properties of the product which are reported in Annex I to ESPR and allow to indirectly address reliability and reusability. Conversely, emotional durability refers to the emotional attachment that the user has to the product and it does not fall into the definition of "durability" reported in the ESPR (**Table 2**). Although emotional durability is not a product aspect, its relevance to the life-cycle environmental impacts of the textile apparel was largely taken into account in the following sections of the PS.

Although the product aspect of **maintenance** is strictly connected to the physical durability, it was addressed separately because it is mostly related to information to be provided to the user, rather than connected to the physical performance of the product.

The third group of product aspects is led by **repairability** which has a definition and characteristics that closely relates to upgradability, possibility of refurbishment, and possibility of remanufacturing. When addressing repairability with product modularity, use of standard components, and the other relevant parameters, the product aspects of upgradability, refurbishment and remanufacturing is indirectly addressed.

The expected **generation of waste** is considered as a product aspect to be addressed individually, providing the feedstock for the recycling system.

The fifth group gathers **recyclability and recycled content**, because recycled material should come from recyclable textile products. From this perspective, these product aspects share the same ecosystem and are affected by the same process techniques, business models, legislation, and industrial practices. More details about this will be provided in the analysis of technologies in section 9.2.5.

The product aspect addressing **environmental impacts** includes the assessment of use (and efficiency) of water, energy and resources, which are the fundamental elements affecting the environment (see section 3.3). The following steps of the PS will develop the environmental and economic model that will take into account all resources used in the entire life-cycle of the textile apparel. In particular, the part of the model related to raw material production will gather available data coming from the most commonly used practices. This approach will support the identification of resource use that less negatively impact the environment in this specific stage. Additionally, Task 5 will report a specific analysis on microplastics release in the whole life-cycle of textile products.

Although the **presence of substances of concern** strongly affects other product aspects, it is suggested to be addressed separately because it mainly refers to information requirements to be reported by the economic operator placing/making available the product on the market. Substances are used to give specific characteristics to the product, facilitate the manufacturing stage, or affects the treatment of the product when it becomes waste. Consequently, substances of concern could directly affect the physical durability, the recyclability, the recycled content and the environmental impacts.

Therefore, the next stages of the PS will address the following groups of relevant product aspects:

- Physical durability, which includes physical durability, reliability and reusability;
- Maintenance;
- Repairability, which includes repairability, upgradability, possibility of refurbishment, and possibility of remanufacturing;
- Generation of waste;
- Recyclability and recycled content;
- Environmental impacts, which include environmental impacts, energy use and energy efficiency, water use and water efficiency, resource use and resource efficiency; and
- Presence of substances of concern.

9.2 Analysis of technologies

For each relevant product aspect, this section describes the product technologies following a three-step analysis:

- Step 1: analysis of the ecosystem related to the specific product aspect;
- Step 2: identification of a methodology to describe the product technologies;
- Step 3: description of the product technologies based on previous steps. This description could be supported by a categorization to best describe the products in the scope.

In step 1, the ecosystem related to the specific product aspect was studied considering four elements:

- the **process techniques**, which are the instruments and practices used along the stages of the product's life-cycle to manufacture or treat product technologies,
- the **business models** of economic operators in the ecosystem,
- the **user behaviour**,
- the **legislative framework** and **industrial best practices**.

In step 2, the methodology used was specific to the product aspect and it was based on the analysis of the specific ecosystem. In step 3, the categorization aimed to gather all products that can be subject to the same future requirements.

Sections 9.2.1, 9.2.2 and 9.2.3 address the extension of product lifespan in term of physical durability, maintenance and repairability, respectively. Section 9.2.4 analyses the waste generation, while section 9.2.5 addresses the recirculation of materials in terms of recyclability and recycled content. Section 9.2.6 analyses the environmental impacts, including the use and efficiency of water and energy. Finally, section 9.2.7 addresses the presence of substances of concern.

9.2.1 Physical durability

This section describes the physical durability of textile apparel, focussing on measurable intrinsic properties linked to the physical resistance against degrading factors due to use and maintenance habits. These degrading factors generate failures, such as fabric breakdown, pilling, loss of dimensional stability and discolouration (Cooper and Claxton, 2022c).

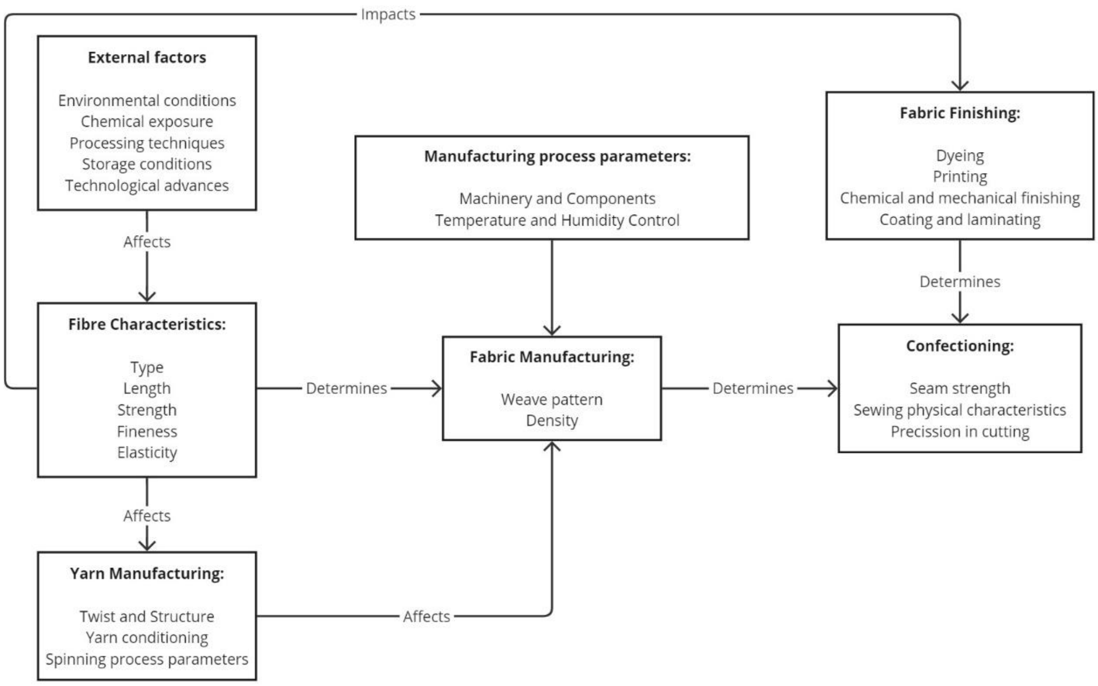
9.2.1.1 The ecosystem of physical durability

Manufacturing factors and process techniques

The characteristics of the product technologies related to physical durability are strictly related to all process techniques involved in the manufacturing stage, as well as the choice of raw materials and the choice of function of the product made at the design stage.

Figure 21 shows a simplification of the complex relations among the numerous factors influencing the physical durability of textile apparel. These factors are grouped according to the specific process during the manufacturing stage. The fibre characteristics directly affect yarn and fabric manufacturing and finishing processes. At the same time, there are external factors such as environmental and storage conditions, and chemical exposure that directly affect the characteristics of the fibres. During the manufacturing of the yarn, the chosen spinning method provides specific levels of evenness, softness and strength. Moreover, spinning parameters such as the twist level, spinning tension, temperature and humidity control play a crucial role on the characteristics of the yarn. The fabric manufacture is strictly related to the final application: weaving is generally used for relatively more rigid and stronger fabrics (e.g. used in pants and shirts), whereas knitting is usually used for relatively more elastic fabrics (e.g. used in T-shirts and dresses). Fabric manufacturing is affected by the specific process techniques used and the ability to control temperature and humidity during the process. During the finishing processes, dyeing and printing give colour-related characteristics, whereas chemical and mechanical finishing provide functional and physical properties, respectively. Fabric manufacturing and finishing directly affect the confectioning process where the physical characteristics of sewing, the precision of cuts and seam strength play an important role in the final appearance and physical durability of the textile apparel. Section 10.9.2 provides more details about the complexity simplified in **Figure 21**.

Figure 21. Overview of the main factors influencing the physical durability of textile apparel



Source: Own production based on AITEX's knowledge and (Rahman et al., 2023)

User behaviour

Users influence the physical durability of textile apparel mainly at the moment of the purchase when choosing a product with specific characteristics ([134]). Therefore, users set a specific market demand for future products to be placed on the market. This is particularly true whenever the product is placed on the market by a company following the consumer-led operation model (see Section 5.5).

The analysis of user behaviour in Section 6 revealed that product quality is an important parameter taken into consideration when users buy an item of textile apparel. Physical durability is considered one of the main quality aspects. However, when choosing a textile apparel in physical shops, users are driven by their subjective judgement based on the look and touch. When buying online, users still rely on the possibility to check the look and touch of the textile apparel if there is the possibility to return it.

Price is another important aspect that users take into account when buying textile apparel, but they generally do not consider it an indicator of quality, and therefore they also do not consider it to be an indicator of physical durability (Section 6). At the same time, the literature revealed that relatively cheap products are disposed of more frequently than higher-priced ones (Morgan and Birtwistle, 2009a; Joy et al., 2012a). However, no research was found analysing the potential relation between price of products and their intrinsic durability properties.

All in all, although physical durability refers to intrinsic properties of textile apparel, currently users have no way to access this information.

Legislative frameworks and industrial practices

Currently, the industry uses numerous standards to measure specific parameters related to the physical durability of textile apparel (Section 4.4). In France, economic operators placing products generating waste on

[134] Users also affect the actual lifespan of the products with their maintenance practices, but this topic is addressed in section 9.2.2, where the product aspect of maintenance is analysed.

the French market are requested by the Law n° 2020-105 ([135]) to report information about durability of the product. It is unknown to the authors what specific parameters and framework should be used to describe the physical durability of textile apparel in this context.

Business models

Companies in the textile apparel industry adopt numerous business models (Sections 5.5. and 5.6). Some of them promote physically durable products and tend to communicate the intrinsic characteristics of the textile apparel. This approach is most common among economic operators dealing with sportswear and workwear. Other companies place on the market textile apparel with high frequency, either to satisfy the demand of customers for new items, or to promote consumption of new collections. Usually, economic operators using this business model would not promote physical durability of the textile apparel because the item would be changed or disposed of by the user relatively soon after purchase.

9.2.1.2 Natural vs synthetic fibres – duality or complexity?

The physical durability of textile apparel is often perceived to be higher for products made with synthetic fibres, compared to those made with natural fibres. This perception may be attributed to the fact that synthetic fibres are man-made fibres designed to be stronger than natural fibres (**Table 121** in section 10.9.2 reports comparison on characteristics). However, the reality is more complex and the factors influencing the physical durability of textile apparel are multifaceted and interconnected (Section 9.2.1.1 and Section 10.9.2). In practice, a textile apparel with a dense cotton fabric and well-constructed seams can outlast a polyester-based product with loosely woven fabric and inadequately constructed seams. Additionally, each fibre and fibre blend has specific properties used for particular applications.

To meet consumer needs, textile apparel must satisfy three key requirements: (1) perform a specific function, (2) meet consumer taste and comfort expectations, and (3) be reasonably priced. Achieving these requirements involves a complex engineering process that takes into account the various factors influencing physical durability. The diverse range of fibres, each with unique characteristics, plays a crucial role in providing specific properties to textile apparel.

As a result, the majority of textile apparel on the EU market is made from blends of natural and chemical fibres (48-60%). Single-fibre products account for a smaller share, with 18-28% made of cotton and 11-17% made of polyester (Refashion, 2023; Bakowska et al., 2025).

9.2.1.3 How to assess physical durability

The assessment of physical durability should evaluate the capability of textile apparel to maintain its properties over time, resisting to aging factors, such as wear and tear and cleaning cycles. The following methodology was adopted in this PS because it takes into account the interaction among manufacturing factors and process technologies (see section 9.2.1.1), the main causes of failures, and the availability of standardised test methods to assess specific parameters.

The methodology comprises five steps:

1. Selection of the key parameters, complying with the principle of economy
2. Identification of the characteristics of a new item,
3. Simulation of the aging process,
4. Assessment of the effects of the aging process,
5. Grouping products with homogeneous characteristics.

The selection of the **key parameters** was based on most common failure modes found in the literature and their corresponding available standardised test methods (**Table 43**).

[135] LOI n° 2020-105 du 10 février 2020 relative à la lutte contre le gaspillage et à l'économie circulaire. Available at [this link](). Last accessed on 10 October 2024.

Table 43. Most common textile apparel failure modes and associated testing parameters

Failure mode group	Type of failure	Occurrence (*) (%)	Associated testing parameters
Fabric related	Pilling	55	Pilling resistance Visual inspection
Colour related	Colour fading	53	Visual inspection
Fabric related	Fabric breakdown	29	Tensile strength Bursting resistance
Fabric related	Accidental damage	29	Determined by the user
Fabric related	Loss of dimensional stability	20	Dimensional stability
Logo failure	Logo failure	16	Visual inspection
Colour related	Discolouration	15	Visual inspection
Fabric related	Hole(s) in seams	14	Tensile strength
Fabric related	Trim failure	8	Visual inspection (without considering the functioning test of buttons and zippers)

(*) Occurrence of failure in the sample analysed by Cooper and Claxton (2022)

Source: (Cooper and Claxton, 2022c) and AITEX's knowledge

The identification of the **characteristics of the new item** were fibre-neutral, so that textile apparel made of any type of natural fibres, man-made fibres and their blends could meet the thresholds. This approach took into account the multiple fibre compositions of products in the scope discussed in section 9.2.1.2. The characteristics of the new item were identified based on AITEX's experience in testing textile products.

The **ageing process** of a textile apparel included the effects of numerous factors: the wearing during the actual use, the cleaning (washing or dry cleaning), the drying (line-drying or tumble drying), the potential ironing, and the storage. For the purpose of the methodology, the simulation of ageing only focussed on the simulation of cleaning cycles, because this is the factor that most affects the wear and tear of an item of textile apparel (Neuß and Schlich, 2019; Cooper and Claxton, 2022c). In terms of type of cleaning, the literature reports that dry cleaning is mostly used for formal wear, whereas the rest of textile apparel is usually cleaned using washing machines (Laitala and Klepp, 2020a). Available standardised test methods are capable to simulate the cycles of washing and dry cleaning (**Table 69**).

The effect of the ageing process is assessed comparing the performances of an aged product, which underwent a defined number of cleaning cycles, with those of a new product. The difference in performances is expressed as a percentage reporting the decrease of the key parameters. The better-performing products will present a smaller property loss compared to the worse-performing products.

When simulating the aging process, the number of cleaning cycles expresses the objective physical resistance of a textile apparel, which should not be confused with its service lifespan that includes the subjective judgement of the last owner before disposal. The number of cleaning cycles was mainly based on AITEX's experience and validated by their professional network.

The products in the scope are too heterogeneous to be described with the same physical durability parameters and performance levels. Therefore, the scope was divided into **categories** containing all products that can be described with the same key parameters, same performance levels, and undergo the same number of cleaning cycles, because they follow similar manufacturing processes, have similar functions, and count with similar main failure modes. In practice, the technology of the fabric (knitted vs woven) implies specific failure modes, whereas the function implies a defined aging simulation.

The tests for assessing the key parameters were identified taking into account the function of the product and the manufacturing process techniques. This procedure adopted the **principle of economy** based on two aspects:

- The selection of parameters relevant to the specific product category, and
- The optimization of the number of tests, using standardised methods addressing more than one parameter.

For example, the assessment included the performance of the seams when used with woven products and excluded them when seams were used in knitted products. This choice was made because the former are weak parts of the textile apparel, whereas the latter are technically well integrated into the fabric and do not represent a vulnerability of the product. An example about the optimization of the number of tests is given by the assessment of colour fading, discolouration and logo failure via only the standard on visual inspection instead of adding specific colour-related tests.

9.2.1.4 Description of product technologies per category

Table 44 reports the description of eleven product categories from the perspective of the physical durability, whereas **Table 128** reports a description of all standardised test methods proposed in the framework.

Table 44. Product description from the perspective of physical durability

ID	Category description	Key parameter (unit)	Test method	Characteristics of the new product	Simulation of the ageing process
1	Trousers, shorts and skirts, excluding denim	Dimensional change (%)	ISO 3759:2011	±3%	20 washing cycles following ISO 6330 Washing treatment according to label (domestic washing).
		Tensile strength (N)	ISO 13934-1: 2014	Longitudinal: ≥160 N Transversal: ≥120 N	
		Pilling resistance (5-step grading system)	ISO 12945-2: 2020 (2000 cycles)	Grade ≥4	
		Seam resistance (N)	ISO 13935-2:2014	≥100 N	
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
2	Denim trousers, shorts and skirts	Dimensional change (%)	ISO 3759:2011	±3%	20 washing cycles following ISO 6330 Washing treatment according to label (domestic washing).
		Tensile strength (N)	ISO 13934-1: 2014	Longitudinal: ≥190 N Transversal: ≥130 N (on seam)	
		Pilling resistance (5-step grading system)	ISO 12945-2: 2020 (2000 cycles)	Grade ≥4	
		Seam resistance (N)	ISO 13935-2:2014	≥120 N	
		Visual inspection for: Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
3	Sweaters, mid-layers and knitted dresses	Dimensional change (%)	ISO 3759:2011	±5%	20 washing cycles following ISO 6330 Washing treatment according to label (domestic washing)
		Bursting resistance (kPa)	ISO 13938-2:2019 (50 cm^2)	≥160 kPa	
		Pilling resistance (5-step grading system)	ISO 12945-1:2020 (14 400 cycles)	Grade ≥4	
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
4	T-shirts and polos	Dimensional change	ISO 3759:2011	±5%	30 washing cycles according to ISO 6330 Washing treatment according to label (domestic washing)
		Bursting resistance (kPa)	ISO 13938-2:2019 (50 cm^2)	≥160 kPa	
		Pilling resistance (5-step grading system)	ISO 12945-1:2020 (14 400 cycles)	Grade ≥4	

ID	Category description	Key parameter (unit)	Test method	Characteristics of the new product	Simulation of the ageing process
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
5	Shirts	Dimensional change (%)	ISO 3759:2011	±3%	30 washing cycles following ISO 6330 Washing treatment according to label (domestic washing)
		Abrasion resistance (number of cycles)	ISO 12947-2:2016	≥20 000	
		Pilling resistance (5-step grading system)	ISO 12945-2:2020 (2000 cycles)	Grade ≥4	
		Seam resistance (N)	ISO 13935-2:2014	≥100 N (on confection seam)	
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
6	Blouses and woven dresses	Dimensional change (%)	ISO 3759:2011	±3%	20 washing cycles following ISO 6330 Washing treatment according to label (domestic washing)
		Abrasion resistance (number of cycles)	ISO 12947-2:2016	≥15 000	
		Pilling resistance (5-step grading system)	ISO 12945-2:2020 (2000 cycles)	Grade ≥4	
		Seam resistance (N)	ISO 13935-2:2014	≥80 N (on confection seam)	
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
7	Jackets and coats	Dimensional change (%)	ISO 3759:2011	±3%	3 cleaning cycles: either following ISO 6330 (washing machine) or following ISO 3175-2 (dry cleaning). For domestic washing, treatment according to label.
		Abrasion resistance (number of cycles)	ISO 12947-2:2016	≥20 000	
		Pilling resistance (5-step grading system)	ISO 12945-1:2020 (2000 cycles)	Grade ≥4	
		Seam resistance (N)	ISO 13935-2:2014	≥100 N (only for blazers)	
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	

ID	Category description	Key parameter (unit)	Test method	Characteristics of the new product	Simulation of the ageing process
8	Hosiery: leggings, stockings, tights and socks	Dimensional change (%)	ISO 3759:2011	±3%	30 washing cycles following ISO 6330 Washing treatment according to label (domestic washing)
		Abrasion resistance (number of cycles)	ISO 13770 method 1	≥20 000	
		Bursting resistance (kPa)	ISO 13938-2: 2019 (7.3 cm^2)	≥220 kPa	
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
9	Underwear: underpants and boxers	Dimensional change (%)	ISO 3759:2011	±3%	30 washing cycles following ISO 6330 Washing treatment according to label (domestic washing)
		Visual inspection for: (1) Colour change (2) Pilling (3) Trimmings aspect (4) Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
10	Swimwear	Dimensional change (%)	ISO 3759:2011	±3%	15 washing cycles following ISO 6330 Washing treatment according to label (domestic washing)
		Elasticity of fabric (%)	ISO 20932-3:2018	≤7% after 1 minute (only for feminine items)	
		Colour fastness to artificial light (8-step grading system)	ISO 105-B02:2014	Grade ≥5	
		Colour fastness to sea water (5-step grading system)	ISO 105-E02:2013	Grade ≥4	
		Colour fastness to chlorinated water (5-step grading system)	ISO 105-E03:2010	Grade ≥4	
		Visual inspection for: Colour change Pilling Trimmings aspect Self-staining (5-step grading system)	ISO 15487:2018	Colour change: Grade ≥4 Pilling: Grade ≥4 Trimmings aspect: Grade 5 Self-staining: Grade 5	
11	Accessories	NA	NA	NA	NA

When measuring the characteristics of the new product, the tests addressing dimensional change and visual inspection need to be run after 1 cleaning cycle.
Washing treatments are supposed to follow information reported on the label. Although this information is usually available, it should not be given for granted because it is not mandatory by law.
All products made with denim fabric should not be tested for colour change because this type of fabric is designed to lose colour over time.
NA: Not available, because the category is too heterogeneous.

Source: AITEX's knowledge

Despite the complexity of the products in scope, two test methods were used to assess five **key parameters** for all product categories: the dimensional change and, via visual inspection, colour change, pilling, appearance of trims and self-staining. All these parameters have to be assessed after a cleaning cycle.

The breakage of fabric took into account the two manufacturing techniques:

- Woven fabrics were described with the tensile strength, seam strength and abrasion resistance;
- Knitted fabrics were described via bursting resistance.

Since pilling is the most common failure mode (see **Table 43**), it was assessed via visual inspection in all categories. Nevertheless, there are specific categories whose function makes these products more prone to rubbing or friction, and therefore a more specific test was included.

Key parameters like elasticity and colour fastness to artificial light, sea water and chlorinated water were chosen to describe swimwear, which have a specific function and are exposed to peculiar external agents like salty and chlorinated water and strong sunlight.

Seam resistance was included in categories with woven textile apparel whose structure and fit design creates stress during movement on the seams, especially in areas like shoulders, sides and armholes. As previously mentioned, knitted products are less prone to seam failure due to the specific interaction between fabric and seams.

The list of key parameters did not include the assessment of trims because:

- Problems with trims are the least occurring failure mode (see **Table 43**);
- The assessment of trim appearance is included in the visual inspection;
- Failures of buttons are the most commonly self-repaired parts of the textile apparel (see Section 6.3.3);
- Failure of zippers occurred only 2% of the times (Cooper and Claxton, 2022c).

The potential inclusion of specific test methods for buttons ([136]) and zippers ([137]) would clash with the economy principle and would not lead to a substantial improvement in the description of the physical durability of these products.

The values set for the **characteristics of the new products** show that some key parameters decrease their performances even after one cleaning cycle. This is the case of colour change and pilling analysed via visual inspection that can score Grade 4 (slight distortion or damage, minimal and only noticeable upon close inspection), rather than Grade 5 (no visible distortion or damage, fabric maintains its original appearance) after a single cleaning cycle. Additionally, the dimensional change of the fabric can be between 3 and 5%.

Even without undergoing the first cleaning cycle, the new items do not necessarily score at the top of the scale of the tests. This is the case of pilling resistance that can score Grade 4 (slight pilling with some pilling visible but not extensive), rather than Grade 5 (no pilling with no visible pilling on the fabric surface). Additionally, the assessment of colour fastness ([138]) for new swimwear could show similar performances:

- To artificial light: Grade 5 (good light fastness) rather than Grade 8 (outstanding light fastness);
- To sea water and to chlorinated water: Grade 4 (good colour fastness) rather than Grade 5 (excellent colour fastness).

These minimum values assigned to new items underline that new items are sometimes placed on the market exhibiting relatively poor performances as regards the key parameters that describe physical durability.

The reported number of cleaning cycles is aligned with version 2.0 of the PEFCR A&F (Quantis, 2024) and the available scientific literature (Easter and Badgett (2019) and studies reported in Section 5.8).

[136] Button attachment: UNE EN 17394-2:2021 focuses on children's apparel security.
[137] Zipper attachment and functioning: UNE EN 16732:2016 includes tear tests and zipper fatigue tests.
[138] The colour fastness tests measure how much the colour of the textile apparel fades and stains.

Textile apparel **accessories** were not described because they are too heterogeneous – they would require a further categorization based on their:

- Function: (1) gloves and mittens, (2) scarves, shawls, and mufflers, (3) ties and cravats, (4) hats and headgear, (5) handkerchiefs and veils, (6) belts and suspenders;
- Material composition: at least (1) silk products vs (2) non-silk products;
- Fabric technologies: (1) knitted, and (2) crocheted.

This would result in **about 16 potential sub-categories**, whose products undergo none or very few cleaning cycles. Consequently, the physical durability should be assessed with specific approaches, which require a disproportionate effort compared to the very small market share of these products. The portion of apparent consumption of accessories compared to the total textile apparel was rather constant from 2006 to 2022. More precisely, the apparent consumption of accessories was about 5% and 4% of the total apparent consumption of textile apparel in terms of mass and value, respectively (**Figure 40**). Due to this disproportionate effort demand, these products are excluded from the description of the physical durability of textile apparel.

Based on the framework reported in **Table 44**, **technologies of textile apparel** can be distinguished as follows:

- **Bad case** (poorly performing products): performance level of at least one key parameter decreases more than 50% after aging;
- **BC**: performance level of all key parameters decreases between 30% and 50% after aging;
- **BAT**: performance level of all key parameters decreases between 20% and 30% after aging;
- **BNAT**: performance level of all key parameters decreases less than 20% after aging.

The performance decrease of the key parameters should be calculated as reported in **Table 45** and applies to all product categories.

Table 45. Guidance for the calculation of performance decrease in the framework of the physical durability

Result of the test method	Key parameter	Decrease of performance level
Numerical	Abrasion resistance (number of cycles) Bursting resistance (kPa) Dimensional change (%) Elasticity (%) Seam resistance (N) Tensile strength (N)	$\frac{Value\ after\ aging - Value\ of\ the\ new\ item}{Value\ of\ the\ new\ item} * 100\ (\%)$
5-step grading system	Colour fastness to chlorinated water Colour fastness to sea water Colour change via visual inspection Pilling resistance Pilling via visual inspection Trimmings aspect via visual inspection Self-staining via visual inspection	Each step represents a change of 20%
8-step grading scale	Colour fastness to artificial light	Each step represents a change of 12.5%

Description of all test methods is reported in Table 128

Source: own elaboration

9.2.2 Maintenance

Maintenance is the ability of a product to be kept in a condition where it is able to fulfil its intended purpose through one or more actions. In the context of textile apparel, it comprises the set of activities that a user carries out, fundamentally during the use phase, in order to maintain the product in a condition that satisfies their needs. It includes activities such as cleaning, drying, ironing, storing and wearing, in specific environments and conditions. It does not include any operations addressing the repair of the product, which is addressed under a separate specific product aspect (see section 9.2.3).

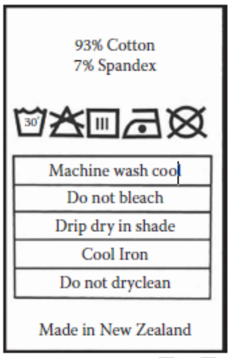
Maintenance operations are specific to the item they refer to. In particular, the fibre composition, the fabric construction type, the presence of non-fibre-based parts and the finishing treatments of the item are crucial factors determining the suitable maintenance strategies to make the product last longer. This section mainly focuses on the information that the manufacturer provides to the user to properly maintain textile apparel.

9.2.2.1 The ecosystem affecting maintenance

Process techniques and design choices

Maintenance instructions are commonly communicated through specific symbols on care labels. These symbols are designed to be universally recognisable providing clear guidance on textile apparel care. However, the meaning of some of these symbols is not clear to some users, who tend to mistake the suggested care practices. There are ongoing efforts to standardise and improve the clarity of these symbols by using both symbols and captions to facilitate the understanding (Yan et al., 2008; Nayak and Ratnapandian, 2018) (Section 10.6.2.7). Figure 22 shows an example of care label that combines symbols and captions.

Figure 22. Example of a care label combining symbols and caption



Source: Nayak and Ratnapandian (2018)

Traditionally, care labels have been physically sewn during the confectioning phase onto textile apparel, providing essential instructions on washing, drying, and ironing. However, with the rise of digital technology, many brands now complement the physical labels with online care guides and mobile apps. These digital platforms offer more detailed explanations and interactive features that help consumers better understand and follow textile apparel care instructions (Nayak and Ratnapandian, 2018)

User behaviour

Consumer behaviour strongly affects textile apparel maintenance, because the choices made by the users may adhere or not to the best practices reported on the care label. When care information is reported on the item of textile apparel, users could disregard it, have difficulties interpreting the instructions or they could even remove the label because it results uncomfortable when wearing the item (see section 6.3.2 and 10.6.2.7). The removal of physical labels from textile apparel is indirectly promoted by labels displaying a cutting line.

The price of the new item could play an important role when analysing the attention that users pays to care label information. Users are more likely to follow instructions on the care label if they handle a relative expensive product, rather than if they handle a relatively cheap one (Wakes et al., 2020b).

Sections 6.3.1 and 10.6.2 report the most relevant best use practices in terms or textile apparel care:

- Following information provided in the care label,
- Running laundry with sorted items according to their colour, fabric type, and washing temperature,
- Using the suitable washing temperature,
- Running short washing cycles and reduced spin speed,
- Using the right quantity and type of detergents and softeners,
- Preferring air-drying out of direct sunlight to tumble drying,
- Minimising wash frequency and ironing,

- Properly folding or hanging to prevent fabric deformation
- Storing in cool and dry places.

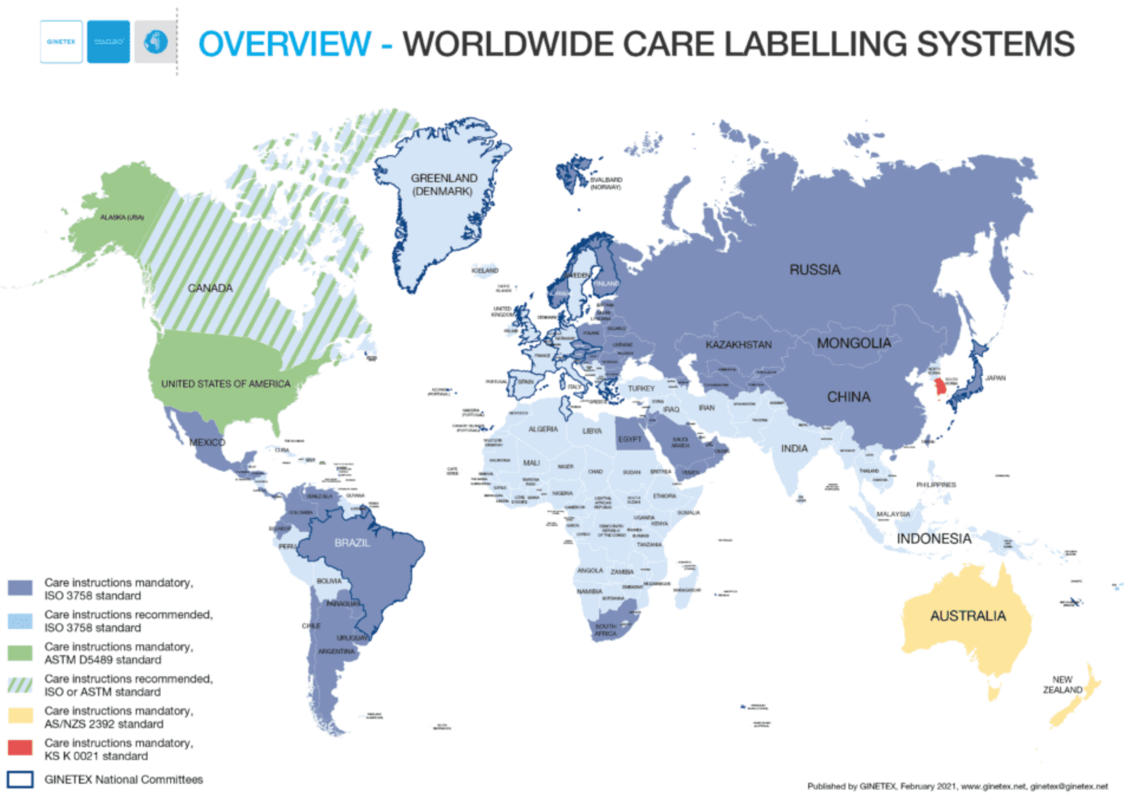
Legislative framework and industrial best practices

Care instructions are not currently mandatory under EU law but they are often provided by manufacturers to prevent customer complaints. Many countries voluntarily follow the GINETEX Standard ([139]), which establishes care labelling system for textiles based on symbols. The European Commission is currently considering the introduction of harmonised and partially mandatory textile labelling rules on textile care, in the context of the review of the Textile Labelling Regulation (EU) 1007/2001 (TLR) ([140]).Nine Member States already require mandatory care labels ([141]) (GINETEX, 2017b).

Table 129 in section 10.9.4 reports the description of standards used in some regions of the world. They mainly differ as regards: (a) temperature units, (b) requirement of captions alongside symbols, (c) adopted symbols, and (4) legal requirements (mandatory vs voluntary).

Figure 23 shows legal requirements and the adoption of standards in specific regions of the world.

Figure 23. Care labelling systems in the world



Source: UK Fashion and Textile Association. Available at [this link](). Last accessed 12 November 2024.
Previously published by GINETEX in February 2021

Table 46 reports the best practices that manufacturers and retailers try to implement.

[139] Ginetex website. Available at this link. Last accessed 12 November 2024

[140] Revision of the Textile Labelling Regulation (EU) 1007/2011. Available at this link. Last accessed on 12 November 2024.

[141] Austria, Bulgaria, Estonia, Finland, Hungary, Lithuania, Romania, Slovakia and Sweden, as well as, in the EEA, Norway.

Table 46. Best practices on care labelling implemented by producers and retailers

Factor	Action
Legibility	Labels should use easily understandable symbols alongside with written instructions. Symbols and letters on labels must remain legible throughout the textile apparel's useful life. The label should use medium-width lettering, where no individual letter should be less than 1.5 mm high.
Parts of the product	If the product is composed of more than one part, the care instruction should take into account the heterogeneity of the product parts.
Comprehensive coverage	Care instruction symbols should apply to the entire textile apparel, including trimmings, zippers, linings, buttons, and sewing thread, unless otherwise specified on separate labels.
Consistent label placement	Labels should be positioned in the same place across all similar items of textile apparel.
Durability of labels	Care labels should be made of materials that are resistant to the care treatments indicated on the label, at least to the same extent as the textile apparel itself.
Material-based instructions	Care instructions should be based on the product's end use and fibre composition. If fabrics contain blended fibres, the care instructions should take into account the most sensitive fibre for the specific treatment.
Pre-sale verification	The care instructions should be verified before being placed on the market to ensure their correctness.

Source: Own production based on (Nayak and Ratnapandian, 2018)

Business models

As previously mentioned, in general companies are interested to provide care instructions to avoid complaints from customers. Nevertheless, this approach could vary according to the business model the company adopts. In general, companies that want to promote long-lasting products might pay particular attention when providing maintenance instructions. Differently, companies that want to promote a fast turnover in the consumption of textile apparel might tend to invest little attention on communicating care instructions.

9.2.2.2 How to assess maintenance

Based on the information gathered in sections 9.2.2.1 and 9.2.2.2, the assessment of maintenance should be based on three main aspects:

1. Type of information provided, addressing all steps of the use-phase:
    (a) cleaning,
    (b) drying,
    (c) ironing,
    (d) storing,
    (e) wearing,
    (f) additional suggestions;
2. Carrier; and
3. Communication strategy.

Information about **cleaning** should address all types of cleaning operations the product can/should undergo: e.g. dry cleaning by professionals or home washing. In the case of professional cleaning, directions should be provided on compatible products for dry cleaning. In the case of home washing, directions should be provided on washing temperature, type and dosing of detergents and softeners ([142]), spin speed, type of textile products that can be washed with it (e.g. similar colours and fibre types).

Information about **drying** should include directions on the optimal type of drying, with specific information regarding drying temperature in the tumble dryer, and sunlight exposure when line drying (air-drying) is used.

Information about **ironing** should include ironing temperature, and best practices about humidity of the item to be ironed.

[142] In general, specific chemical formulations can weaken certain fibre types increasing the risk of damage (Cooper and Claxton, 2022c).

Information about **storing** should include directions on how to fold and hang the product, with description of the optimal environmental conditions. If relevant, specific information should be provided distinguishing good practices about storage after wearing from storage after cleaning operations.

Information about **wearing** should specify the function that the product is designed for: e.g. sport activities, leisure time, resistance to humid environment and rain, etc.

Information about **additional suggestions** should include any further information that could support the suitable maintenance of the product.

The **carrier** of information can be a physical label where information is directly reported on it and/or digital-based, where the information can be reached on an online platform. In this case, it should be very clear and simple for the user how to obtain the information.

Finally, regardless of the carrier used, the information should be provided with a **standardised strategy** (or structure), so that users can easily navigate information provided by any economic actor.

This framework is suitable to describe all products included in the scope of the PS without any further grouping or categorization.

Although user behaviour plays a crucial role in the effects generated by product maintenance, the assessment of maintenance in the framework of the ESPR focuses only on the instructions that the manufacturer provides to the user. The behaviour of the user will be taken into account in the environmental and economic models to be built in the following tasks of the PS.

9.2.2.3 Description of products based on maintenance

Table 47 reports the description of product technologies in the context of maintenance of textile apparel.

Table 47. Description of product technologies in the context of maintenance of textile apparel

Information	BC	BAT	BNAT
Cleaning	Using symbols reported in ISO 3758:2023	It reports symbols reported in ISO 3758:2023 explained with captions	It reports all types of cleaning operation the product can/should undergo: e.g. dry cleaning by professionals or home washing. In the case of professional cleaning, directions should be provided on compatible products for dry cleaning. In the case of home washing, directions should be provided on washing temperature, type and dosing of detergents and softeners, spin speed, type of textile products that can be washed with (e.g. similar colours and fibre types).
Drying	Using symbols reported in ISO 3758:2023	It reports symbols reported in ISO 3758:2023 explained with captions	It reports symbols reported in ISO 3758:2023 explained with captions.
Ironing	Using symbols reported in ISO 3758:2023	It reports symbols reported in ISO 3758:2023 explained with captions.	It reports symbols reported in ISO 3758:2023 explained with captions.
Storing	Not available.	Not available.	It includes directions on how to fold and hang the product, with description of the optimal environmental conditions. If relevant, specific information should be provided distinguishing good practices about storage after wearing from storage after cleaning operations.
Wearing	Not available.	Not available.	It specifies the function that the product is designed for: e.g. sport activities, leisure time, resistance to humid environment and rain, etc.
Additional suggestions	Not available.	Reduction of washing frequency and prefer line drying.	It includes any further information that could support the suitable maintenance of the product.
Carrier	Physical label.	Physical label and a website reported on the label.	Physical label is used for basic most important information or warnings, while other information is reachable with a support of a device (e.g. Radio Frequency Identification (RFID) system) incorporated in the product, so that it does not create discomfort and it is difficult to remove.

Information	BC	BAT	BNAT
Communication strategy	Using symbols reported in ISO 3758:2023.	It reports symbols reported in ISO 3758:2023 explained with captions.	Users can easily navigate information provided by any economic actor because it is provided following a standardised format.

Physical labels are usually made of polyester and satin due to their softness and resistance properties (Nayak and Padhye, 2015).
Care symbols use ISO 3758:2023 ([143]).

Source: own production

9.2.3 Repairability

According to the ESPR, the repairability is defined as the ability of a defective product or waste to return to a condition where it fulfils its intended use (**Table 2**). In the context of textile apparel, this return to the intended use includes the acceptance by the user, who should still be satisfied with the potential new aesthetics of the product after repair operations. This could be the case for example in the use of patches, mending operations on fabrics, or the use of buttons different from the original ones.

9.2.3.1 The ecosystem affecting the repairability

Design principles for repairable items – choices and process techniques

Textile apparel is often composed by many pieces of fabrics and by non-textile parts such as buttons, zippers and many more. Fabrics could be organised on one or more layers, which could have the same or different fibre composition and properties. Additionally, specific parts of textile apparel could have exclusively an aesthetic function and be made of numerous materials such as leather, plastics, metal and fibre-based. All these parts composing textile apparel are mostly joined with seams, but other ways such as heat-bonding and laser-based techniques are also in use. Furthermore, an item of textile apparel can also be seamless and be made of only one piece of fabric.

The products included in the scope of the PS are very heterogeneous in terms of number, properties and functions of their parts. This heterogeneity goes beyond the intended function of the product, because the same product could be made in numerous ways. For example, a t-shirt can be made of a knitted fabric with no seams, or it can be made by numerous panels of fabric joined with seams, buttons and sequins, resulting in a product made of numerous parts, each of them with a specific function.

Table 43 in section 9.2.1.3 reports that the fabric is the part which is most affected by failures, followed by seams and trims. Fabric is usually damaged by colour fading, discoloration, breakdown, fraying and thinning, pilling and stains.

From the general design perspective, modularity, use of standardised parts and availability of spare parts are believed to be important for product repairability (Cordella, Sanfelix, et al., 2019). **Modular products** are easily disassembled without damaging the product, so that the damaged part can be repaired. In the context of textile apparel, modularity leads to trade-offs with comfort, because seams or components joining different parts of the textile apparel create a discontinuity in the fabric in contact with the skin which is usually perceived in terms of discomfort. Additionally, modularity leads to a trade-off with the physical durability because seams are weak parts of textile apparel.

The **use of standard parts** in the textile industry is rather limited mainly due to its intrinsically creative nature. The European Environment Agency identified fasteners as the main textile apparel part that could be subjected to standardization without affecting the creative nature of this industry (EEA et al., 2022). The size, material and attachment method of zippers, buttons, snaps, and other fasteners could be standardised as well as the thickness of the yarns. However, it is difficult to envisage standardization involving the fabric, which is the main part of textile apparel and which is also the part that is most prone to being damaged (**Table 43** in section 9.2.1.3). The standardization of fabric would potentially limit the creative nature of the textile apparel industry.

The **availability of spare parts** in the textile apparel industry should take into account the high number of different collections placed on the market and the real use of these spare parts. Section 5.6 indicated that retailers place on the market up to one collection per week. Making available spare parts for all these different

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[143] ISO 3758:2023 Textiles — Care labelling code using symbols. Available at [this link](). Last accessed on 13 November 2024.

items would imply the manufacture of product parts that most probably would never be used due to the fast changing preferences and attitudes of the users. Additionally, the use of spare pieces of fabric is strictly connected to the fashion trends and user acceptance to wear a product composed by pieces of fabric in a different status (new and worn), which would resemble patches.

Business models

The European Environment Agency estimated that companies working in the textile repair sector decreased in the last decade, reporting that they are small in size and a have a turnover equal to about 0.25% of the apparel textile sales in Europe (EEA et al., 2022). A more detailed analysis of the apparel repair sector is hindered by the way in which collection of this data is performed by Eurostat, which aggregates under the NACE code 95.29 repair of many personal and household goods, including bicycles, books, musical instruments, apparel, etc… ([144]).

In recent years, some fashion brands have started offering repair services to their customers and/or manuals and directions to address some simple repairs of their products, such as replacing a zipper or sewing a button.

Fashion trends depend on many players such as stylists, influencers and fashion brands. They could potentially promote repaired products with for example visible mending and patches, but in reality, such products are not socially accepted in the majority of social gatherings, such as workplaces, parties, etc (Choi et al., 2022; Hong et al., 2024).

User behaviour and economic aspects

The decision of repairing an item of textile apparel is highly subjective and depends on individual values, fashion trends, price, skills and time available to users.

The **emotional attachment** to the product largely influences the decision to repair an item or to replace it with a new one. Textile apparel is more likely to be repaired when it evokes meaningful memories, it is an expression of user identity or provides particular comfort (Page, 2014; Gwilt, 2021; Damhorst, 2019).

The **price of repair** compared to the price of the new item plays a crucial role when the user decides to repair or replace an item of textile apparel. Expensive items tend to be repaired more often than cheap ones due to the cost-effectiveness of the choice (Gwilt, 2021). In particular, if the price of repair exceeds about 40% of the price of the new item, users tend to replace the product rather than repairing it (Cordella, Sanfelix, et al., 2019; Ribeiro et al., 2023). A simple exercise reported in section 10.9.5 shows that in the EU, professional repair operations can be much more expensive than the purchase of a new item. In this context, the user prefers to buy a new item rather than repairing the damaged one.

When a user decides to repair an item, self-repair is the most common practice followed by unpaid repair via associations such as repair cafes ([145]) and lastly via paid support using professional repairer. Besides economic reasons reported above, it seems that this ranking among different options is largely affected by user mistrust of the capabilities of professional repairers and the cost in terms of time that is associated to repairing operations including logistics (Laitala et al., 2021b; EEA et al., 2022; McQueen et al., 2023).

However, self-repair is a viable option only if the user has suitable skills and available time. Usually, users do not have the right skills for self-repair. Although in general women are more likely to repair their defective apparel than men, younger generations, regardless of gender, tend to lack knowledge about the necessary tools, materials and practices (EEA et al., 2022; McQueen et al., 2023; Hernandez et al., 2024). Disregarding user skills, the value given to the time spent in self-repair plays a crucial role when a user decides what to do with their damaged item (Jain, 2021).

Legislative framework and best practices

Currently, there is no legal framework for repair of textile apparel in EU. The promotion of reparability is left to individual fashion brands' voluntary initiatives. However, on 30 July 2024, Directive 2024/1799 on repair of goods ([146]) entered into force, with the aim of promoting repair of goods both within and outside the legal

[144] Eurostat: NACE Rev. 2 – Statistical classification of economic activities in the European Community, available at this link. Last accessed 10 October 2024.

[145] Repair cafes are local no-profit workshops where volunteers repair or help repairing numerous goods, including textile apparel. Available at this link. Last accessed on 11 November 2024.

[146] Directive (EU) 2024/1799 of the European Parliament and of the Council of 13 June 2024 on common rules promoting the repair of goods and amending Regulation (EU) 2017/2394 and Directives (EU) 2019/771 and (EU) 2020/1828 (Text with EEA relevance). Available at this link.

guarantee. Member States have to transpose the Directive into national legislation and apply it from 31 July 2026.

Under Directive 2024/1799, manufacturers of products that are subject to reparability requirements under EU law will have to repair those products within a reasonable time and for a reasonable price. For such an obligation to apply, repairability requirements would have to be set in product-specific legislation, potentially for instance in the future Delegated Act on textile products under the ESPR.

Furthermore, manufacturers are required to make information available about their repair services to consumers in an easily accessible manner and consumers will be able to find repairers more easily through a new online European Repair Platform.

Directive 2024/1799 has also amended the existing Sale of goods Directive (EU) 2019/771 ([147]), adding an additional year to the legal guarantee if the choice is made to repair a product instead of replacing it under the legal guarantee.

9.2.3.2 How to assess repairability

Section 9.2.3.1 reported how emotional attachment, fashion trends and repair price strongly affect the success of reparability for textile apparel. In addition to these aspects, repairability can be assessed via more product-related properties identifying the product parts and describing the level of four key parameters: (1) disassembly complexity, (2) tool accessibility, (3) use of standard fasteners, and (4) repair support resources. **Table 48** provides a description of textile apparel in the context of repairability without taking into account potential trade-offs between reparability and physical durability. These trade-offs will be assessed in Task 5 and 6 of the PS.

[147] Directive (EU) 2019/771 of the European Parliament and of the Council of 20 May 2019 on certain aspects concerning contracts for the sale of goods. Available at this link.

Table 48. Repairability assessment via four key factors

Key parameters	Relatively easy reparability	Relatively difficult reparability
Disassembly complexity It evaluates how easily parts of textile apparel can be separated without damaging the product.	Product parts can be easily separated without damaging the product. This is especially the case when the product is made of only one part. Type of connectors: Temporary seams: Double-stitched or easily accessible seams that can be opened with minimal damage (e.g., simple lockstitch or chainstitch). Fabric Layers: Single-layer designs or modular textile apparel (e.g., detachable lining) are easier to access for repair. Access Points: Visible and accessible access points: Clear, deliberate access points for modifying or replacing specific parts make disassembly easier.	Product parts are difficult to separate without damaging the product Type of connectors: Permanent seams: These are difficult to open without damaging the fabric (e.g., overlocking or serged seams). If the seams must be cut or torn, this lowers the repairability level. Use of adhesives or heat-sealing require specialised tools. Fabric Layers: Layered textile apparel: Items with multiple bonded or fused fabric layers are harder to disassemble without damaging the underlying structure. Access Points: Concealed or no access points: Products without clear areas to begin disassembly or where components are sealed shut.
Tool accessibility It evaluates whether common household tools can be used to repair the product or if specialised tools are needed. This is strictly connected to the type of product failure.	Common household tools are sufficient for repairs. Type of Tools Required: Scissors, needles and thread. Availability of Tools: Commonly found in physical or online stores.	Specialised tools are required to disassemble and repair the product. Type of Tools Required: Industrial or professional tools like sewing machines and similar tools. Availability of Tools: Usually expensive tools available only in professional distribution.
Standard fasteners It evaluates if standard fasteners are used.	Easy to source compatible parts and materials. Use and availability of standardised fasteners: It uses standard fasteners that are easily available in physical and online shops.	Difficult to source compatible parts or materials. Use and availability of standardised fasteners: Unique/proprietary fastener, which are difficult to source.
Repair support resources It evaluates the availability of repair instructions and services.	Availability of repair support. Repair instructions: It includes detailed repair documentation that supports the repair process and it is easily accessible. The guide provides specific instructions tailored to the product via guides, photos, or videos. Repair services offered: Accessible in the region where the product is sold.	Absent or very general repair support. Repair instructions: It lacks of specific repair information. Repair services offered: Not accessible or not available in the region where the product is sold.

Source: own production.

9.2.3.3 Description of products based on repairability characteristics

Following the framework reported in section 9.2.3.2, **Table 49** reports a description of product technologies in the context of repairability. However, the necessary condition for a repairable product is that the price of the repair should be acceptable to the user when compared to the price of a similar new item.

Table 49. Description of product technologies from the repairability perspective

Key parameter	Base Case (BC)	Best Available Technology (BAT)	Best Not yet Available Technology (BNAT)
Disassembly complexity	When products are made of more than one part, their disassembly is highly complex, requiring multiple steps to access damaged parts. The products use standard fasteners, but they are usually hard to access or remove.	When products are made of more than one part, their disassembly has low complexity, with easily accessible parts. The products use standard fasteners, designed for simple removal.	When products are made of more than one part, their disassembly can be performed without tools. The products use fasteners that can be detached and reattached multiple times without damage.
Tools accessibility	The repair operations require basic and specialised tools.	The repair operations require only basic tools.	The repair operations require no tools.
Standard fasteners	Compatible fasteners are available.	Compatible standard fasteners are available.	Compatible standard fasteners are available with personal customization via 3D printers.
Repair support resources	Repair support is very limited, with vague instructions and service limited to portions of the region where the product is sold.	The product has detailed, repair guidance about the failure of most common damaged product parts. Repair services are available in the whole region where the product is sold.	Interactive repair support is available real-time via augmented reality, artificial intelligence or other technologies. Repair services are available in the whole region where the product is sold.

Source: JRC own production.

9.2.4 Waste generation

In this PS, the following definitions were used:

- Textile waste is a textile product which the holder discards or intends or is required to discard ([148]).
- Post-industrial textile waste is textile waste generated during the manufacturing of textile products and their precursors (manufacturing of fibre, yarn and fabric, and during confectioning) (Huygens et al., 2023).
- Pre-consumer textile waste is textile waste generated as a result of discarding unsold textile products.
- Post-consumer textile waste is a textile product that have been discarded after consumption and use by the citizen or end-users of commercial and industrial activities (hotel, care, automotive, etc.). For this reason it is commonly referred to as household and commercial post-consumer textile waste, respectively (Huygens et al., 2023).

Pre-consumer textile waste is generated at manufacturer and retailer stages and it includes the following unsold products:

- Finished products that the manufacturers do not send to their customers due to order change or cancellation;
- Products that were placed on the market but were not purchased by consumers;

[148] The definition of textile waste is inspired by the definition of waste reported by the Waste Framework Directive (WFD). Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance). Available at this link.

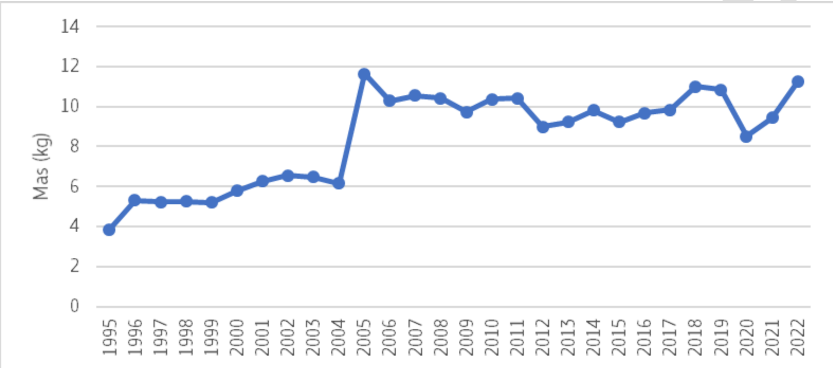
- Products returned to the retailer after being purchased;
- Products that the retailer decides not to place on the market.

This last type of pre-consumer textile waste includes obsolete products belonging to collections that the retailer considers not suitable for the fast changing market, and products that do not meet the retailer' standards, whose remanufacturing is not economically viable (Roberts et al., 2023).

9.2.4.1 Textile waste in numbers

The consumption of textile apparel drives the generation of its waste. **Figure 24** shows that the yearly apparent consumption of an EU-27 citizen increased from about 6 kg before 2005 up to about 10 kg between 2005 and 2022. In particular, in 2019 the EU generated about 6 Mt of textile apparel waste (**Table 50**). A substantial degree of uncertainty exists on these values because Member States and companies have different definitions of textile waste and standards for reporting waste generation, and reporting standards to official databases (e.g. Eurostat) (Huygens et al., 2023).

Figure 24. Apparent consumption of textile apparel per capita in EU-27



Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Table 50. Amount of textile apparel waste generated due to EU consumption in 2019

Type of waste	Mass (Mt/y)	Contribution to the total (%)
Post-consumer	5.2	87
Pre-consumer	0.16	3
Post-industrial	0.64	11
Total	6	100

Source: Huygens et al. (2023)

Post-industrial waste ranges from 25% to 45% of all fabric used in the production (Aus et al., 2021). The quantity of pre-consumer waste is currently considered underestimated mainly due to lack of transparent reporting (Aus et al., 2021; Duhoux et al., 2024).

In terms of fate of textile waste, it is estimated that about 10% of post-industrial and pre-consumer textile waste is recycled, while the rest is incinerated, landfilled or exported to third countries with unknown final destiny. Only about 5% of the post-consumer textile waste is recycled in the EU, about 17% is exported to third countries and the rest is either incinerated or landfilled (Huygens et al., 2023).

Besides textile waste, the textile industry generates waste from packaging, hangers, which are usually made of plastics, and spent chemicals used in the manufacturing stage. Wastewater is also generated, but it is not included in this analysis because it is addressed in section 9.2.6 on environmental impacts as emissions into water (Roth et al., 2023).

9.2.4.2 Analysis of the ecosystem

Although the types of textile waste have some peculiarities, their generation has some common drivers when focussing on business models and user behaviours.

On one hand, the dominant **business models** of many fashion designers, fashion brands and retailers incentivise the continuous consumption of new products:

— placing on the market up to 47 new collections per year (see Section 5.6),

— offering multiple seasonal discounts over the year to incentivise the consumption of products that are considered obsolete, and

— generating a sense of urgency and exclusivity by placing on the market numerous limited editions and using the dark pattern in online sales (see Section 6).

In particular, the brand-led operation model promotes new trends via numerous Fashion Weeks and trade shows all around the world, as well as by advertising the proposals of fashion editors, stylists, celebrities and influencers. Additionally, companies using the consumer-led operation model aim to predict the demand of users via trend forecasting agencies or in-house forecasting models, which lead to overproduction to meet the fast changing requests of as many people as possible in different parts of the world (Roberts et al., 2023; McKinsey & Company, 2024; Brondino, 2022).

On the other hand, **users** choose products based on (1) what is available on the market, (2) what is economically convenient, and (3) what makes them feel good and accepted by others. Therefore, the change of user demand depends on the new trends, and the needs of individuals to self-represent and feel accepted when meeting others at work, in their free time and in special occasions (see Section 6).

The following three subsections deepen into aspects of the ecosystem that are specific to each type of textile waste.

9.2.4.2.1 Post-industrial waste

When focussing on the manufacturing stages, business models and process techniques largely affect the generation of post-industrial textile waste.

As described in section 5.6, the **business model** of European and North American fashion companies rely on the manufacture of companies located in third countries, which operate as:

— Primary suppliers: main suppliers that provide the products directly to the fashion company.

— Sub-contractors: secondary suppliers that primary suppliers might use to fulfil part of their job.

— Licensed suppliers: companies producing goods under a licensing agreement, which allow them to use in third countries the patents and trademarks of the fashion companies.

Within this structure, suppliers are asked to rapidly produce and adapt to the volatile requests of the market, which could lead to changes or even cancellation of orders. Lead time from the concept of the textile apparel to the potential customer purchase could be as short as 15-21 days. This business model challenges a careful design, resource planning, and quality control during the manufacturing processes. As consequence, post-industrial textile waste increases because (Aus et al., 2021; Zhao and Kim, 2021; Fernandez-Stark et al., 2022; Duhoux et al., 2024; McKinsey & Company, 2024):

- The supply chain is characterised by the bullwhip effect ([149]), where suppliers enlarge their inventories to tackle demand fluctuations;
- Suppliers waste part of their inventories when stock location storage becomes limited;
- Suppliers overproduce to benefit from economies of scale;
- Material belonging to cancelled orders is directly wasted rather than remanufactured;
- Lack of manufacturing quality control leads to low-performing products rejected by fashion brands.

Process techniques adopted in the manufacture of textile apparel are crucial elements conditioning the generation of post-industrial textile waste. In particular, key factors include poor planning, inefficient

[149] The bullwhip effect refers to the phenomenon where order variability increases as the orders move upstream in the supply chain. The bullwhip effect is sometimes referred to as 'demand amplification', 'variance amplification' or the 'Forrester effect'. This effect becomes significant when the cost from fluctuations in production/ordering outweighs the cost of holding inventory (Wang and Disney, 2016).

manufacturing systems and cutting methods, as well as suboptimal fabric utilisation (Aus et al., 2021; Khairul Akter et al., 2022).

At the confectioning stage, cutting operations are the largest contributors of this type of waste, followed by mistakes during sewing and damages to fabrics (Aus et al., 2021; El Shishtawy et al., 2022; Vilumsone-Nemes et al., 2023). On one hand, design software like CAD (Computer-Aided Design) and the use of artificial intelligence can optimise the use of fabric and decrease the generation of post-industrial waste by 27% when compared to manual cutting (Krsteva and Demboski, 2011; Palacios-Mateo et al., 2021). On the other hand, sewing operations are semi-manual activities affected by the performance of the machinery and the pressure put on the operators to meet the tight deadlines of rapid production (Aus et al., 2021).

In general, the manufacturing process could be optimised adopting methodologies such as Lean Manufacturing, Total Quality Management, Kaizen, Just-In-Time (JIT) and Lean Six Sigma. The adoption of these methodologies optimise processes, improves the alignment of demand and production and reduces the incidence of defective goods (Saleeshya et al., 2012; Harpa et al., 2024).

However, despite technological developments, there is lack of standardised industrial best practices that enable the reduction of post-industrial textile waste. The authors are not aware of any specific **legislation** in producing countries specifically addressing this type of textile waste.

9.2.4.2.2 Pre-consumer waste

When focussing on the retailer stage, all elements of the waste generation ecosystem play an important role.

Process techniques related to the efficiency of the reverse logistic could decrease the number of destroyed returned products avoiding that more items get lost, damaged or with time become obsolete. The literature reports different improvement potential when adopting the Best Management Practices: pre-consumer waste due to returns could be decreased from 44% to 22% or from 25% to 13%. Moreover, detailed product descriptions, especially on size and fitting, could support informed purchase and therefore reduce the number of returns (Ahlström et al., 2020; Duhoux et al., 2024; Roichman et al., 2024).

The **business model** concerning return policies of the retailer and the marketplace plays a relevant role. To overcome reverse logistic issues, some fashion brands offer an integrated shopping experience that combines e-commerce and physical stores. In this case, customers can purchase online and potentially return in physical stores where they can get customised recommendations (McKinsey & Company, 2024).

The bullwhip effect characterising the manufacturing processes affects invest also retailers, who try to enlarge their inventories to meet the requests of the changing market (Fernandez-Stark et al., 2022; Duhoux et al., 2024; McKinsey & Company, 2024). As a consequence, as soon as fashion trends change, new collections generate obsolete goods that remain unsold. Therefore, items less affected by changing trends and with high demand are less likely to remain unsold (Duhoux et al., 2024).

Section 6.4.4 reported that **users** are not aware of the consequences of returning items of textile apparel after their online purchase – most of them think that the items are always re-sold. The investigation showed that customers find convenient purchasing online when returns are free of charge. In these cases, customers have the opportunity to try and touch the product directly at home without going to the physical store. This opportunity sometimes evolves to the extreme behaviours of bracketing and 'wardrobing'. The former describes users purchasing multiple sizes of the same item and returning those that do not fit. The latter describes consumers purchasing expensive items, wearing them, and then returning them (see Section 10.6.3).

From a **legislative perspective**, the destruction of pre-consumer textile waste is often preferred by companies because there are taxation advantages related to VAT payment (Duhoux et al., 2024). With the entrance into force of the ESPR, from 19 July 2026, the destruction of unsold textile products is prohibited unless derogations apply in cases where destruction is necessary, for instance due to health and safety reasons. Only micro and small enterprises will be exempted from this prohibition. However, the ESPR addresses only the unsold products that are placed on the EU market, while it does not address pre-consumer textile waste generated at manufacturing stage.

9.2.4.2.3 Post-consumer waste

When focussing on the end-of-life of textile apparel, the analysis of reasons for textile apparel disposal sheds light on what mostly affects the generation of post-consumer waste. The investigation reported in Section 6.2.1 highlighted three main reasons:

1. The loss over time of product intrinsic performance,
2. The change in perceived value, and
3. The change over time of the body shape of the user resulting in unfitted textile apparel.

The first reason is strictly connected to the physical durability of the product over aging processes. The second reason is related to the desire or need to change the textile apparel due to changing fashion trends, personal tastes, or social life. The third reason is connected to physiological change of the human body over time.

In addition to these three factors, a study revealed that users are more prone to dispose of cheaper products than of higher-priced items because they usually develop higher emotional attachment to the latter than to the former (Forbrugerrådet Tænk, 2022).

From the **legislative perspective**, the Waste Framework Directive (2008/98/EC) and the recently published revision of the Waste Shipment Regulation (2024/1157) (WSR) ([150]) regulate the management of post-consumer waste in EU and its potential shipment within the EU and from the EU to third countries, respectively. In particular, the proposal to establish Extended Producer Responsibility (EPR) schemes for textiles in all EU Member States should ensure that producers will cover the costs of textile waste management and research and development on e.g. recycling technologies (see Section 4.1.2). Additionally, the WSR allows the shipment of textile waste produced in EU only to non-OECD countries that have expressed their willingness to receive the waste and demonstrate the ability to treat it in an environmentally sound manner ([151]).

9.2.4.3 How to assess and describe product technologies in the context of waste generation

The generation of waste is not an intrinsic property of a single product technology, but rather depends on many elements of its ecosystem, and is driven by the total consumption of textile apparel. Currently, it is not possible to understand if a product was manufactured using specific process techniques and under particular business models. Moreover, it is unknown how many companies use advanced technologies to minimise their post-industrial and pre-consumer waste. Nevertheless, the study of the literature and the consultation with stakeholders reveals that the majority of the products consumed in EU are produced with the business models incentivising overconsumption and overproduction as described in section 9.2.4.2.

To sum up, it is difficult to distinguish BC, BAT and BNAT among the product technologies placed on the market. In the following steps of the preparatory study, the description of waste generation will be modelled taking into account the variability and uncertainties of all factors playing a role: the influence of the dominant business models, user behaviours and the general performances of available process techniques.

9.2.5 Recyclability and recycled content

This section analyses the recyclability and recycled content of textile apparel starting from their definitions reported in section 9.1:

- **Recyclability** is the ability of products after becoming waste to be reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.
- According to the ISO 14021, the **recycled content** is the proportion, by mass, of recycled material, from pre- and post-consumer waste, in a product or packaging.

These definitions will be revised in the end of this section based on the analysis of this specific product aspect.

[150] Regulation (EU) 2024/1157 of the European Parliament and of the Council of 11 April 2024 on shipments of waste, amending Regulations (EU) No 1257/2013 and (EU) 2020/1056 and repealing Regulation (EC) No 1013/2006. Available at this link.

[151] Decision of the Council on the Control of Transboundary Movements of Wastes Destined for Recovery Operations. Available at this link. Last accessed on 18 October 2024.
The Waste Shipment Regulation (2024/1157) prohibits the exports of textile waste (Basel Convention entry B3030) destined for recovery in countries to which the OECD Decision does not apply. Specific countries can be included via a Delegated Act (see Article 41).

9.2.5.1 The ecosystem of recyclability and recycled content

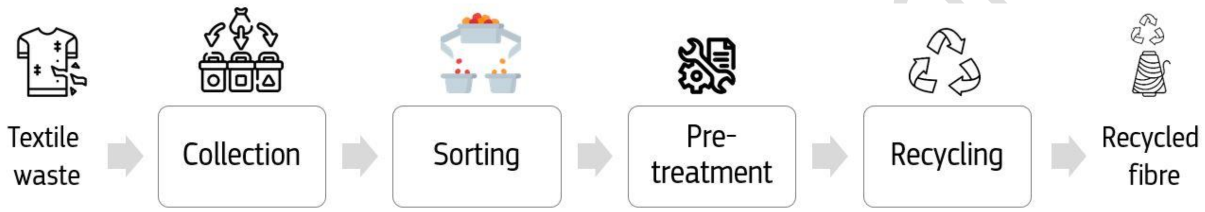
Process techniques and design choices

Figure 25 shows the description of the recycling system of textile waste aiming to produce recycled fibres.

In the first place, textile waste is collected separately from other waste fractions and is subsequently sorted following criteria that depend on the techniques used in the following stages of the recycling system. Then the waste is treated to prepare the material for the following process and finally it undergoes the actual recycling process that results in a recycled fibres output. The recycling process includes recycling techniques and potential further treatments to obtain the recycled fibre ([152]). **Figure 25** does not include the transportation of the waste potentially occurring between different processes because it is not relevant to the analysis performed.

In this section, only the waste undergoing recycling will be described but the reader should keep in mind that the waste management of textile waste includes all processed described in Section 10.2.8.

Figure 25. Recycling system of textile waste



Source: own elaboration using icons from www.flaticon.com

The separate **collection** of textile waste guarantees that this waste fraction can enter the recycling system.

Since post-industrial textile waste is managed by manufacturers, the waste is already separated from other waste fractions and it is directly delivered to other actors of the value chain. When the waste is generated at fibre stage, the spinnable part is usually reintegrated in the manufacturing process, whereas the non-spinnable part is usually given to other actors of the value chain for further applications, such as nonwovens filters, insulation, and filling (Boschmeier et al., 2024). When the waste is generated during spinning, broken ends of slivers and laps are usually reintegrated in the manufacturing process, whereas waste from blow-room machines and carding is usually given to other actors of the value chain for further treatments or applications (Bedez Ute et al., 2019). Differently, when the waste is generated during the manufacturing of fabric or confectioning, manufacturers may send the waste to specialised companies for further treatments or disposal.

Similarly to the post-industrial textile waste, the pre-consumer textile waste is managed by manufacturers and retailers. Also in this case, the waste is already separated from other waste fractions and it is directly delivered to other actors of the value chain.

The separate collection of post-consumer textile waste includes pick-up and drop-off schemes. Pick-up schemes involve scheduled collection routes targeting specific waste types, such as bulky or frequently disposed waste. In pick-up schemes, consumers are usually provided with containers, especially in door-to-door or kerbside collection. Alternatively, drop-off schemes require individuals to deliver their waste either to designated containers or through take-back systems offered by retailers. In Europe, post-consumer textiles waste are mainly collected via drop-off containers (Huygens et al., 2023).

In the recycling system, **sorting** is relevant mainly for post-consumer waste. Post-industrial waste and pre-consumer waste do not need to be sorted because at the generation site, manufacturers and retailers, the waste is already segregated according to similar characteristics, such as cut-offs of the same fabric, or the unsold items belonging to the same collection. However, returned items could be an exception – according to the retailer logistics, this waste could need to be sorted.

[152] This happens because the output of recycling techniques can be an intermediate product that needs to be further treated before becoming a recycled fibre. **Table 51** provides more details.

At sorting facilities, items are sorted according to their reusability, composition and colour. The sorting criteria are set by second-hand traders and recyclers looking for items with specific characteristics. There are mainly three types of sorting techniques (EuRIC, 2021):

- Manual sorting relies on human inspection of the waste. It is particularly accurate, especially when sorting reusable items, but it is labour-intensive and takes a relative long time.
- Automated sorting uses machines equipped with near-infrared (NIR) spectroscopy to identify the colour and the surface composition of the items. It is fast, but it not as accurate as human inspection.
- Hybrid sorting combines human inspection with automation to balance accuracy and efficiency.

The sorting process is mainly challenged by the difficulty to accurately identify the fibre composition of the textile waste. On one hand, the reading of the fibre composition reported on labels is time consuming if done with human inspection. Information is not necessarily accurate or it could be even not accessible due to absence of the label or removal of the writing due to ageing processes. On the other hand, the use of near-infrared spectroscopy has difficulties when used for multi-layered items, or on items with layered fabrics, whose outer fibres are different from the inner ones.

After sorting, the waste undergoes **pre-treatment**, which optimises the material processing in the specific recycling technique to be used. Usually, during pre-treatment, non-textile parts are separated from the parts containing fibres. This is commonly done manually, with loss of some part of the fabric, while new process techniques use mechanical separation together with shredding of the waste. Alternatively, other new process techniques allow disassembly of waste in cases where specific stitches have been used for the confectioning. These stiches can be loosened or dissolved under specific electromagnetic or heat treatments, respectively. During pre-treatment, fabrics are usually shredded to improve the efficiency of recycling technology adopted in the following step of the recycling system.

Table 51 reports the status of the **recycling techniques** in 2023. Available techniques were described via their feedstock, the main recycling output, the possibility to deal with disruptors and their maturity. Each technique can process feedstock with specific characteristics and can provide recycled fibres with specificities that affect their application in textile products. Additionally, disruptors like non-textile parts, dyes, coatings, and undesired fibres (e.g. elastane) could be an obstacle for some techniques, but not for all of them. The level of maturity of the techniques refers to 2023, but the general picture could rapidly change given the fast technical evolution of the sector.

Table 51. Status of recycling techniques for textile waste in 2023

Recycling technique	Feedstock	Main output	Disruptors	Maturity of the technique and comments
Mechanical recycling	Textile waste almost exclusively constituted of cotton, wool, or synthetic fibres. Blends are usually not processed.	Recycled fibres are shorter than virgin fibres.	Non-textile materials have to be removed. Fibre contaminants and colours of feedstock will be transferred to recycled fibres. This usually requires colour sorting before recycling.	It is the most commonly used technology at scale. Recycled fibres have lower mechanical properties than virgin fibres. This usually forces the use of recycled fibres with virgin fibres. The mechanical characteristics of the recycled fibre limit its application. A portion of recycled fibre is usually not spinnable. The physical and mechanical characteristics of the recycled fibres highly depend of the status of fibres used as feedstock.
Thermo-mechanical recycling	Textile waste constituted of fibres based on thermoplastic polymers. High purity is required. Input textile waste should consists only of one polymer type (e.g. acrylic, nylon, polyester) or of compatible polymer types.	Polymers in the form of granulate or fibres	Non-textile materials have to be removed. Pigments and dyes remain in the output material.	It is at about TRL=7. During the process the polymers/fibres are deteriorated. Thus, recycled fibres should be blended with virgin fibres.
Chemical recycling for cellulosic fibres	Textile waste mainly constituted of cellulosic fibres. Presence of impurities and non-targeted fibres decreases the efficiency of the process. A specific process step removes impurities and non-targeted fibres.	Regenerated cellulose as pulp.	Non-textile materials are removed before or during the process. A process stage removes dyes and finishes. It has a bleaching step similar to the traditional wood pulp production.	Most technologies have reached high readiness (TRL=7-9). This is particularly true for feedstock with pure cotton. The potential degradation in length and strength of the cellulosic fibres influences the performance of the regenerated pulp.
Chemical recycling for synthetic fibres (mainly PES and PA6)	Textile waste constituted of at least 80-90% PES or PA6.	PES or PE6 monomers/oligomers.	Non-textile materials are removed before or during the process. Contaminants like dyes can be handled to achieve homogeneous colours of recycled monomers/oligomers.	Depolymerisation techniques processing PA6 are operational at scale. Techniques processing PES have TRL=4-7 and are expected to enter the market within less than 5 years.

Recycling technique	Feedstock	Main output	Disruptors	Maturity of the technique and comments
Chemical recycling for wool-rich blends or polycotton fabrics	Textile waste rich in wool, or textile waste made of polycotton. A degree of contamination is accepted by specific techniques.	Depending on the process, the output is: - wool fibres ready for carding; - cellulosic pulp; - PES fibres, polymers, or monomers.	Non-textile materials are removed before or during the process. Colours can be removed also via bleaching.	Wool recycling using hydrochloric acid is at operational scale. The solvent-based dissolution and filtration technique used for polycotton is currently at TRL=5-6. The hydrothermal techniques used for polycotton are at TRL=6-7. The enzymatic technique used for polycotton is estimated to be at TRL=5.
Thermo-chemical recycling via pyrolysis and gasification	Textile waste with any fibre composition.	Syngas or pyrolysis oil, which could serve as a basis to produce methanol and then transform the methanol in different monomers for later polymer production.	Non-textile materials are removed before or during the process.	Pyrolysis has already been implemented as industrial scale (TRL 9), but applications for textile waste treatment are unknown. Syngas and pyrolysis oil are usually used as fuels.

TRL: Technology Readiness Level, which is a 9-grade scale. TRL=1: Basic principles observed; TRL=2: Technology concept formulated; TRL=3: Experimental proof of concept; TRL=4: Technology validated in lab; TRL=5: Technology validated in relevant environment (industrially relevant environment in the case of key enabling technics); TRL=6: Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling techniques); TRL=7: System prototype demonstration in operational environment; TRL=8: System complete and qualified; TRL=9: Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space).

PES: polyester; PA6: polyamide/nylon 6; Polycotton: blend made of cotton and polyester

Source: own elaboration based on (Duhoux et al., 2021; Lu et al., 2023; Huygens et al., 2023) and inputs from stakeholders.

Overall, the most used recycling technique is mechanical recycling which processes mono-fibre textiles, preferably cotton and wool. Blends are not usually processed with mechanical recycling because the output would be a mix of fibres with different properties that have very difficult application in textile products. This happens because the characteristics of the feedstock are directly transferred to the recycled fibres, which in addition have lower mechanical properties than fibres in the feedstock. These characteristics of the mechanically recycled fibres largely limit their applications and force to spin recycled fibres with virgin high-performing fibres (**Table 51**).

Chemical recycling of man-made cellulosic fibres is also implemented at operational scale, especially when feedstock is made of pure cotton, even though process capacities in the EU are still low. Also regenerated cellulosic pulp has fibres with lower length and strength compared to the feedstock. Thus, mixing the recycled material with virgin material helps improving the performance of the yarn containing recycled cellulosic fibres.

In chemical recycling of synthetic fibres, a different output is obtained processing polyamide-rich textiles via chemical recycling for nylon 6 (PA6 – polyamide), where the monomers can be further processed to build a synthetic fibre with characteristics comparable to the virgin material (**Table 51**).

Table 51 shows that blends are still difficult to recycle – only wool recycling using hydrochloric acid and depolymerisation techniques processing PA6 are implemented at scale. This represents a big technological challenge that should be addressed because the majority of textile apparel placed on the EU market is made with blends of natural and chemical fibres (48-60%). Single-fibre products account for smaller shares: 18-28% made of cotton, and 11-17% made of polyester (Refashion, 2023; Bakowska et al., 2025).

This analysis allows to better understand information reported in **Table 21**, which shows that recycled fibres represent a very low share of the market and that the most recycled ones are wool (7%), polyamide (PA) (2%), cotton (1%), and MMCF (0.5%). Polyester is not included in this list because polyester fibres of recycled origin are currently manufactured from PET derived from packaging (separately collected plastic beverage bottles).

Currently, the type of textile waste processed for the production of recycled fibres is mainly post-industrial. Also pre-consumer waste is used, but in lesser quantity. This happens because these types of waste:

- Are available at manufacturing or retailing sites, thus they are already segregated from other waste fractions;
- Do not need to be sorted, because they already are when generated;
- Are constituted by undamaged and clean fibres;
- Have known composition.

In particular, post-industrial waste has no non-textile parts and is often free of coatings and other disruptors for the most used recycling techniques. This means that it can often be further processed without prior pre-treatment.

Conversely, post-consumer waste has largely not been used as feedstock until now because its treatment is more challenging and expensive than the other waste types. The reasons for this are that: (1) post-consumer textile waste needs to be segregated from other waste fractions and sorted; (2) fibres are damaged, which would result in less performing mechanically recycled fibres; (3) requires fibre and chemical composition to be analysed – see sorting techniques. Although post-industrial and pre-consumer textile waste are currently the cheapest option, the resulting recycled fibres are still more expensive than virgin fibres.

At present, textile products including recycled fibres report their recycled content either via a manufacturer declaration, or via a third party verification system. Since there is no laboratory test capable of determining the recycled or virgin origin of fibres, the only possible verification tool has to rely on chain of custody systems.

The study of the literature and the preliminary exchange with stakeholders revealed that designers and recyclers have apparently opposite needs. The former uses fibre blends, dyes, coating and other current recycling disruptors to improve the performances of the textile product and simultaneously meet the taste of the users, who would like to buy products at low price (see section 9.2.1.1). The latter, due to the current status of recycling techniques (see **Table 51**), would need to process textile products made with only one fibre and carrying a minimum amount of disruptors.

Business models and user behaviour

A recent analysis performed by the JRC reported that recycling is not adequately in place and that the lack of a strong business case for recycling has negative effects on the business case of other economic actors in the recycling system, such as collectors and sorters (Huygens et al., 2023).

The main barrier to the development of a market for recycled fibres results from the general low cost of products: from the raw material to the final product placed on the market. Textile products containing recycled fibres are more expensive than the same products made only of virgin fibres. The research conducted by the JRC found that the insufficient internalisation of externalities in the global textile supply chain produces economic market barriers to recycling. Therefore, the economy of scale for the establishment of a profitable recycling system is challenged due to (Huygens et al., 2023):

- Technical limitations in recycling techniques (see **Table 51**);
- The design of non-recyclable textile products (technological externalities);
- Risk aversion to adopting recycled fibres by the next value chain user (consumption externalities);
- The cost associated to the identification of feedstock characteristics suitable for the specific recycling technology.

Despite the problem highlighted above, there are some fashion brands promoting the use of textile apparel with recycled content. Additionally, the preliminary exchange with some stakeholders revealed that a few large fashion brands are also promoting the collaboration between designers and operators in the recycling system to design recyclable textile apparel.

With a growing interest in textile products containing recycled fibres, there should be also a growing demand for certification schemes based on chain of custody systems capable of tracking the source of the recycled fibres used.

Users contribute to increasing the demand for textile products containing recycled fibres. The analysis performed in Section 6.2.7 revealed that it is mostly young and educated individuals usually look for these products. The investigation performed by Pranta et al. (2024) revealed that individuals with higher income have a higher likelihood to purchase textile products with recycled content compared to individuals having a lower-income. This confirms the difficulty of recycled fibres to compete with virgin fibres.

Legislative framework

The legislative framework addressing the recycling system could be described focussing on the types of textile waste.

Post-industrial textile waste is not subject to any specific legislation in the EU nor in producing third countries. The Waste Framework Directive (2008/98/EC) only establishes generic objectives to prevent waste generation but contains no specific provisions addressing this type of waste.

Pre-consumer textile waste is addressed by the ESPR, which prohibits the destruction of unsold textile products in the EU. Only micro and small enterprises will be exempted from this prohibition. However, the ESPR only addresses unsold products in the EU, while it does not address pre-consumer textile waste generated at manufacturing stage in third countries. The authors are not aware of any legislation in third producing countries addressing pre-consumer textile waste.

Post-consumer textile waste is addressed by the Waste Framework Directive (2008/98/EC) and the newly published Waste Shipment Regulation (2024/1157) (WSR) ([153]), regulating the management of post-consumer waste in EU and its potential shipment within the EU and from the EU to third countries, respectively. In particular, the proposal to establish Extended Producer Responsibility (EPR) schemes for textiles in all EU Member States should ensure that producers will cover the costs of textile waste management and research and development on e.g. recycling technologies (see Section 4.1.2).

9.2.5.2 How to assess recyclability

The analysis of the ecosystem reported in the section 9.2.5.1 suggests to address recyclability with an integral and dynamic approach assessing the evolution over time of all elements of the recycling system, from the

[153] Regulation (EU) 2024/1157 of the European Parliament and of the Council of 11 April 2024 on shipments of waste, amending Regulations (EU) No 1257/2013 and (EU) 2020/1056 and repealing Regulation (EC) No 1013/2006. Available at this link.

feedstock to all process techniques involved. To this aim, in the framework of this PS, a recyclable textile apparel must have the following five characteristics, which apply as soon as it becomes waste:

1. It can be effectively collected;
2. It can be sorted, i.e. segregated from other textile waste and sent to the subsequent suitable recycling pathways;
3. It can be pre-treated before recycling, or can be sent directly to recycling without specific pre-treatment;
4. Its fibre content can be fully used as feedstock for one or more recycling techniques to produce recycled fibres usable in textile products;
5. It has no elements or substances in amounts that disrupt the collection, sorting, preparation for recycling and recycling, or that limit the use of the recycled fibre.

Therefore, textile apparel that meets all these five characteristics is considered to be recyclable, otherwise it is not recyclable. This integrated approach was chosen to assess the recyclability of textile apparel because all elements in the recycling system are important. This integral approach based on these five characteristics is a similar approach used by the French Law n° 2020-105 ([154]) to define recyclable textile products.

The approach proposed in this PS does not include any geographical limitation of the processes involved, because it assumes that the recycling system will comply with the provisions on environmentally sound management of waste under the WSR, where it is required that the requirements applied in the country of destination ensure a similar level of protection of human health and the environment than the requirements stemming from Union legislation. Moreover, it does not refer to specific characteristics of the feedstock or particular process techniques, because it aims to promote the technological evolution from the perspectives of the product design, sorting and recycling techniques.

Point 4 of the approach guarantees the successful application of the recycled fibre into any textile product. This choice takes into account: (a) the objective of the Textile Strategy to close the loop of materials in textile products, (b) the current technological limitations described in section 9.2.5.1, and (c) the fact that the application of recycled fibres into textile apparel will be described/promoted via the recycled content (see section 9.2.5.4).

Despite its integral and dynamic nature, this approach is in line with the generic definition of recyclability reported in section 9.1, which is inspired by the WFD. Moreover, this approach is applicable in the same way to all products in the scope of the PS, making no necessary any categorization in the context of recyclability.

On the assumption that mandatory EPR for textiles based on the Commission proposal to amend the WFD is adopted, upon its entry into force, it will support this integrated approach because economic operators (i.e. fashion brands and retailers) placing products on the EU market would pay eco-modulated fees to support the waste management of textile apparel. It is envisaged that eco-modulation of EPR fees for textiles will be based on future ecodesign criteria, which could include recyclability requirements. In this framework, designers and economic actors of the recycling system will be invited to work side-by-side to place on the EU market recyclable products.

The proposed approach will need to be complemented by a standardised verification system assuring that the textile apparel indeed complies with the five characteristics reported above.

9.2.5.3 Description of the product technologies in the context of recyclability

In the framework of recyclability, the product technologies could be described as follows.

- BC are not recyclable;
- BAT are products that currently can be processed by techniques reported in **Table 51**, which are implemented at scale, i.e. (1) single-fibre textile apparel recycled with mechanical recycling, (2) pure cotton textile apparel recycled with chemical recycling for the production of MMCFs, (3) PE6-

[154] LOI n° 2020-105 du 10 février 2020 relative à la lutte contre le gaspillage et à l'économie circulaire. Available at this link. Last accessed on 22 October 2024.

rich textile apparel recycled with chemical recycling for synthetic fibres, and (4) wool-rich blends recycled with chemical recycling based on hydrochloric acid.

— BNAT are products that can be processed with techniques at intermediate maturity level reported in **Table 51**.

However, the definition of these BAT and BNAT establishes some biases in terms of fibre composition and absence of specific components or substances in the product, which does not reflect the technological neutrality pursued in this PS. The development of design options in Task 6 will address this lack of technological neutrality.

9.2.5.4 How to assess recycled content

The analysis of the ecosystem related to recyclability and recycled content suggests to connect the assessment of the recycled content with the recyclability of the textile apparel and with the type of textile waste treated. The assessment takes into account two main aspects:

- The availability of recyclable textile apparel, which implies the production of a recycled fibre with performances suitable for the use in textile apparel;
- A verification system capable to track fibres coming from post-consumer textile waste.

The first aspect is very much connected to the definition of recyclable textile apparel reported in section 9.2.5.2. This connection allows to close the loop for fibres used in textile apparel and guarantees the availability of recycled fibres. Only if recyclable textile products are placed on the market, there will be availability of recycled fibres to be used in new items. In particular, the reference to the performance of recycled fibres takes into account the technological developments in spinning techniques, which over time will be capable to spin fibres with lower performances.

The second aspect narrows down the type of textile waste that can be used to produce the recycled fibres. **Table 52** reports a description of the three types of textile apparel waste in the context of recyclability and recycled content. Although post-industrial and pre-consumer textile waste have evident technical advantages when they are used to produce recycled fibres, they are often the result of overproduction, overconsumption and can be also attributed to inefficiencies in the production system (section 9.2.4.2). The inclusion of post-industrial textile waste as a source of the recycled content for new textile apparel could incentivise the generation of this type of waste. Furthermore, this textile waste type is also the only one that is not specifically regulated (**Table 52**).

The second aspect excludes the use of pre-consumer waste because its generation is not fully regulated. When it is generated at manufacturing stage outside EU, it is not addressed by any legislation. When it is generated at manufacturing and retailer stages in EU, it is addressed by the ESPR, which forbids the destruction of unsold textile products in the EU. However, the ESPR does not address pre-consumer waste generated by micro and small enterprises. Also the inclusion of these types of textile waste as the source of the recycled content of a new item would incentivise their generation especially when it occurs at manufacturing stage outside EU (**Table 52** and section 9.2.4.2). Sections 5.1 and 5.2 report that the largest majority of the EU consumption is affected by the production occurring outside EU.

Therefore, in the framework of the PS, the definition of recycled content should be narrowed down compared to that reported by the ISO 14021 and used in section 9.1. Following the two aspects reported above, *the recycled content is the proportion, by mass, of recycled fibres coming from recyclable textile apparel disposed of as post-consumer waste*.

The recycled content of a new textile apparel is fibre-specific, and it is also specific to the function that the item must provide. For this reason, all products included in scope are described by the framework reported in this section. A categorization of the products in scope based on the types of fibres and the specific function to be provided by the item would result in a disproportionate number of categories, which would not meet the aims of the PS.

Table 52. Description of the textile apparel waste in the context of the recyclability and the recycled content

Characteristic	Post-industrial	Pre-consumer	Post-consumer
Status of the material	Undamaged and clean fibres.	Undamaged and clean fibres.	Worn material with damaged fibres. It is often relatively dirty, with various form of stains and moist content, generating mould and hygienic problems.
Non-textile components	Absent	Present	Present
Knowledge of fibre composition	Known and detailed by the manufacturer.	Based on what is reported on the label in accordance with the TLR. The reading of one label allows the identification of fibre composition of the entire collection.	Based on the analysis of the item's surface via infrared spectroscopy.
Degree of heterogeneity	Very low – homogeneous waste	Low	Very high
Location of generation	Manufacturing stage (available in producing countries, which are mainly countries in Asia - see Sections 5.1 and 5.2)	- Manufacturing stage (available in producing countries, which are mainly countries in Asia - see Sections 5.1 and 5.2) - Retail stage (available in EU)	User stage (available in EU)
Sorting	Not always needed, because it is already sorted in the moment of generation.	Not always needed. - Products belonging to collections that not reach the customer are already sorted; - Returned products could need some sorting depending on the retailer logistic.	Needed
Pre-treatment	It is ready for recycling because it includes mainly cuts of fabrics. Potentially, only shredding is needed.	Needed	Needed
Regulating legislation	Most of the production occurs in Asian countries, where the authors did not find any legislation addressing the generation of this type of waste. Very little production occurs in EU. The generation of post-industrial waste generated in EU are not specifically regulated. The WFD sets only generic objectives to prevent waste generation. The shipment of post-industrial waste generated in EU is subjected to the WSR. The material described here as post-industrial waste could in some Member States be also identified as a by-product, which would put it out of the scope of the WSR.	Waste generated at manufacturing stage: - Not addressed by any legislation identified by the authors if production occurs outside EU; - Addressed by the ESPR, which bans destruction of unsold products, with exemption only for micro and small enterprises. Waste generated at retailer stage are addressed by the ESPR, which bans destruction of unsold products, with exemption only for micro and small enterprises. The shipment of post-industrial waste generated in EU are subjected to the WSR. However, unsold products that did not become waste are outside the scope of the WSR.	This type of waste is fully generated in EU and is addressed by the WFD (EPR and EoW), and the WSR.

TLR: Textile Labelling Regulation (1007/2011)
ESPR: Ecodesign for sustainable Product Regulation (2024/1781)
WFD: Waste Framework Directive (2008/98/EC)
EPR: Expended Producer Responsibility, under the WFD
EoW: End-of-Waste criteria, under the WFD
WSR: Waste Shipment Regulation (2024/1157)
The analysis does not include transportation of the waste because it depends on the location of the treatment facilities.

Source: own production

9.2.5.5 Description of the product technologies in the context of recycled content

In the framework of the recycled content, the base case of the product technologies would have no recycled content (see **Table 21**). Differently, the identification of BAT and BNAT should distinguish fibres and product functions.

In general, when constructing fabrics, knitted products are generally better suited for incorporating mechanically recycled fibres due to their more flexible structure compared to woven fabrics (Boschmeier et al., 2024). However, a notable exception is represented by denim trousers, which can incorporate up to 20% post-consumer recycled material (Kuppen, 2024).

9.2.6 Environmental impacts

The product aspect on 'environmental impacts' is defined as any change to the environment, whether adverse or beneficial, wholly or partially resulting from a product during its life cycle.

This section analyses the elements affecting the environmental impacts generated by the consumption of textile apparel in EU to best describe the product technologies. Therefore, the analysis reported in this section does not aim to give a comprehensive overview of the environmental impacts caused. Task 5 of the PS will include a comprehensive environmental assessment of the base case of products included in the scope.

9.2.6.1 The ecosystem affecting the environmental impacts

Process techniques

For each stage of the life cycle of the product, there are numerous process techniques that contribute to the product development. Each of those techniques have different environmental performances. Therefore, the choice of process techniques plays a key role in the environmental impacts of textile apparel.

Different levels of environmental impacts, related to specific process techniques, can be seen in production stages such as yarn manufacturing. A range of spinning techniques is available. Ring-spinning is the most commonly used in the textile industry due to its versatility in terms of the range of fibres that can be processed. Its main advantage is that it produces finer and stronger yarns than other spinning techniques due to good fibre control, orientation and alignment during spinning. However, it has high rates of power consumption, caused by the necessity of rotating the bobbin at a rate of one turn for each twist inserted. In contrast, open-end spinning was developed in an attempt to overcome the speed limitations of ring spinning. Another advantage is a reduction in energy consumption (Elhawary, 2015a). In the case of wool spinning processes, significant differences can be seen between fabric derived from carded yarn (woollen process) and fabric manufactured using combed yarn (worsted process) in terms of the quantity of lubricants applied, with 5% in the former and 2% in the latter (Roth et al., 2023).

Knitting is a mechanical process and involves knotting yarn together with a series of needles. The main knitting production methods are straight knitting, fully fashioned knitting, integral knitting, and complete textile apparel knitting. Straight knitting most commonly relies on the weft technique, which consists of using one continuous yarn which is fed to and looped in rows by one or more needles at a time. Fully fashioned knitting machines can produce custom-shaped sheets of fabric by adding/removing the stiches, so that there is little or no need for cutting panels, reducing the amount of discarded material. Integral knitting is an advancement of the fully fashioned knitting technique. An integral knitting machine is able to add additional trimmings as an integrated part of the fabric panel, reducing fabric losses from cutting, as well as sewing requirements. Finally, complete textile apparel knitting machines are able to knit complete textile apparel, eliminating the cutting and sewing steps altogether, decreases raw material consumption and producing higher-quality textile apparel (Roth et al., 2023).

Another example of these differences can be seen in the dying process, in this case in terms of water consumption. In batch dyeing, a certain amount of textile material is loaded into a dyeing machine and brought to equilibrium with a solution containing the dye and the auxiliaries. An important parameter in dyeing is the liquor ratio of the equipment: the weight ratio between the total dry material and the total liquor (a liquor ratio of 1:10 means 10 litres of water for 1 kg of textile material). This parameter not only influences the amount of water and energy consumed in the dyeing process, but also plays an important role in the level of exhaustion of the dye and in the consumption of chemicals and auxiliaries. Dyeing machines vary greatly in their liquor ratios, depending also on the type of substrate to be dyed and its hydrophilicity. For instance, in woven and knitted fabrics, liquor ratios can vary from 1:2 in airflow equipment, to 1:40 in winch beck equipment (Roth et al., 2023). These differences will significantly influence the environmental impacts of final products. Dyeing can also be carried out in batch or in continuous/semi-continuous mode. Batch dyeing processes generally require higher water and energy consumption than continuous processes. Continuous and semi-continuous dyeing processes consume less water, but this also means a higher dyestuff concentration in the dye liquor.

The term finishing covers all those treatments that serve to impart to the textile the desired end-use properties. These can include properties relating to visual effect, handle and special characteristics such as water and fire proofing. Finishing may involve mechanical/physical and chemical treatments. Among textile finishing processes, chemical ones are the most significant from the point of view of the emissions generated. As in dyeing, the emissions are relatively different between continuous and discontinuous processes. Continuous finishing processes do not require washing operations after curing.

Finally, in terms of waste management techniques, a number of options are available, from landfilling and incineration, to mechanical recycling. In this case, as reported in Solis et al. (2024), recycling is a preferred pathway for most of the environmental impact categories.

In essence, the wide variability of process techniques available to manufacture textile apparel has a fundamental relevance on the environmental impact of final products.

Business model of economic operators in the ecosystem

Companies have multiple choices in the definition of their strategies and business models. These choices imply different levels of environmental impact of the final product.

As described in Section 5.5, two main models can be identified in the textile apparel industry (DG GROW, 2021a). A consumer-led model, where the requests of the consumer are the centre; and a brand-led operation model, where the brand dictates the design and the manufacture. Other classification of business models can also be made. For instance, in terms of supply chain approach. On one hand, there is the integrated approach, where the production is entrusted to internal suppliers and the logistics aims to quickly react to customers' demands. On the other hand, there is the centralised approach, where the production is mostly outsourced and supported by audit and quality control programmes. Hybrid versions of those business models can also be found. Each business model has different characteristics, each of them with different implications on the environmental impact of products. In this section, a brief description of these characteristics is made.

The trend turnover is a fundamental factor that defines a business model. Some companies opt to implement business models characterised by continuous novelty and disposable trends in constant change (Centobelli et al., 2022), designing their products for rapid trend turnovers through obsolescence and early disposal. Other companies, in contrast, implement business models with less frequent trend turnovers, focusing on product durability and reverse logistics. The number of seasons or trends that are placed on the market largely affects the environmental impacts. Rapid trend turnovers tend to drive consumers (directly or indirectly) to replace clothes, even when it is still not necessary from technical perspective.

Related with trend turnover is production time, which refers to the time between the design of the product and the availability of such product for the consumer. Production time largely affects several aspects of the supply chain, from procurement to manufacturing capacity, planning and inventory management. Shorter production times increases the probability of manufacturing errors. This also increases the generation of waste, due to the required destruction of products that cannot be sold (see section 9.2.4). Shorter production times also requires the use of air transport, rather than cargo ships, increasing the environmental impact of the distribution stage.

The location of different stages of the supply chain also affects the environmental impact of products. Many companies outsource the transformation process of raw materials into completed textile apparel to third countries, often to allow access to low-cost labour and less stringent environmental regulations, such as water or air emission levels which are less ambitious than in the country of origin (Centobelli et al., 2022). If the numerous stages of the supply chain are scattered over the globe, more transport is required, increasing the environmental impact of the distribution stage.

The location of different stages of the supply chain also affects the energy source used to produce textile apparel. The manufacturing of textile apparel is energy intensive. Each country has a different energy mix ([155]) that has a significant influence on the impact of the final product.

[155] A different combination of energy sources to produce electricity

Different environmental impacts can also be expected, related with the ownership of the apparel. There are companies that opt for renting products rather than selling them to individuals. When a product is rented, it has the possibility to be used by more consumers. This is particularly true for products that are not used very frequently –such as gala dresses- or for products that quickly become unusable –such as clothes for children-. In principle, products sold under this business model (sold as a service rather than a product) produce lower environmental impacts, due to the higher intensity of use among different users across their lifetime.

Textile apparel that is commercialized as a service (rented, shared, etc.) will need higher levels of physical durability, which can require for example a more dense fabric with higher amount of fibres and electricity compared to products with lower performances. This, among other process techniques imply different levels of environmental impacts of the final product.

In essence, decisions made by companies in terms of the business model implemented to place textile apparel on the market have a significant relevance on the environmental impact of the final product.

User behaviour

User behaviour is an important aspect that affects the environmental impact of textile apparel.

Consumers influence the environmental impact of clothing when they make purchase decisions. Apparel is often bought spontaneously, simply because leisure and fun are associated with the act of buying clothes. Only a minority of consumers inform themselves correctly before buying apparel (Kleinhückelkotten et al., 2018b). When a consumer chooses to acquire a product that has been placed on the market under a business model based on fast trend turnovers and short production times, they are contributing –possibly unknowingly- to the environmental impacts associated with that business model. The amount of products that are purchased also influences overall environmental impact of clothing.

Consumers also have an influence on the environmental impact of textile apparel, depending on the way they use and maintain these products. Using clothes in the right environment contributes to increase their lifespan. Storing and folding apparel may also have an influence on the lifespan of apparel, since it may affect their intrinsic quality.

Related with product use are the unwritten social rules that govern specific gatherings, such as workplaces, celebrations such as weddings or regional festivities that last several days. In these events, it is expected that attendees will not wear the same apparel on different days. The expectation is that different apparel will be worn on different days, even when it is not necessary from technical point of view. This contributes to an increased consumption and production of textile apparel, and therefore to their environmental impact.

Maintenance activities can also contribute to increase lifespan of products and avoid (or delay) the acquisition of new products, minimising the overall environmental impact. Clothes must be sorted appropriately before washing to avoid premature deterioration. On occasions, consumers use quantities of detergent and softeners which are merely based on their perception, rather on manufacturers' recommendations (A.I.S.E, 2017a), potentially increasing the impact of the product use stage. In terms of washing, water temperature and washing frequency are not always optimised, contributing to an excessive consumption of energy. Drying can be performed either naturally or using dryers, a choice which is highly related with user choice, availability of space in the household or geographic location. The choice of clothes that do not need ironing –or that require less frequent ironing- can also have an influence on the environmental impact of the final product.

Consumers also have an effect on the environmental impact of textile apparel when they make decisions related with its end of life. As pointed out in section 10.6.3.1, this is influenced by the individual characteristics of the consumers, their habits, demographic context, product traits and perceived quality (Cluver, 2008b; Goworek, Lynn Oxborrow, et al., 2020). Perceived quality of the product is a decisive factor to discard textile apparel (Aakko and Niinimäki, 2021). Low perceived quality also triggers early disposal (Piippo et al., 2022b). This is also magnified by the loss of symbolic value given by the consumer (Gwozdz et al., 2017b). Discarding products when they are still technically functional increases their environmental impact, due to a low intensity of use.

In essence, user behaviour of textile apparel can have a significant relevance in the environmental impact of final products.

Legislative framework and industrial best practices

The legislative framework has an influence as well on the environmental impact of final products.

In the EU, the Industrial Emissions Directive aims to reduce industrial pollution by requiring industries to adopt preventive measures and use the best available techniques (BATq). It mandates integrated permits covering all environmental impacts and sets strict emission limits for key pollutants. This Directive applies to the manufacturing of textile apparel. The BAT for the textiles industry are described in the Best Available Techniques Reference Document (Roth et al., 2023). The end of life is addressed in the Best Available Techniques Reference document for Waste Treatment (Pinasseau et al., 2018b).

As pointed out in Section 5.7, countries outside of the EU tend to have less stringent measures about environmental protection, in particular on emission limits for key pollutants. The EU has the most ambitious legislative framework worldwide, covering aspects such as emissions to air and water, energy consumption and energy efficiency, water use, waste generation, and usage and management of chemicals. Comparing this framework with that of China, the top global exporter of apparel, it can be seen that the latter only addresses emissions to air and water as well as waste generation. In contrast with the EU BREF, the Chinese framework also covers noise emissions. With regards to India (the fifth global exporter of apparel), only emissions to water are addressed. The full comparison of aspects covered in different Best Available Techniques reference documents around the world can be seen in **Table 31**.

A comparison in terms of specific substances is made in **Table 53**. The emission levels to water of three substances/parameters are compared: chemical oxygen demand (COD), chromium and zinc (the comparison of values on emissions to air was not possible due to different practices and key environmental indicators used in the different frameworks). In **Table 53** it can be seen that there are significant differences in the level of ambition between the EU, China and India.

Table 53. Environmental performance levels for emission into water in specific regions

Key Environmental Indicator	EU	India	China
COD (mg/l)	40-100	100	7-30 000
Chromium (mg/l)	0.01-0.1	2	n/a
Zinc (mg/l)	0.04-0.5	n/a	n/a

n/a: Not Addressed

Source: own production based on Section 5.7 and 10.5.2

The EU BREF sets the emission limits on COD between 40-100 mg/l for all activities and processes, whereas in India and China those limits are set at 100 mg/l in the former and between 7-30 000 mg/l in the latter. In the case of chromium, China does not establish a limit. The EU limit is established between 0.01-0.1 mg/l, more ambitious than the 2 mg/l set in India. In terms of zinc, only the EU establishes a limit value, between 0.04-0.5 mg/l.

These differences are particularly relevant for textile apparel, since most of the activities related with raw material production and manufacturing occur out of the EU (in countries such as China or India). Deciding to manufacture products outside of the EU means that the emission levels of manufacturing plants will be subject to less stringent emission requirements. Therefore, considering the relevance of the manufacturing stage in textile apparel, producing textile apparel outside of the EU increases the environmental impact of the final product. Moreover, companies producing textile apparel in the EU must face higher costs than companies producing outside of the EU, due to the prevention and reduction of emission activities that they need to implement.

9.2.6.2 How to assess the environmental impacts and description of product technologies

The analysis of the ecosystem affecting the environmental impact of textile apparel shows the difficulty to identify in a rigid framework the characteristics of specific product technologies. However, the information gathered in the previous sections allow to build a reasonable picture.

The BC takes into account that China, India, and Bangladesh manufacture the largest part of textile apparel consumed in EU. This means that the BC is described by process techniques adopted in these countries, where the legislation allows higher emission into the environment compared to what happens in EU. The business model that characterises the BC promotes overproduction and overconsumption, supported by users that tend to change frequently their wardrobe. The end of life of the BC is described by landfilling and incineration of textile waste in the EU as well as in third countries.

The BAT takes into account EU manufacture and the currently available less-impacting business models, user behaviours and waste management options. This means that the BAT is described by process techniques adopted in EU and described in the EU-BREF. The business model that characterises the BC promotes a production rate similar to that before 2004, when the apparent consumption of EU was about half of the current one (**Figure 10** in Section 5.2). The end of life of the BAT is described by energy recovery and recycling in the EU of the textile waste.

Since the environmental impacts are affected by very numerous aspects, the description of BNAT will be simply more ambitious than BAT and will take into account all the BNAT reported for other product aspects.

This description of the product technologies is suitable for all products in the scope of the PS.

9.2.7 Presence of substances of concern

Substances of concern are defined in Article 2(27) of the Regulation and largely encompass substances that are of concern due to their negative effects upon the health of humans and to that of receptors in the environment as a consequence of their adverse long-term effects. These substances are specifically identified via being listed as (a) Substances of Very High Concern (SVHCs) in the REACH “Candidate List”, (b) by having a harmonised classification under specific hazard classes defined in the CLP Regulation or (c) by being identified as Persistent Organic Pollutants (POPs) by the POPs Regulation. In addition a specific class of SoCs are defined in ESPR, which (d) hinder reuse and recycling (of materials in the product in which SoCs are present) and which should be identified in the product-specific delegated acts to be developed under ESPR. It is worth noting that a single substance could potentially be identified simultaneously under several SoC classes (a, b, c and d).

9.2.7.1 Ecosystem of Substances of Concern

Manufacturing factors and process techniques

A very large variety of chemical substances are used by the textile sector in the different manufacturing stages, from fibre production, to spinning, weaving or dyeing and finishing of fabrics, to name just a few of the many processes involved. Chemicals are used to make fabrics more durable, softer or to provide colour and colour-fastness or a water or stain-repellent finish, among many other uses. Some chemicals are specific to the different fibres used to make textiles (cotton, polyester, wool, etc.).

It is not a simple task to determine the number of chemicals used by the textile sector, given the large variety of processes in which these are used, the multitude of functions they provide and the global distribution of chemicals supply chains and textile manufacturers. Roos et al. (2019) claim that the number of chemicals in use in the textile industry exceeds 15 000, with over 10 000 dyes and pigments and about 5 000 auxiliary chemicals, quoting figures from the Colour Index ([156]) and TEGEWA ([157]), respectively. A recent report[158] on the use of PFASs in the textile sector indicates that more than 8 000 chemical substances are used by this sector. Regardless of which the precise figure may be, the sheer numbers involved provide an indication of the magnitude of the challenges that the sector faces in implementing supply-chain transparency and traceability of chemicals.

Although it is acknowledged that chemicals play an essential role in achieving a competitive textile apparel sector that satisfies the demands of consumers, reports such as that by the Swedish Chemicals Agency, that investigated 2 450 substances used by the textile sector and found 750 classified as hazardous for human health and 440 as hazardous for the environment, are a cause of concern (KEMI, 2014). As for other material streams, it is also acknowledged that legacy chemicals may be reintroduced back into the economy via recycled fibres.

Similarly, a recent report by the European Environment Agency([159]) on per- and polyfluoroalkyl substances (PFAS) highlights the specific concerns that this group of substances pose both due to their health and environmental impacts as well as because of their consequences on circularity. According to this study, it is estimated that textiles account for approximately 35% of the total global fluoropolymer demand and that a third of all PFAS in the EU (41 000 – 143 000 tonnes) are used in the textile sector, which is thereby estimated to be the biggest contributing use sector to PFAS pollution in Europe. Furthermore, in its report on textiles, published in the year 2017, the Ellen McArthur Foundation stated:

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[156] https://colour-index.com/

[157] Textiles Auxiliaries e-market. https://www.thk-online.net/

[158] A Review of PFAS as a Chemical Class in the Textile Sector. Natural Resources Defense Council, 2021. https://saicmknowledge.org/library/review-pfas-chemical-class-textiles-sector-policy-brief

[159] EEA 2024. Briefing no. 11/2024. PFAS in textiles in Europe's circular economy. https://www.eea.europa.eu/en/analysis/publications/pfas-in-textiles-in-europes-circular-economy

"*The use of substances of concern in textile production has negative effects on farmers, factory workers, and the surrounding environment. While there is little data on the volume of substances of concern used across the industry, it is recognised that textile production discharges high volumes of water containing hazardous chemicals into the environment. As an example, 20% of industrial water pollution globally is attributable to the dyeing and treatment of textiles*" (Ellen MacArthur Foundation, 2017).

In this report a call for action is made in moving towards a new textiles economy, requiring, as regards substances of concern, to develop "*a robust evidence base on the usage of chemicals, including the amount used, as well as identification of substances of concern and the impacts of these*".

User behaviour

Section 6 reports information available on behavioural trends among users with regards to textile apparel. It covers aspects that include the way users choose to buy apparel, their habits during the use phase, and why they decide to dispose of them. It also distinguishes user behaviour aspects at pre-purchase, post-purchase and disposal stages.

In a survey spanning 27 EU Member States, 60% of 26 718 respondents perceive chemicals in apparel fabrics as minimally risky, with most not seeing them as a threat to people whereas, looking at the country level, health risks are deemed very important by about two-thirds of respondents in Germany and Slovakia whereas respondent in Denmark and the UK attributed a lower importance to this aspect (European Commission, 2009). Similar conclusions can be derived from a survey by Fashion Revolution (2020) which indicates that only about 37% of respondents in United Kingdom, France, Germany, Italy, and Spain considers it important to buy apparel produced without harmful chemicals.

Despite the uneven level of concern by users regarding chemicals in apparel, especially as regards substances that pose a risk to human health or to the environment, the establishment of information requirements under ESPR on the presence of substances, in particular of substances of concern in apparel will contribute to the generation of information that can further provide transparency to enable an informed public opinion. This in turn can inform possible actions that could be addressed in specific legislation on the safe use of chemicals such as REACH.

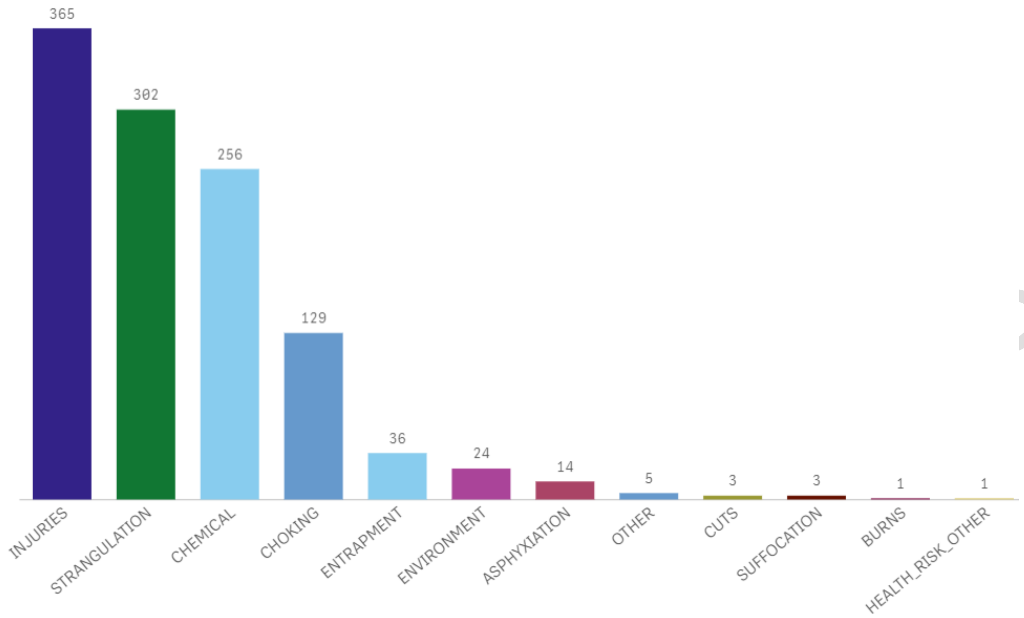
Business models

The high throughput business models, already mentioned in previous sections, result in very short textile apparel manufacturing times, with the appearance of dozens of collections every year and where manufacturing occurs largely out of the EU. This model based on production happening largely out of the EU also has consequences related to the use of chemicals, given regulations on the use and management of chemicals differ, as do levels of enforcement, control and monitoring. According to Niinimäki et al. (2020), the majority of the chemicals use connected to producing textiles for the EU occurs outside the EU.

Although it is not possible to pin-point impacts of the business model on specific chemicals, it seems clear that the large increase in production, taking place in third countries where often legislation and environmental controls and less stringent than in the EU, results in increased emissions of chemicals, notably via waste water during dyeing and washing processes, and can result in the use of substances that are regulated in the EU and other constituencies, which subsequently risk entering these markets, incorporated within textile products. Ogugbue and Sawidis (2011) state that some 0.7 million tons of synthetic dyes are produced annually worldwide and that the textile industry releases up to 200 000 tons per year of these dyes via effluents resulting from inefficient dyeing and finishing processes. Most of these dyes escape conventional wastewater treatment processes and persist in the environment. Evidence of the use of regulated hazardous substances in textiles, and of their presence in products imported into the EU can be found consulting alerts in Safety Gate([160]), the EU rapid alert system for dangerous non-food products, where reports of textile apparel and footwear items can be found containing Chromium VI, nickel, different phthalates, cadmium and other regulated substances. An analysis of the total alerts registered in Safety Gate in the period 2019 – 2023 for the product category "Clothing_textiles" indicates that chemical risks are the third most frequent risk reported (22.5%).

[160] https://ec.europa.eu/safety-gate-alerts/screen/search?resetSearch=true

Figure 26. Risks associated to textile apparel



Source: EU Safety Gate statistical tool. Available at this link. Last accessed on 13 November 2024

Legislative frameworks and industrial practices

As indicated in Section 4.1, currently there is no specific EU legislation addressing the mandatory sustainability of textiles, but EU Ecolabel criteria for textile products ([161]) exist, this being a voluntary scheme for companies willing to show the good environmental performance of their products. Article 6(6) and 6(7) of the Ecolabel Regulation (EC) No 66/2010 specify that the Ecolabel may not be awarded to products containing substances classified under CLP as toxic, hazardous to the environment, carcinogenic, mutagenic or toxic for reproduction or containing substances meeting the SVHC criteria defined in Article 57 of REACH. Derogations from this prohibition are possible except for substances identified as SVHCs and thereby listed in the so-called “Candidate List” established under REACH. The specific implementation of these general provisions into chemical-specific criteria applicable to textiles are developed as criteria 13 and 14 of the EU Ecolabel criteria for textile products enacted in Commission Decision 2014/350/EU and in the restricted substance list defined in its Appendix 1 and the list of restricted dyes specified in its Appendix 2.

More specifically as regards limitations on chemicals, the REACH regulation has the main purpose of ensuring the safe use of chemicals in the EU. REACH regulates, amongst many other aspects, the restriction of the placing on the market and use of certain substances listed in its Annex XVII, including in some cases, the incorporation of substances into articles. The authorisation title of REACH applies to the placing on the market and use of substances of very high concern (SVHC), aiming at their progressive substitution by less hazardous substances or technologies and by subjecting their use to specific conditions.

A number of restrictions in Annex XVII to REACH specifically mention textiles in their scope. These include entries: 4 - Tris (2,3 dibromopropyl) phosphate; 7 - Tris(aziridinyl)phosphinoxide; 8 - Polybrominatedbiphenyls; 18 - Mercury compounds; 20 - Organostannic compounds; 43 - Azocolourants and Azodyes; 46/46a - Nonylphenol and Nonylphenol ethoxylates; 47 - Chromium VI compounds (relevant to leather articles); 68 - C9-C14 PFCAs and 72 - CMRs in textiles and footwear.

Other restrictions, of general application to articles placed on the market for supply to the general public, or covering all articles placed on the market, may also apply to textile articles, for instance entries 50 – (certain) polycyclic aromatic hydrocarbons; 51 and 52 (certain phthalates); 61 - Dimethylfumarate; and 63 – Lead and its compounds.

[161] EU Ecolabel criteria for textile products. Commission Decision of 5 June 2014 establishing the ecological criteria for the award of the EU Ecolabel for textile products. Commission Decision (2014/350/EU). Available at this link.

Article 33 of REACH sets up a supply chain communication duty requiring suppliers of articles containing SVHC above 0.1% to communicate certain information to the recipients of those articles. Furthermore, Article 9 of the Directive 2008/98/EC, the Waste Framework Directive, promotes the reduction of the content of hazardous substances in materials and products by defining a reporting obligation that apply to suppliers of articles (as defined under REACH), requiring them to provide information regarding the presence of SVHC in articles, including textile articles, pursuant to the referred Article 33, to the European Chemicals Agency (ECHA). This information is collected in the SCIP database ([162]), operated by ECHA, and access is provided to waste treatment operators and consumers.

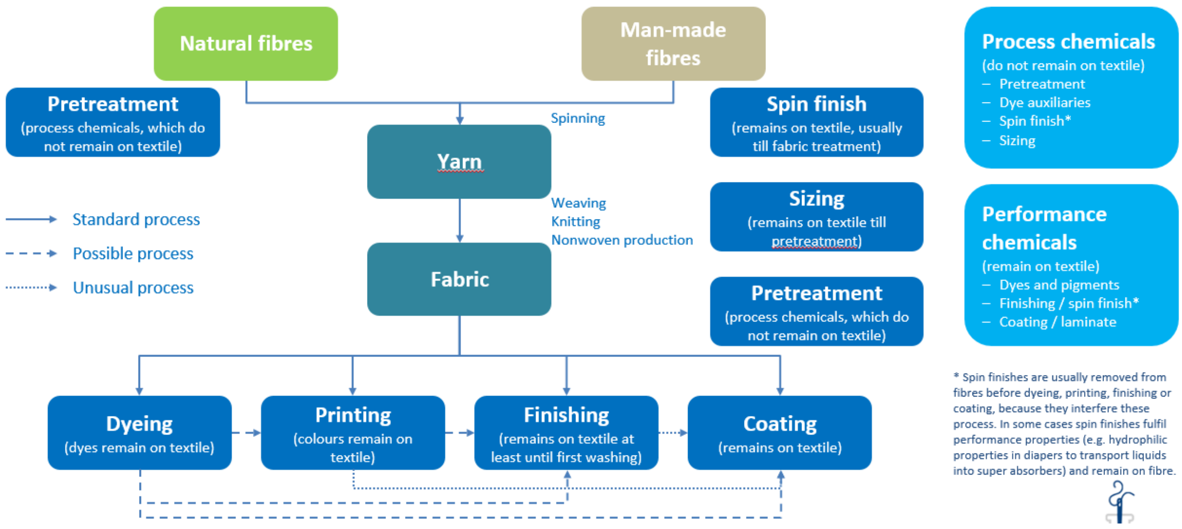
Similarly to REACH, the POPs Regulation regulates persistent organic pollutants with the objective of protecting human health and the environment by prohibiting, phasing out as soon as possible, or restricting the manufacturing, placing on the market and use of substances subject to the Stockholm Convention. Some of these restrictions are relevant to textiles, for instance those associated with certain brominated flame retardants (e.g. certain PBDEs), surface-active substances such as PFOS or PFOA, or substances with biocidal properties such as pentachlorophenol.

Whereas the EU and many developed countries have legislation regulating chemicals, including their use by the textile sector, such legislation does not exist or is less stringent in other countries where textile production takes place. A recent report by Toxics Link ([163]) highlights that "*A review of the global regulatory requirements highlights that there are stringent regulations concerning most of these chemicals only in the developed world, especially in the EU; whereas, regulations on some of the chemicals either do not exist or are less stringent in the developing or emerging economies*".

9.2.7.2 Methodology to assess Substances of Concern

As explained in previous sections, retailers and brands in the textile apparel sector are facing increasing regulatory and reputational challenges to control chemicals present in their products. The sheer number of chemicals involved, the complexity of supply chains and the fact that the majority of processes involving the use of chemicals takes place in third countries, make tracking of chemicals in textiles a complex endeavour. **Figure 27** provides an overview of processes using process and auxiliary chemicals.

Figure 27. Processes using process and auxiliary chemicals



Source: Adapted from EUCTL - European Chemistry for Textile and Leather, the European Association representing the companies that operate in Europe, producing and putting on the market chemicals used in the textiles and leather value chains.

KEMI (2014) describes the different types of chemicals used in textile production in terms of:

[162] SCIP database from the European Chemical Agency. Available at this link. Last accessed on 13 November 2024.
[163] An overview of toxic chemicals in textiles. Toxics Link 2021. https://toxicslink.org/publications/reports/toxics-chemical-in-textile-report

Functional chemicals, which are intended to remain in the final article and are expected to be present at certain concentrations in order to achieve the desirable function. Some examples include:

- Dyestuffs and pigments
- Crease resistant agents
- Anti-shrinking agents
- Oil, soil and water repellents
- Plasticisers
- Flame retardants
- Biocides for defined functionalities in articles, e.g. antibacterial agents
- Stabilisers
- Stiffening agents
- Reactive resins for various finishing treatments

Auxiliary (Process) chemicals, which are involved in some step of textile processing but are not intended to remain in the product. These include:

- Organic solvents
- Surfactants
- Softeners
- Salts
- Acids and bases
- Biocides as preservatives in the process or during storage and transport

Unintended chemical substances - contaminants and degradation products

These are chemicals not intended to remain in the finished article, such as contaminants and degradation products, have no function in neither the textile production process nor in the finished textiles.

- Formaldehyde released from certain reactive resins
- Polyaromatic hydrocarbons (PAH) impurities in pyrolysed products e.g Carbon Black
- Arylamines derived from certain azo dyestuffs and pigments
- Toxic metals (e.g heavy metals) due to impurities from the raw material

Retailers and other operators placing textile apparel on the market have implemented chemical management strategies to enable compliance and to meet their due-diligence obligations as regards chemicals in their products. Effectively there are two types of approaches to obtain information about substances of concern in products.

The **first** relies on **supply chain information** and the implementation of different **supply chain transparency measures**. In this sense retailers and other operators in the supply chain rely on declarations by suppliers, binding contractual terms and third party certification to provide information about substances in products, in particular about those which should not be present in them (positive lists). International and European sectorial initiatives have created relevant Restricted Substance Lists (RSLs) and Restricted Manufacturing Substance Lists (RMSLs) to capture and harmonise reporting of compliance regarding process and auxiliary substances regulated under different legislations and in different countries. Examples of these are the AFIRM Restricted Substances List ([164]) and the ZDHC Manufacturing Restricted Substances List ([165]) used by the textiles and footwear sectors. Other restricted substance-based approaches rely on certification of

[164] https://afirm-group.com/wp-content/uploads/2024/04/2024_AFIRM_RSL_2024_0404_EN.pdf
[165] https://mrsl.roadmaptozero.com/

compliance with the requirements in different ecolabels. The EU Ecolabel for textiles, which has a strong focus on chemicals, as well as the privately managed Oekotex 100 standard for the textile sector ([166]) are examples of this approach.

Broader disclosure approaches for chemicals along textile supply chains, which require a high level of take-up and implementation and the necessary IT infrastructure, in a way not dissimilar to the digital product passport concept introduced under ESPR, have been the subject of numerous studies, pilots and initiatives. In this sense, UN/CFACT has recently provided a recommendation providing industry actors with a set of internationally agreed practices for the harmonized collection and transmission of data for tracking and tracing materials, products, and processes across an entire value chain (UNECE, 2022). Further detailed information on related blockchain based pilot projects, on the developed business requirements specification for traceability and transparency and on the associated data model can be download from the dedicated website ([167]). A number of privately developed traceability information platforms ([168]) focusing on the textile sector are already on the market. The EU funded Interreg project ECHT ([169]), which has the purpose to Enable Digital Product Passports with Chemicals Traceability for a Circular Economy is also relevant.

The **second approach** is **analytical** and relies on direct testing of textile apparel articles to verify the presence and concentration of specific substances of concern. This approach requires the existence of suitable analytical methods for the target chemicals, involves representative sampling of products and is costly. Consequently only targeted analyses have to date been applied to check compliance as regards regulated substances, usually following a risk based approach. AFIRM, ZDHC or the Oekotex standard provide information on available analytical methods for specific substances. Other sources of test method information, for instance as regards substances restricted under REACH, can be found in the Compendium of Analytical Methods recommended by the ECHA Forum to check compliance of REACH Annex XVII restrictions ([170]). Such targeted assessments, checking for compliance of textile products have been carried out under the REACH4Textiles ([171]) project and, more recently, by IKEA and H&M in a project ([172]) focusing on collected textile apparel targeted for fibre-to-fibre recycling.

In general it can be stated that a combination of the two approaches is necessary. Both still have limitations in terms in accessibility of data, costs and capacity, especially for small and medium sized enterprises.

9.2.7.3 Description of product technologies

The use of chemicals in textile apparel manufacture is often related to the specific fibre type as well as to specific finishings (e.g. water-proofing) which are generally not product category specific. Consequently, at this point in the development of the project it is difficult to envisage the possibility of potential information or performance requirements that would be category specific.

Building a base case (BC) and the definition of products representing the best available technology (BAT) is particularly challenging for chemicals, given the large number of substances used by the sector and the lack of quantitative information on the distribution of substances. For certain specific substances and substance families, BAT and BNAT products could potentially be defined in terms of products having switched to non-toxic or less toxic (or in general more sustainable) alternatives – e.g. alternatives to the use of PFAS. Given the current paucity of detailed information on SoCs in textile apparel, the setting of information requirements, as prescribed under ESPR, with justified exemptions and thresholds for declaration of substances, seems clearly warranted.

9.3 Mutual influence of product aspects and product categorization

The analysis reported in section 9.2 described the product technologies as result of the complex interaction among process techniques, business models, user behaviour and legislative frameworks in the perspective of each relevant product aspects. It was crucial to analyse product technologies in silos to better understand the complexity of the ecosystem belonging to each relevant ecodesign aspect. However, these product aspects are

[166] https://www.oeko-tex.com/importedmedia/downloadfiles/OEKO-TEX_STANDARD_100_Standard_EN_DE.pdf

[167] https://unece.org/trade/traceability-sustainable-textile apparel-and-footwear

[168] Such as: TextileGenesis https://textilegenesis.com/ ; Global Textile Scheme https://www.globaltextilescheme.org/ and

[169] https://echt.nweurope.eu/

[170] ECHA 2021. https://www.echa.europa.eu/documents/10162/13577/compendium_of_analytical_methods_en.pdf/4c730fb9-1b48-2e14-6ee3-7a36391b7322

[171] https://www.centexbel.be/en/toxic-substances-textiles

[172] https://hmgroup.com/wp-content/uploads/2021/10/Press-release-HM-Group-and-IKEA-study.pdf

strictly connected to each other and influence each other. The analysis of product technologies already showed that:

- Waste generation is strictly connected to recyclability and recycled content;
- The recycled content depends on the recyclability and directly affects the physical durability whenever the recycled fibres have lower performances and are fed into the recycling process;
- Physical durability is affected by maintenance and affects the repairability;
- The use of specific chemicals and substances affects the physical durability, recycling and recycled content;
- The environmental impacts are influenced by all the other relevant product aspects.

The analysis of technologies must now find a synthesis in Task 5 and Task 6, when the environmental and economic model will describe the BC and the Design Options for each product category. In this way, the interactions among the relevant product aspects will be quantified to best find potential trade-offs to be expressed in the Design Options.

The first step of this synthesis is the adoption of product categories valid for all relevant product aspects. In the case of textile apparel, this exercise is very simple because the only product aspect described via categories was the physical durability. This allows the adoption of the categories reported in **Table 44** of section 9.2.1.4 as the product categorization to be used in the following steps of the development of the PS.

Therefore, Task 5 will analyse 11 representative products, one for each product category: (1) Trousers, shorts and skirts excluding denim, (2) Denim trousers, shorts and skirts, (3) Sweaters, mid-layers and knitted dresses, (4) T-shirts and polo, (5) Shirts, (6) Blouses and woven dresses, (7) Jackets and coats, (8) Hosiery: leggings, stockings, tights and socks, (9) Underwear: underpants and boxers, (10) Swimwear, (11) Accessories.

References

Aakko M, Niinimäki K. 2022. Quality matters: reviewing the connections between perceived quality and clothing use time. *J Fash Mark Manag Int J* **26**(1): 107–125. doi: 10.1108/JFMM-09-2020-0192

Aakko M, Niinimäki K. 2021. Quality matters: reviewing the connections between perceived quality and clothing use time. *J Fash Mark Manag Int J*, in press.

AB-REOC and BV-OECO. 2019. De Belgische consument en kleding.

Accenture. 2022. Drugie życie ubrań. Available at https://www.accenture.com/content/dam/accenture/final/a-com-migration/manual/r3/pdf/pdf-174/Accenture-Drugie-Zycie-Ubran.pdf.

Adam Barone. 2022 Nov 28. Quota. Investopedia. Available at https://www.investopedia.com/terms/q/quota.asp. Accessed 2023 Aug 17.

Adıgüzel F, Linkowski C, Olson E. 2020. Do Sustainability Labels Make Us More Negligent? Rebound and Moral Licensing Effects in the Clothing Industry. In: Muthu SS, Gardetti MA, editors. *Sustainability in the Textile and Apparel Industries*. Cham: Springer International Publishing. p. 1–18. doi: 10.1007/978-3-030-38532-3_1

Ahlström F, Ferning C, Cheniere MK, Sorooshian S. 2020. Performance Indicators of Textile Reverse Logistics. *IOP Conf Ser Earth Environ Sci* **442**(1): 012012. doi: 10.1088/1755-1315/442/1/012012

A.I.S.E. 2017a. Pan-European consumer habits survey 2017. Perceptions of cleanliness and hygiene. Available at https://www.aise.eu/documents/document/20180528165059-aise_consumershabitssurvey2017_summary_final.pdf.

A.I.S.E. 2017b. Low temperature washing. Available at https://www.aise.eu/documents/document/20171215161844-aise_expo17_laundry-b2-low_temp_def.pdf.

A.I.S.E. 2017c. Pan-European consumer habits survey 2017. Perceptions of cleanliness and hygiene. Available at https://www.aise.eu/documents/document/20180528165059-aise_consumershabitssurvey2017_summary_final.pdf.

A.I.S.E. 2020. Pan-European consumer habits survey 2020. Available at https://www.aise.eu/our-activities/information-to-end-users/consumer-research.aspx.

AK Wienn, Greenpeace. 2023a. FASHION CONSUMPTION IN AUSTRIA: a high level of awareness, but potential to do more. Available at https://www.akeuropa.eu/en/sustainable-fashion-consumption-austria-high-level-awareness-potential-do-more.

AK Wienn, Greenpeace. 2023b. Fashion Consumption in Austria: a high level of awareness, but potential to do more. Available at https://www.akeuropa.eu/en/sustainable-fashion-consumption-austria-high-level-awareness-potential-do-more.

Aldalbahi A, El-Naggar M, El-Newehy M, Rahaman M, Hatshan M, Khattab T. 2021. Effects of Technical Textiles and Synthetic Nanofibers on Environmental Pollution. *Polymers* **13**(1): 155. doi: 10.3390/polym13010155

Alliance of Commerce, Deloitte. 2022. Les Cahiers de la mode durable. Available at https://www.alliancecommerce.org/cahier-de-la-mode-durable-n3-prolonger-la-vie-des-produits-un-defi-pour-les-marques/.

Altroconsumo, IPSOS. 2024. Italiani a tu per tu con la moda sostenibile. Available at https://www.impegnatiacambiare.org/altrovestire/news/italiani-moda-sostenibile?utm_content=Box1.0-italiani-moda-sostenibile&utm_term=&utm_source=db-int_nmb&utm_campaign=fus-newsletter-apr-4-b-

purple&utm_medium=nl_nmb&utm_content=242634&utm_id=2a765871-0be5-42de-885b-766ad9ffdd86&sfmc_activityid=376cb9df-47f2-4363-b138-e4459e2bfe94&utm_medium=nl_nmb. Accessed 2024 May 21.

Alyssa Hardy. 2020 Jan 9. Let's Stop Pretending We Need New Clothes Every Season. InStyle. Available at https://www.instyle.com/fashion/future-of-fashion-is-seasonless. Accessed 2023 Sep 15.

Amasawa E, Kimita K. 2023. Deducing environmental implication of clothing rental from consumer voices and behaviors: a social experiment in Japan. 5th PLATE Conference. Available at https://aaltodoc.aalto.fi/handle/123456789/122687.

Amicarelli V, Bux C, Spinelli MP, Lagioia G. 2022. Life cycle assessment to tackle the take-make-waste paradigm in the textiles production. *Waste Manag* **151**: 10–27. doi: 10.1016/j.wasman.2022.07.032

Amini R, Ghaffarianhoseini Amirhosein, Ghaffarianhoseini Ali, Berardi U. 2021. Numerical investigation of indoor thermal comfort and air quality for a multi-purpose hall with various shading and glazing ratios. *Therm Sci Eng Prog* **22**: 100812. doi: 10.1016/j.tsep.2020.100812

Amobonye A, Bhagwat P, Raveendran S, Singh S, Pillai S. 2021. Environmental Impacts of Microplastics and Nanoplastics: A Current Overview. *Front Microbiol* **12**: 768297. doi: 10.3389/fmicb.2021.768297

Anisha, Kalaivani. 2016. Factors influencing buyers behaviour while purchasing. *Shanlax International Journal of Commerce* **4**(3). Available at https://www.shanlaxjournals.in/pdf/COM/V4N3/COM_V4_N3_020.pdf.

Anthesis. 2015. Clothing Durability Report. Banbury: WRAP. Available at https://www.teraz-srodowisko.pl/media/pdf/aktualnosci/1694-Clothing-Durability.pdf. Accessed 2023 Dec 16.

Asdecker B, Sucky E. 2019. Der Weg aus der Retourenfalle. *Best in procurement : BIP ; das Magazin für Manager in Einkauf und Logistik* **10**(6): 46–48.

Aslan B, Stevenson M, Hendry LC. 2015. The applicability and impact of Enterprise Resource Planning (ERP) systems: Results from a mixed method study on Make-To-Order (MTO) companies. *Comput Ind* **70**: 127–143. doi: 10.1016/j.compind.2014.10.003

Asociación para la Gestión del Residuo Textil y el Calzado. 2024. Usos, costumbres y nuevos desafíos en la industria textil. Available at https://gestionresiduotextil.org/wp-content/uploads/2024/04/estudio-gestion-residuo-textil.pdf.

Athey SN, Erdle LM. 2021. Are We Underestimating Anthropogenic Microfiber Pollution? A Critical Review of Occurrence, Methods, and Reporting. *Environ Toxicol Chem* **41**(4): 822–837. doi: 10.1002/etc.5173

Aus R, Moora H, Vihma M, Unt R, Kiisa M, Kapur S. 2021. Designing for circular fashion: integrating upcycling into conventional garment manufacturing processes. *Fash Text* **8**(1): 34. doi: 10.1186/s40691-021-00262-9

Badgett JO. 2017. An Evaluation of the Quality of Mens 100% Cotton Jersey Knit T-Shirts Representing Three Retail Categories. , in press. University of Kentucky Libraries. doi: 10.13023/ETD.2017.289

Bakowska O, Mora I, Walsh W. 2025. Textile waste composition in three EU countries. Report No.: In preparation.

Banale AK. 2017. Investigation of Properties of Silk Fiber Produced in Ethiopia. *J Mater* **2017**: 1–5. doi: 10.1155/2017/7691797

Batra SK, Pourdeyhimi B. 2012. *Introduction to Nonwovens Technology*. DEStech Publications, Inc.

Bauer B, Watson D, Gylling A, Remmen A, Lysemose MH, Hohenthal Chatarina, Jönbrink A-K. 2018. Potential Ecodesign Requirements for Textiles and Furniture. Nordic Council of Ministers. Report No.: TemaNord

2018:535. Available at http://norden.diva-portal.org/smash/record.jsf?pid=diva2%3A1221509&dswid=6042.

Bauer B, Watson D, Gylling A, Remmen A, Lysemose MH, Hohenthal Catharina, Jönbrink A-K. 2018. *Potential Ecodesign Requirements for Textiles and Furniture*. 2018:535. Copenhagen: Nordic Council of Ministers. (TemaNord). doi: 10.6027/TN2018-535

Bedez Ute T, Celik P, Bunyamin Uzumcu M. 2019. Utilization of Cotton Spinning Mill Wastes in Yarn Production. In: Körlü A, editor. *Textile Industry and Environment*. IntechOpen. doi: 10.5772/intechopen.85127

Bernon M, Rossi S, Cullen J. 2011. Retail reverse logistics: a call and grounding framework for research. *Int J Phys Distrib Logist Manag* **41**(5): 484–510. doi: 10.1108/09600031111138835

Beton A, Dias D, Farrant L, Gibon T, Le GY, Desaxce M, Perwueltz A, Boufateh I. 2014 Jan 28. Environmental Improvement Potential of textiles (IMPRO Textiles). *JRC Publ Repos*, in press. doi: 10.2791/52624

BEUC. 2023. FASHION MAKEOVER: MAKING SUSTAINABLE TEXTILES THE CONSUMER NORM. Available at https://www.beuc.eu/sites/default/files/publications/BEUC-X-2023-099_Fashion_makeover_making_sustainable_textiles_fit_consumers.pdf. Accessed 2024 Aug 13.

Boschmeier E, Ipsmiller W, Bartl A. 2024. Market assessment to improve fibre recycling within the EU textile sector. *Waste Manag Res J Sustain Circ Econ* **42**(2): 135–145. doi: 10.1177/0734242X231178222

Botta V. 2021. Durable, repairable and mainstream: How ecodesign can make our textiles circular. ECOS. Available at https://ecostandard.org/section_documents/report-durable-repairable-and-mainstream-how-ecodesign-can-make-our-textiles-circular/.

Boucher J, Friot D. 2017. *Primary Microplastics in the Oceans: A Global Evaluation of Sources*. IUCN International Union for Conservation of Nature. doi: 10.2305/IUCN.CH.2017.01.en

Brice JE, Thorpe H. 2021. Toward More-Than-Human Understandings of Sport and the Environment: A New Materialist Analysis of Everyday Fitness Practices. *Front Sports Act Living* **3**: 660935. doi: 10.3389/fspor.2021.660935

Britannica. 2019. Spinning | Synthetic Fibers, Textile Machinery & Spinning Processes |. Britannica. Available at https://www.britannica.com/technology/spinning-yarn-manufacturing. Accessed 2023 Jul 31.

British Fashion Council's Institute of Positive, Roland Berger. 2023. Solving fashion's product returns-How to keep value in a closed-loop system.

Brondino G. 2022. Global value chain analysis of the automotive and garment sectors: a study of Germany, Spain, Romania, Indonesia and Mexico for 2000 2014. , in press. doi: doi:10.2760/966324

Bye E, McKinney E. 2007. Sizing up the Wardrobe—Why We Keep Clothes That Do Not Fit. *Fash Theory* **11**(4): 483–498. doi: 10.2752/175174107X250262

Cai Y-J, Choi T-M. 2020. A United Nations' Sustainable Development Goals perspective for sustainable textile and apparel supply chain management. *Transp Res Part E Logist Transp Rev* **141**: 102010. doi: 10.1016/j.tre.2020.102010

CECU. 2023. Estudio sobre conductas de sobreconsumo textil. Available at https://cecu.es/wp-content/uploads/2023/12/Informe-sobreconsumo-textil_cecu2023.pdf. Accessed 2024 May 21.

CECU, Amigos de la Tierra. 2022. INFORME SOBRE CONDUCTAS DE CONSUMO Y REPARABILIDAD. Universidad de Salamanca.

Centobelli P, Abbate S, Nadeem SP, Garza-Reyes JA. 2022. Slowing the fast fashion industry: An all-round perspective. *Green Sustain Chem* **38**.

Chang Y, Wang X. 2023. Sweat and odor in sportswear – A review. *iScience* **26**(7): 107067. doi: 10.1016/j.isci.2023.107067

Chapter 3. Fibre fineness and transverse dimensions. 2008. Woodhead Publishing Limited,. Available at http://182.160.97.198:8080/xmlui/bitstream/handle/123456789/1269/Chapter%203-4.pdf?sequence=3. Accessed 2024 Jun 11.

Choi SY, Jo J, Lee Y, Ha J, Lee J. 2022. A cross-cultural study of the proximity of clothing to self between millennial women in South Korea and Mongolia. *Fash Text* **9**(1): 19. doi: 10.1186/s40691-022-00291-y

Choudhary AK, Bansal P. 2017. 8 - Drape measurement technique using manikins with the help of image analysis. In: Nayak R, Padhye R, editors. *Manikins for Textile Evaluation*. Woodhead Publishing. p. 173–195. doi: 10.1016/B978-0-08-100909-3.00008-X

Christensen TH, editor. 2010. *Solid Waste Technology & Management: Christensen/Solid Waste Technology & Management*. Chichester, UK: John Wiley & Sons, Ltd. doi: 10.1002/9780470666883

Circle Economy. 2020. #WHATSINMYCLOTHES: THE TRUTH BEHIND THE LABEL. Available at https://www.circle-economy.com/blogs/whatsinmyclothes-the-truth-behind-the-label.

Clark M. 2011. *Handbook of Textile and Industrial Dyeing: Principles, Processes and Types of Dyes*. Elsevier.

Claxton S, Kent A. 2020a. The management of sustainable fashion design strategies: An analysis of the designer's role. *J Clean Prod* **268**: 122112. doi: 10.1016/j.jclepro.2020.122112

Claxton S, Kent A. 2020b. The management of sustainable fashion design strategies: An analysis of the designer's role. *J Clean Prod* **268**.

Cluver BG. 2008a. Consumer Clothing Inventory Management. Oregon State University.

Cluver BG. 2008b. Consumer Clothing Inventory Management. [Oregon]: Oregon State University. Available at https://www.academia.edu/4969181/Consumer_Clothing_Inventory_Management.

COFREET. 2023. Baromètre COFREET 2022 : Les Français et l'étiquette d'entretien textile. Available at https://www.lavermonlinge.com/article/FR/cofreet/quelques_chiffres/resultats-du-5eme-barometre-cofreet-ipsos.

Conrady T, Kruschwitz A, Stamminger R. 2014. Influencing the sustainability of washing behavior by using motivational interviewing. *Energy Effic* **7**(2): 163–178. doi: 10.1007/s12053-013-9215-9

Consumers, Health, Agriculture and Food Executive Agency., LE Europe., VVA Europe., IPSOS., ConPolicy., Trinomics. 2018. *Behavioural Study on Consumers' Engagement in the Circular Economy: Final Report.* LU: Publications Office. Available at https://data.europa.eu/doi/10.2818/956512. Accessed 2024 Feb 8.

Cook SC, Yurchisin J. 2017. Fast fashion environments: consumer's heaven or retailer's nightmare? *Int J Retail Distrib Manag* **45**(2): 143–157. doi: 10.1108/IJRDM-03-2016-0027

Cooper T, Claxton S. 2022a. Garment failure causes and solutions: Slowing the cycles for circular fashion. *J Clean Prod* **351**: 131394. doi: 10.1016/j.jclepro.2022.131394

Cooper T, Claxton S. 2022b. Garment failure causes and solutions: Slowing the cycles for circular fashion. *J Clean Prod* **351**: 131394. doi: 10.1016/j.jclepro.2022.131394

Cooper T, Claxton S. 2022c. Garment failure causes and solutions: Slowing the cycles for circular fashion. *J Clean Prod* **351**: 131394. doi: 10.1016/j.jclepro.2022.131394

Cordella M, Alfieri F, Sanfelix Forner JV. 2019. Analysis and development of a scoring system for repair and upgrade of products. Luxembourg: Publications Office of the European Union. Report No.: EUR 29711 EN. doi: 10.2760/725068,

Cordella M, Sanfelix J, Alfieri F. 2019. Analysis and development of a scoring system for repair and upgrade of products: final report. LU: Publications Office. Available at https://data.europa.eu/doi/10.2760/725068. Accessed 2024 Aug 14.

Cotton Incorporated. 2014. Winning in the U.S. Activewear Market. Available at https://lifestylemonitor.cottoninc.com/winning-in-the-u-s-activewear-market/.

Cura K, Rintala N, Kamppuri T, Saarimäki E, Heikkilä P. 2021. Textile Recognition and Sorting for Recycling at an Automated Line Using Near Infrared Spectroscopy. *Recycling* **6**(1): 11. doi: 10.3390/recycling6010011

Damhorst M. 2019 Nov 6. Stories We Wear: Promoting Sustainability Practices with the Case of Patagonia. *Fam Consum Sci Res J*, in press. Available at https://www.academia.edu/110827371/Stories_We_Wear_Promoting_Sustainability_Practices_with_the_Case_of_Patagonia. Accessed 2024 Oct 10.

Dan MC, Ostergaard T. 2021. Circular Fashion: The New Roles of Designers in Organizations Transitioning to a Circular Economy. *Des J* **24:6**.

D&B. 2020a. Gedragsonderzoek kleding. Available at https://open.overheid.nl/documenten/ronl-6e59a9f4-1e95-4ffd-9316-a49affe5b271/pdf.

D&B. 2020b. Gedragsonderzoek kleding. Available at https://open.overheid.nl/documenten/ronl-6e59a9f4-1e95-4ffd-9316-a49affe5b271/pdf.

De Almeida A, Fonseca P, Schlomann B, Feilberg N. 2011. Characterization of the household electricity consumption in the EU, potential energy savings and specific policy recommendations. *Energy Build* **43**(8): 1884–1894. doi: 10.1016/j.enbuild.2011.03.027

De Klerk HM, Lubbe S. 2008. Female consumers' evaluation of apparel quality: exploring the importance of aesthetics. *J Fash Mark Manag Int J* **12**(1): 36–50. doi: 10.1108/13612020810857934

DG ENV. 2023. Combatting microplastic pollution in the European Union (Part 3/3). European Commission, Directorate-General for Environment. SWD(2023)332 Report No.: part 3/3. Available at https://ec.europa.eu/transparency/documents-register/detail?ref=SWD(2023)332&lang=en&lang=en.

DG GROW. 2021a. Data on the EU textile ecosystem and its competitiveness - Final report. Luxemburg: European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. Available at https://op.europa.eu/en/publication-detail/-/publication/574c0bfe-6142-11ec-9c6c-01aa75ed71a1/language-en/format-PDF/source-298907666. Accessed 2023 Apr 12.

DG GROW. 2021b. Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling: final report. Luxemburg: European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. Available at https://data.europa.eu/doi/10.2873/828412. Accessed 2023 Jul 4.

Djafarova E, Bowes T. 2021. 'Instagram made Me buy it': Generation Z impulse purchases in fashion industry. *J Retail Consum Serv* **59**: 102345. doi: 10.1016/j.jretconser.2020.102345

Dodd N, Gama CM. 2017 Jun. Revision of the EU Green Public Procurement (GPP) Criteria for Textile Products and Services: Technical Report with final criteria. *Jt Res Cent JRC*: 80. doi: 10.2760/906174

Donatello S, Danneck J, Löw C, Watson D, Konstantas A, Trzepacz S, Liu R, Köhler A, Faraca G. 2021. Circular economy perspectives in the EU textile sector: final report. LU: European Commission. Directorate

General Joint Research Centre. Available at https://data.europa.eu/doi/10.2760/858144. Accessed 2023 Apr 17.

Drycleaning Institute. 2015. International Fair claims guide for consumer textiles products. Alexandria - New South Wales: Drycleaning Institute of Australia Ltd. Available at https://irp-cdn.multiscreensite.com/670b4da8678441db9ca09d24ced7de7c/files/uploaded/Fair%20Claims%20Guide.pdf. Accessed 2024 Feb 5.

Duhoux T, Lingås D, Mortensen LF. 2024. Volumes and destruction of returned and unsold textiles in Europe's circular economy. European Topic Centre on Circular economy and resource use. Report No.: ETC CE Report 2024/4. Available at https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2024-4-volumes-and-destruction-of-returned-and-unsold-textiles-in-europes-circular-economy. Accessed 2024 Aug 2.

Duhoux T, Maes E, Hirschnitz-Garbers M, Peeters K, Asscherickx L, Christis M, Stubbe B, Colignon P, Hinzmann, M, Sachdeva A. 2021. Study on the technical, regulatory, economic and environmental effectiveness of textile fibres recycling: final report. LU: European Commission. Directorate General for Internal Market, Industry, Entrepreneurship and SMEs. Available at https://data.europa.eu/doi/10.2873/828412. Accessed 2023 Sep 19.

Easter E, Badgett J. 2019. An Evaluation of the Quality of Men's 100% Cotton Jersey Knit T-Shirts. *J Text Sci Fash Technol* **3**(2). doi: 10.33552/JTSFT.2019.03.000557

ECOS, Botta V, Cabral I. 2021. Durable, repairable and mainstream - How ecodesign can make our textiles circular. ECOS - Environmental Coalition on Standards. Available at https://ecostandard.org/wp-content/uploads/2021/04/ECOS-REPORT-HOW-ECODESIGN-CAN-MAKE-OUR-TEXTILES-CIRCULAR.pdf. Accessed 2023 Feb 11.

EEA. 2022a. An overview of Europe's repair sector. Available at https://circulareconomy.europa.eu/platform/sites/default/files/2022-12/Repair%20sector.pdf.

EEA. 2022b. Textiles and the Environment - The role of design in Europe's circular economy. European Environment Agency. Report No.: ETC/CE 2022/2. Available at https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-products/etc-ce-report-2-2022-textiles-and-the-environment-the-role-of-design-in-europes-circular-economy. Accessed 2024 Feb 5.

EEA. 2024. ETC CE Report 2024/4 Volumes and destruction of returned and unsold textiles in Europe's circular economy. Available at https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2024-4-volumes-and-destruction-of-returned-and-unsold-textiles-in-europes-circular-economy.

EEA, Manoochehri S, Schluep M, Dams Y, Mehlhart G, Lingås DB, Marin G, Nicolau M, Colgan S. 2022. An overview of Europe's repair sector. European Environment Agency. Report No.: 2022/6. Available at https://www.eionet.europa.eu/etcs/etc-ce/products.

Elhawary IA. 2015a. Fibre to Yarn: Staple-Yarn Spinning. In: *Textiles and Fashion*. p. 191–212.

Elhawary IA. 2015b. Chapter 9 - Fibre to Yarn: Staple-Yarn Spinning. In: Sinclair R, editor. *Textiles and Fashion*. Woodhead Publishing. p. 191–212. doi: 10.1016/B978-1-84569-931-4.00009-X

Ellen MacArthur Foundation. 2017. A new textiles economy: Redesigning fashion's future. Ellen MacArthur Foundation. Available at http://www.ellenmacarthurfoundation.org/publications.

Ellen MacArthur Foundation. 2021. Circular business models: redefining growth for a thriving fashion industry.

Elmogahzy Y. 2019. 1 - Structure and mechanics of yarns. In: Schwartz P, editor. *Structure and Mechanics of Textile Fibre Assemblies (Second Edition)*. Woodhead Publishing. p. 1–25. doi: 10.1016/B978-0-08-102619-9.00001-8

Elmogahzy YE. 2020. Performance characteristics of traditional textiles: Denim and sportswear products. In: *Engineering Textiles*. Elsevier. p. 319–346. doi: 10.1016/B978-0-08-102488-1.00013-7

ElShishtawy N, Sinha P, Bennell JA. 2022. A comparative review of zero-waste fashion design thinking and operational research on cutting and packing optimisation. *Int J Fash Des Technol Educ* **15**(2): 187–199. doi: 10.1080/17543266.2021.1990416

Engelberg J, Brassell E. 2019. Differences in Fuel Usage in the United States Housing Stock. U.S. Department of Housing and Urban Development and U.S. Census Bureau. Report No.: H150-19. Available at https://www.census.gov/programs-surveys/ahs/research/publications/h150-19.html.

EPA Circular Economy Programme, B&A. 2021. TEXTILES: ATTITUDES & BEHAVIOURS NATIONAL SURVEY 2021. Available at https://www.epa.ie/our-services/monitoring--assessment/circular-economy/textiles/national-attitudes-and-behaviours-survey-2021/.

Eppinger E, Slomkowski A, Behrendt T, Rotzler S, Marwede M. 2022. Design for recycling of e-textiles: current issues of recycling of products combining electronics and textiles and implications for a circular design approach. In: *Recycling Strategy and Challenges Associated with Waste Management Towards Sustaining the World*.

Eur Eau. 2020. The governance of water services in Europe. Belgium: The European Federation of National Associations of Water Services. Available at https://www.eureau.org/resources/publications/eureau-publications/5219-the-governance-of-water-services-in-europe-2020-edition/file. Accessed 2023 May 8.

EURATEX. 2020. Facts & Key Figures 2020 of the European Textile and Clothing Industry. EURATEX, Economic and Statistics. Available at https://euratex.eu/wp-content/uploads/EURATEX-Facts-Key-Figures-2020-LQ.pdf.

EURATEX. 2022a. Facts & Key Figures 2022 of the European Textile and Clothing Industry. EURATEX, Economic and Statistics. Available at https://euratex.eu/facts-and-key-figures/.

EURATEX. 2022b Dec 16. The EU Textiles industry is highly concerned about the potential loss of competitiveness, caused by the EU's inaction of the energy crisis, and Chinese and US subsidies to domestic industry. EURATEX. Available at https://euratex.eu/news/the-eu-textiles-industry-is-highly-concerned-about-the-potential-loss-of-competitiveness-caused-by-the-eus-inaction-of-the-energy-crisis-and-chinese-and-us-subsidies-to-domestic-industry/. Accessed 2023 Aug 15.

EuRIC. 2021. Handling&Sorting Specifications for re-use and recycling of used textiles. The European Recycling Industries´ Confederation. Available at https://euric.org/images/Position-papers/EuRIC_Handling__Sorting_Specs_July2021.pdf.

European Commission. 2009. Special Eurobarometer 314 - Europeans' attitudes toward chemicals in consumer products: Risk perception of potential health hazards. Chemicals - Chemical Safety. Available at https://europa.eu/eurobarometer/surveys/detail/752.

European Commission. 2010. Special Eurobarometer 357 - International Trade report. Report No.: Eurobarometer 74.1. Available at https://europa.eu/eurobarometer/surveys/detail/905.

European Commission. 2019. Special Eurobarometer 501 - Attitudes of European citizens towards the environment. Environment. doi: 10.2779/902489

European Commission. 2023. Retail. Internal Market, Industry, Entrepreneurship and SMEs. Available at https://single-market-economy.ec.europa.eu/single-market/services/retail_en. Accessed 2023 Sep 19.

European Commission. Directorate General for Environment. 2014. Flash Eurobarometer 388 - Attitudes of Europeans towards waste management and resource efficiency. Publications Office. Available at https://data.europa.eu/doi/10.2779/14825.

European Commission. Directorate General for Environment. 2023. Flash Eurobarometer 535 - The EU ecolabel: report. LU: Publications Office. Available at https://data.europa.eu/doi/10.2779/463334. Accessed 2024 Jan 26.

European Commission. Directorate General for Internal Market, Industry, Entrepreneurship and SMEs. 2021. *Study on the Technical, Regulatory, Economic and Environmental Effectiveness of Textile Fibres Recycling: Final Report*. LU: Publications Office. Available at https://data.europa.eu/doi/10.2873/828412. Accessed 2023 Sep 19.

European Parliamentary Research Service. 2019. Environmental impact of the textile and clothing industry - What consumers need to know. European Parliament. Available at https://www.europarl.europa.eu/RegData/etudes/BRIE/2019/633143/EPRS_BRI(2019)633143_EN.pdf.

Eurostat. 2023. European business statistics user's manual for PRODCOM: 2023 edition. Publications Office. Available at https://data.europa.eu/doi/10.2785/39767. Accessed 2023 Dec 1.

Farrant L, Olsen SI, Wangel A. 2010. Environmental benefits from reusing clothes. *Int J Life Cycle Assess* **15**(7): 726–736. doi: 10.1007/s11367-010-0197-y

Fashion Revolution. 2020. A survey of EU consumer attitudes to sustainability and supply chain transparency in the fashion industry. Available at https://issuu.com/fashionrevolution/docs/fashrev_consumersurvey_2020_full.

Fernandez-Stark K, Bamber P, Couto V. 2022. Analysis of the Textile and Clothing Industry Global Value Chains: Summary. Inter-American Development Bank. doi: 10.18235/0004663

Ferrándiz M, Fages E, Rojas-Lema S, Ivorra J, Gomez-Caturla J, Torres-Giner S. 2021. Development and Characterization of Weft-Knitted Fabrics of Naturally Occurring Polymer Fibers for Sustainable and Functional Textiles. *Polymers* **13**: 665. doi: 10.3390/polym13040665

Fibre Fineness - an overview | ScienceDirect Topics. n.d. Available at https://www.sciencedirect.com/topics/engineering/fibre-fineness. Accessed 2024 Jun 11.

Finnish Ministry of the Environment. 2023a. Konsumenterna i den cirkulära economist MOT ett ett Samhälle som främjar cirkulär economist och reparation. Helsinki. Available at https://urn.fi/URN:ISBN:978-952-361-231-0.

Finnish Ministry of the Environment. 2023b. Konsumenterna i den cirkulära economist MOT ett ett Samhälle som främjar cirkulär economist och reparation. Helsinki. Available at https://urn.fi/URN:ISBN:978-952-361-231-0.

Forbrugerrådet Tænk. 2022. Vejen til et tøjforbrug med mindre miljø-og klimaaftryk. Danish Consumer Council. Available at https://taenk.dk/det-kaemper-vi-for/sammen-mod-toejspild.

Foresight Factory. 2021. Future of Shopping - Global Report. Available at http://www.foresightfactory.co/wp-content/uploads/2021/07/Snap-Final-Global-Report-.pdf.

FRC, Public Eye. 2022. E-commerce "dark patterns" fuel fashion overconsumption. Available at https://www.publiceye.ch/en/topics/fashion/e-commerce-dark-patterns-fuel-fashion-overconsumption. Accessed 2024 May 21.

Frydendal J, Hansen LE, Bonou A. 2018. Environmental Labels and Declarations. In: Hauschild MZ, Rosenbaum RK, Olsen SI, editors. *Life Cycle Assessment*. Cham: Springer International Publishing. p. 577–604. doi: 10.1007/978-3-319-56475-3_24

Ghaani Farashahi B, Easter E, Annett-Hitchcock K. 2018a. Price and perceived product quality: a comparison of denim jeans in three price categories. *J Fash Mark Manag Int J* **22**(3): 369–386. doi: 10.1108/JFMM-10-2017-0104

Ghaani Farashahi B, Easter E, Annett-Hitchcock K. 2018b. Price and perceived product quality: a comparison of denim jeans in three price categories. *J Fash Mark Manag Int J* **22**(3): 369–386. doi: 10.1108/JFMM-10-2017-0104

GINETEX. 2017a. TEXTILE CARE SYMBOLS. Available at https://www.ginetex.net/thematique/GB/textile/a-2.

GINETEX. 2017b. TEXTILE CARE SYMBOLS. Available at https://www.ginetex.net/thematique/GB/textile/a-2.

GINETEX. 2019 Nov 7. DURABILITY OF CLOTHES: A MAJOR CONCERN FOR EUROPEANS. Available at https://www.ginetex.net/thematique/GB/textile/a-barometer-for-textile-care-labelling-in-europehttps://www.ginetex.net/userfiles/files/Maarc%20pour%20COFREET_Barometre%20IPSOS_GINETEX.pdf.

Gita Gopinath. 2020 Apr 14. The Great Lockdown: Worst Economic Downturn Since the Great Depression. IMF. Available at https://www.imf.org/en/Blogs/Articles/2020/04/14/blog-weo-the-great-lockdown-worst-economic-downturn-since-the-great-depression. Accessed 2023 Aug 15.

Gooijer H, Stamminger R. 2016. Water and Energy Consumption in Domestic Laundering Worldwide – A Review. *Tenside Surfactants Deterg* **53**(5): 402–409. doi: 10.3139/113.110456

Gottfridsson M, Zhang Y. 2015. Environmental impacts of shoe consumption - Combining product flow analysis with an LCA model for Sweden [Master Thesis]. [Gothenburg]: Chalmers University of Technology. Available at https://publications.lib.chalmers.se/records/fulltext/218968/218968.pdf. Accessed 2023 Feb 17.

Goudar IV, Kulloli SD. 2022. Flax fibre and blended yarn characteristics. , in press. Available at https://www.thepharmajournal.com/archives/2022/vol11issue3/PartZ/11-3-392-331.pdf.

Goworek H, Oxborrow Lynn, Claxton S, Hill H. 2020. Managing sustainability in the fashion business: Challenges in product development for clothing longevity in the UK. *2020* **Journal of Business Research**(117): 629–641.

Goworek H, Oxborrow L., Claxton S, McLaren A, Cooper T, Hill H. 2020. Managing sustainability in the fashion business: Challenges in product development for clothing longevity in the UK. *J Bus Res* **117**: 629–641. doi: 10.1016/j.jbusres.2018.07.021

Gray R, Sabaiduc C, Salvidge C, Doriza A. 2022. Clothing longevity and circular business models receptivity in the UK. UK: WRAP. Available at https://wrap.org.uk/resources/report/citizen-insights-clothing-longevity-and-circular-business-models-receptivity-uk.

Greenpeace. 2015. Wegwerfware Kleidung Repräsentative Greenpeace-Umfrage zu Kaufverhalten, Tragedauer und der Entsorgung von Mode. Available at https://www.greenpeace.de/sites/default/files/publications/20151123_greenpeace_modekonsum_flyer.pdf.

Guy A, Green E, Banim M, editors. 2001. *Through the Wardrobe: Women's Relationships with Their Clothes*. 1st ed. Oxford International Publishers Ltd. doi: 10.2752/9781847888921

Gwilt A. 2021. Caring for clothes: how and why people maintain garments in regular use. **35**(6): 870–882. Taylor & Francis. doi: 10.1080/10304312.2021.1993572

Gwozdz W, Steensen Nielsen K, Müller T. 2017a. An Environmental Perspective on Clothing Consumption: Consumer Segments and Their Behavioral Patterns. *Sustainability* **9**(5): 762. doi: 10.3390/su9050762

Gwozdz W, Steensen Nielsen K, Müller T. 2017b. An Environmental Perspective on Clothing Consumption: Consumer Segments and Their Behavioral Patterns. *Sustainability* **9**(5): 762. doi: 10.3390/su9050762

Harpa R, Piroi C, Buhu A, Ciobanu L. 2024. LEAN SIX SIGMA AND SUSTAINABILITY IN TEXTILE INDUSTRY: ASYSTEMATIC LITERATURE REVIEW. In: *International Symposium "Technical Textiles - Present and Future". Edition 2023*. Sciendo. p. I–II. doi: 10.2478/9788367405355-fm

Harris F, Roby H, Dibb S. 2016. Sustainable clothing: challenges, barriers and interventions for encouraging more sustainable consumer behaviour: Sustainable clothing. *Int J Consum Stud* **40**(3): 309–318. doi: 10.1111/ijcs.12257

Hasanbeigi A, Price L. 2012. A review of energy use and energy efficiency technologies for the textile industry. *Renew Sustain Energy Rev* **16**(6): 3648–3665. doi: 10.1016/j.rser.2012.03.029

Hearle JWS, Morton WE. 2008. *Physical Properties of Textile Fibres*. Elsevier.

Heiny K, Schneide D. 2021. Attitude-Behavior Gap Report: How the industry and consumers can close the sustainability Attitude-Behavior Gap in fashion. Zalando. Available at https://corporate.zalando.com/en/our-impact/sustainability/sustainability-reports/attitude-behavior-gap-report.

Henninger CE, Alevizou PJ, Goworek H, Ryding D, editors. 2017. *Sustainability in Fashion: A Cradle to Upcycle Approach*. Cham: Springer International Publishing. doi: 10.1007/978-3-319-51253-2

Henninger CE, Brydges T, Iran S, Vladimirova K. 2021. Collaborative fashion consumption – A synthesis and future research agenda. *J Clean Prod* **319**: 128648. doi: 10.1016/j.jclepro.2021.128648

Hernandez L, Petreca B, Baurley S, Bianchi-Berthouze N, Cho Y. 2024. Examining clothing repair practices, core competences, techniques, tools and community structures involved in extending the life of garments. *Int J Sustain Fash Text* **3**(1): 99–121. doi: 10.1386/sft_00041_1

Herweyers L, Catarci Carteny C, Scheelen L, Watts R, Du Bois E. 2020. Consumers' Perceptions and Attitudes toward Products Preventing Microfiber Pollution in Aquatic Environments as a Result of the Domestic Washing of Synthetic Clothes. *Sustainability* **12**(6): 2244. doi: 10.3390/su12062244

Hildegunn Kyvik Nordås. 2004. *The Global Textile and Clothing Industry Post the Agreement on Textiles and Clothing*. Geneva: World Trade Organization. (WTO discussion papers / World Trade Organization; Vol. 5).

Hong Y, Al Mamun A, Yang Q, Masukujjaman M. 2024. Predicting sustainable fashion consumption intentions and practices. *Sci Rep* **14**(1): 1706. doi: 10.1038/s41598-024-52215-z

Horn S, Mölsä KM, Sorvari J, Tuovila H, Heikkilä P. 2023. Environmental sustainability assessment of a polyester T-shirt – Comparison of circularity strategies. *Sci Total Environ* **884**: 163821. doi: 10.1016/j.scitotenv.2023.163821

Hultén P, Vanyushyn V. 2014. Promotion and shoppers' impulse purchases: the example of clothes. *J Consum Mark* **31**(2): 94–102. doi: 10.1108/JCM-06-2013-0603

Huygens D, Foschi J, Caro D, Caldeira C, Faraca G, Foster G, Solis M, Marschinski R, Napolano L, Astrup Fruergaard T, et al. 2023. Techno-scientific assessment of the management options for used and waste textiles in the European Union. *JRC134586*, in press. doi: doi:10.2760/6292

IEA. 2019. World Energy Balances 2019. Paris: International Energy Agency. Available at https://doi.org/10.1787/3a876031-en.

ILO News. 1996 Oct 28. Globalization Changes the Face of Textile, Clothing and Footwear Industries. Available at http://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_008075/lang--en/index.htm. Accessed 2023 Aug 15.

INDA. 2023. What are nonwovens. Association of the Nonwoven Fabrics Industry. Available at https://www.inda.org/about-nonwovens/. Accessed 2023 Sep 20.

İnovenso Teknoloji Ltd.Şti, Mustafa W. 2023. Breathable waterproof fabrics. , in press. Unpublished. doi: 10.13140/RG.2.2.18928.02565

IPCC. 2023. *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. 1st ed. Cambridge University Press. doi: 10.1017/9781009157896

Jadhav NC, Jadhav AC. 2020. Waste and 3R's in Footwear and Leather Sectors. In: Muthu SS, editor. *Leather and Footwear Sustainability*. Singapore: Springer Singapore. p. 261–293. doi: 10.1007/978-981-15-6296-9_10

Jaffe M, Menczel JD. 2020. Thermal Analysis of Textiles and Fibers, Chapter 1 - Introduction. In: Jaffe M, Menczel JD, editors. *Thermal Analysis of Textiles and Fibers*. Woodhead Publishing. p. 1–6. doi: 10.1016/B978-0-08-100572-9.00001-X

Jain A. 2021 Mar 31. Influence of consumption behaviours, attitudes and barriers toward clothing repair. , in press. doi: https://doi.org/10.7939/r3-bekh-ry58

Jana D, Saskia M, Lars FM. 2023. The role of bio-based textile fibres in a circular and sustainable textiles system. European Environment Agency. Report No.: ETC-CE Report 2023/5. Available at file:///C:/Users/smoldovan/Downloads/ETC-EEA%20-%20Bio-based%20Textile%20Fibres_FINAL.pdf.

Jankoska M, Demboski G. 2017. The influence of the sewing speed and fabric thickness on sewing machine stitch formation parameters. *Adv Technol* **6**(2): 72–77. doi: 10.5937/savteh1702072J

Jia F, Shiyuan Y, Chen L, Chen X. 2020. The circular economy in the textile and apparel industry: A systematic literature review. *J Clean Prod* **259**.

Jørgensen P-E, Werner A, Constantinou G. 2022. Research and identification of textile plants globally - focusing on fiber-to-fiber recycling for the fashion & textile industry. Lifestyle & Design Cluster. Available at https://ldcluster.com/wp-content/uploads/sites/4/2022/08/FINAL-Interactive-mapping-of-global-recycling-textile-plants-august-2022-LDC.pdf.

Joung H-M, Park-Poaps H. 2013. Factors motivating and influencing clothing disposal behaviours: Clothing disposal behaviours. *Int J Consum Stud* **37**(1): 105–111. doi: 10.1111/j.1470-6431.2011.01048.x

Joy A, Sherry JF, Venkatesh A, Wang J, Chan R. 2012a. Fast Fashion, Sustainability, and the Ethical Appeal of Luxury Brands. *Fash Theory* **16**(3): 273–295. doi: 10.2752/175174112X13340749707123

Joy A, Sherry JF, Venkatesh A, Wang J, Chan R. 2012b. Fast Fashion, Sustainability, and the Ethical Appeal of Luxury Brands. *Fash Theory* **16**(3): 273–295. doi: 10.2752/175174112X13340749707123

Kalliala EM, Nousiainen P. 1999. Life Cycle Assessment, environmental profile of cotton and polyester-cotton fabrics. *Tamp Univ Technol* **1**(1). Available at https://proyectaryproducir.com.ar/public_html/Seminarios_Posgrado/Material_de_referencia/LCA%20for%20Cotton%20and%20Polyester-cotton%20fabrics.pdf.

KEMI. 2014. Chemicals in textiles – Risks to human health and the environme. Stockholm: Swedish Chemicals Agency. Report No.: 361 130. Available at https://www.kemi.se/download/18.6df1d3df171c243fb23a98f3/1591454110491/rapport-6-14-chemicals-in-textiles.pdf. Accessed 2023 Oct 19.

Khairul Akter MMd, Haq UN, Islam MdM, Uddin MA. 2022. Textile-apparel manufacturing and material waste management in the circular economy: A conceptual model to achieve sustainable development goal (SDG) 12 for Bangladesh. *Clean Environ Syst* **4**: 100070. doi: 10.1016/j.cesys.2022.100070

Khanna A. 2021. Factors affecting consumer-buying motivations: An empirical study in the behavioral economics perspective. *nternational Journal of Research in Marketing Management and Sales* **3**(2): 19–23.

Kim JJ, In Shin K, Ryu HS, Kim EA, Lee M, Wha Oh K. 2004. Luster Properties of Polyester Filament Yarn Woven Fabrics. *Text Res J* **74**(1): 72–77. doi: 10.1177/004051750407400113

Kleinhückelkotten S, Freudenreich B, Glomb M, Hübner G, Landsbek B, Nebel K, Neitzke H-P, Schaltegger S, Woznica A. 2019. Slow Fashion: Gestalterische, technische und ökonomische Innovationen für massenmarkttaugliche nachhaltige Angebote im Bedarfsfeld "Bekleidung." Hannover, Hamburg.

Kleinhückelkotten S, Neitzke H-P, Schmidt N. 2018a. Mode, Kleidung und Nachhaltigkeit: Einstellungen und Verhalten - Ergebnisse der Repräsentativbefragung 2017. Hannover: Innabe. Available at https://www.ecolog-institut.de/wp-content/uploads/2021/04/InNaBe_Bericht_5-5_Repr%C3%A4sentativbefragung_2.pdf.

Kleinhückelkotten S, Neitzke H-P, Schmidt N. 2018b. Mode, Kleidung und Nachhaltigkeit: Einstellungen und Verhalten - Ergebnisse der Repräsentativbefragung 2017. Hannover: Innabe. Available at https://www.ecolog-institut.de/wp-content/uploads/2021/04/InNaBe_Bericht_5-5_Repr%C3%A4sentativbefragung_2.pdf.

Klepp, Grimstad I. 2001. Hvorfor går klær ut av bruk? Available at https://hdl.handle.net/20.500.12199/5390.

Klepp IG, Laitala K. 2023a. Washing Clothes. In: *The Routledge History of Fashion and Dress, 1800 to the Present*1st ed. London: Routledge. p. 491–506. doi: 10.4324/9780429295607-31

Klepp IG, Laitala K. 2023b. Washing Clothes. In: *The Routledge History of Fashion and Dress, 1800 to the Present*1st ed. London: Routledge. p. 491–506. doi: 10.4324/9780429295607-31

Klepp IG, Laitala K, Wiedemann S. 2020a. Clothing Lifespans: What Should Be Measured and How. *Sustainability* **12**(15): 6219. doi: 10.3390/su12156219

Klepp IG, Laitala K, Wiedemann S. 2020b. Clothing Lifespans: What Should Be Measured and How. *Sustainability* **12**(15): 6219. Multidisciplinary Digital Publishing Institute. doi: 10.3390/su12156219

Koay KY, Cheah CW, Lom HS. 2022. An integrated model of consumers' intention to buy second-hand clothing. *Int J Retail Distrib Manag* **50**(11): 1358–1377. doi: 10.1108/IJRDM-10-2021-0470

Koszewska M. 2016. Understanding Consumer Behavior in the Sustainable Clothing Market: Model Development and Verification. In: Muthu SS, Gardetti MA, editors. *Green Fashion*. Singapore: Springer Singapore. p. 43–94. doi: 10.1007/978-981-10-0111-6_3

Koukouvinos D. 2012. Psychosocial Factors Influencing Young Consumers' Clothing Disposal Behaviour in Greece. , in press.

Krsteva S, Demboski G. 2011. *DETERMINATION OF GENERATED TEXTILE WASTE IN CLOTHING COMPANIES OF DIFFERENT TECHNOLOGICAL LEVEL*. Zrenjanin: Technical Faculty "Mihajlo Pupin."

Kumar V, Hernández N, Jensen M, Pal R. 2023. Deep learning based system for garment visual degradation prediction for longevity. *Comput Ind* **144**: 103779. doi: 10.1016/j.compind.2022.103779

Kuppen M. 2024. Technical Report Denim Deal – State of the art for using post-consumer recycled cotton in denim. , in press.

Laitala K, Berg LL, l Strandbakken P. 2023. Why won't you complain? Consumer rights and the unmet product lifespan requirements. 2023. The 5th Product Lifetimes and the Environment (PLATE) Conference. 31-2 June 2023; Espoo: Aalto University. Available at http://urn.fi/URN:ISBN:978-952-64-1367-9.

Laitala K, Boks C. 2012. Sustainable clothing design: use matters. *J Des Res* **10**(1/2): 121. doi: 10.1504/JDR.2012.046142

Laitala K, Klepp I, Henry B. 2018. Does Use Matter? Comparison of Environmental Impacts of Clothing Based on Fiber Type. *Sustainability* **10**(7): 2524. doi: 10.3390/su10072524

Laitala K, Klepp IG. 2018a. Care and Production of Clothing in Norwegian Homes: Environmental Implications of Mending and Making Practices. *Sustainability* **10**(8): 2899. doi: 10.3390/su10082899

Laitala K, Klepp IG. 2018b. Care and Production of Clothing in Norwegian Homes: Environmental Implications of Mending and Making Practices. *Sustainability* **10**(8): 2899. doi: 10.3390/su10082899

Laitala K, Klepp IG. 2020a. What Affects Garment Lifespans? International Clothing Practices Based on a Wardrobe Survey in China, Germany, Japan, the UK, and the USA. *Sustainability* **12**(21): 9151. Multidisciplinary Digital Publishing Institute. doi: 10.3390/su12219151

Laitala K, Klepp IG. 2020b. What Affects Garment Lifespans? International Clothing Practices Based on a Wardrobe Survey in China, Germany, Japan, the UK, and the USA. *Sustainability* **12**(21): 9151. doi: 10.3390/su12219151

Laitala K, Klepp IG. 2021a. Clothing Longevity: The Relationship Between The Number of Users, How Long and How Many Times Garments are Used. 2021. 4th PLATE 2021 Virtual Conference 26-28 May 2021; Limerick, Ireland. Available at https://www.researchgate.net/publication/352993692_Clothing_Longevity_The_Relationship_Between_The_Number_of_Users_How_Long_and_How_Many_Times_Garments_are_Used.

Laitala K, Klepp IG. 2021b. Clothing Longevity: The Relationship Between The Number of Users, How Long and How Many Times Garments are Used. 2021. 4th PLATE 2021 Virtual Conference 26-28 May 2021; Limerick, Ireland. Available at https://www.researchgate.net/publication/352993692_Clothing_Longevity_The_Relationship_Between_The_Number_of_Users_How_Long_and_How_Many_Times_Garments_are_Used.

Laitala K, Klepp IG. 2022. Review of clothing disposal reasons. Available at https://clothingresearch.oslomet.no/2022/10/19/review-of-clothing-disposal-reasons/.

Laitala K, Klepp IG, Boks C. 2012. Changing laundry habits in Norway: Changing laundry habits in Norway. *Int J Consum Stud* **36**(2): 228–237. doi: 10.1111/j.1470-6431.2011.01081.x

Laitala K, Klepp IG, Haugrønning V, Throne-Holst H, Strandbakken P. 2021a. Increasing repair of household appliances, mobile phones and clothing: Experiences from consumers and the repair industry. *J Clean Prod* **282**: 125349. doi: 10.1016/j.jclepro.2020.125349

Laitala K, Klepp IG, Haugrønning V, Throne-Holst H, Strandbakken P. 2021b. Increasing repair of household appliances, mobile phones and clothing: Experiences from consumers and the repair industry. *J Clean Prod* **282**: 125349. doi: 10.1016/j.jclepro.2020.125349

Laitala K, Klepp IG, Henry B. 2018a. Does Use Matter? Comparison of Environmental Impacts of Clothing Based on Fiber Type. *Sustainability* **10**(7): 2524. Multidisciplinary Digital Publishing Institute. doi: 10.3390/su10072524

Laitala K, Klepp IG, Henry B. 2018b. Use phase of apparel: A literature review for Life Cycle Assessment with focus on wool. , in press. Unpublished. doi: 10.13140/RG.2.2.25769.90729

Laitala K, Klepp IG, Henry BK. 2017. Global laundering practices. Alternatives to machine washing. *H&PC Today – Household and Personal Care Today* **12**(5): 10–16.

Laitala K, Klepp IG, Kettlewell R, Wiedemann S. 2020. Laundry Care Regimes: Do the Practices of Keeping Clothes Clean Have Different Environmental Impacts Based on the Fibre Content? *Sustainability* **12**(18): 7537. doi: 10.3390/su12187537

Lamb P. 2009. Effect of Fibre Properties on Processing Performance: Top to Yarn. *Univ N Engl*, in press.

Lang C, Armstrong CM, Brannon LA. 2013. Drivers of clothing disposal in the US: An exploration of the role of personal attributes and behaviours in frequent disposal: Drivers of frequent clothing disposal. *Int J Consum Stud* **37**(6): 706–714. doi: 10.1111/ijcs.12060

LEITAT. 2017. Implementation of Article 11 under the EU Ecolabel Regulation. Spain: LEITAT-Technological Center. Report No.: Deliverable 4. FINAL REPORT. Available at https://ec.europa.eu/environment/ecolabel/documents/180504%20FINAL_REPORT_ARTICLE11_V3%20with%20disclaimer.pdf. Accessed 2024 Jan 19.

Leslie HA, van Velzen MJM, Brandsma SH, Vethaak AD, Garcia-Vallejo JJ, Lamoree MH. 2022. Discovery and quantification of plastic particle pollution in human blood. *Environ Int* **163**: 107199. doi: 10.1016/j.envint.2022.107199

Lewis T. 2015. Apparel disposal and reuse. In: *Sustainable Apparel*. Elsevier. p. 233–250. doi: 10.1016/B978-1-78242-339-3.00010-8

Li Z, Zhong P, Tang X, Chen Y, Su S, Zhai T. 2020. A New Method to Evaluate Yarn Appearance Qualities Based on Machine Vision and Image Processing. *IEEE Access* **8**: 30928–30937. doi: 10.1109/ACCESS.2020.2972967

Lingås D, Manshoven S, Mortensen LF, Paulsen F. 2023. EU exports of used textiles in Europe's circular economy. EEA. Report No.: ETC CE Report 2023/4. Available at https://www.eionet.europa.eu/etcs/etc-ce/products/etc-ce-report-2023-4-eu-exports-of-used-textiles-in-europe2019s-circular-economy#:~:text=2023.

Lu L, Fan W, Meng X, Xue L, Ge S, Wang C, Foong SY, Tan CSY, Sonne C, Aghbashlo M, et al. 2023. Current recycling strategies and high-value utilization of waste cotton. *Sci Total Environ* **856**: 158798. doi: 10.1016/j.scitotenv.2022.158798

Luo Y, Wu X, Ding X. 2023a. Environmental impacts of textiles in the use stage: A systematic review. *Sustain Prod Consum* **36**: 233–245. doi: 10.1016/j.spc.2023.01.006

Luo Y, Wu X, Ding X. 2023b. Environmental impacts of textiles in the use stage: A systematic review. *Sustain Prod Consum* **36**: 233–245. doi: 10.1016/j.spc.2023.01.006

Luo Y, Wu X, Ding X. 2023c. Environmental impacts of textiles in the use stage: A systematic review. *Sustain Prod Consum* **36**: 233–245. doi: 10.1016/j.spc.2023.01.006

Machado MAD, Almeida SOD, Bollick LC, Bragagnolo G. 2019. Second-hand fashion market: consumer role in circular economy. *J Fash Mark Manag Int J* **23**(3): 382–395. doi: 10.1108/JFMM-07-2018-0099

Mahmoudi MR. 2010. 4 - Blending and composite yarn spinning. In: Lawrence CA, editor. *Advances in Yarn Spinning Technology*. Woodhead Publishing. p. 102–118. doi: 10.1533/9780857090218.1.102

Makov T. 2023. The hidden environmental costs of consumer product returns. 5th PLATE Conference. Available at https://aaltodoc.aalto.fi/handle/123456789/122687.

Maldini I, Balkenende. 2017. Reducing clothing production volumes by design: a critical review of sustainable fashion strategies. 2017. PLATE: Product lifetimes and the environment. Conference proceedings of PLATE 2017, 8-10 November 2017. Technische Universiteit Delft.; Delft, the Netherlands. Available at https://pure.hva.nl/ws/portalfiles/portal/3974950/Article_Plate_published.pdf.

Maldini I, Stappers PJ, Gimeno-Martinez JC, Daanen HAM. 2019. Assessing the impact of design strategies on clothing lifetimes, usage and volumes: The case of product personalisation. *J Clean Prod* **210**: 1414–1424. doi: 10.1016/j.jclepro.2018.11.056

Manshoven S, Christis M, Vercalsteren A, Arnold M, Nicolau M, Lafond E, Mortensen, LF, Coscieme L. 2019. Textiles and the Environment in a circular economy. Belgium: European Topic Centre Waste and Materials in a Green Economy. Report No.: Eionet Report. Available at https://www.eionet.europa.eu/etcs/etc-wmge/products/etc-wmge-reports/textiles-and-the-environment-in-a-circular-economy.

Mao N. 2016. Methods for characterisation of nonwoven structure, property, and performance. In: Kellie G, editor. *Advances in Technical Nonwovens*. Woodhead Publishing. p. 155–211. doi: 10.1016/B978-0-08-100575-0.00006-1

Mao N, Wang Y, Qu J. 2016. SMOOTHNESS AND ROUGHNESS: CHARACTERISTICS OF FABRIC-TO-FABRIC SELF-FRICTION PROPERTIES. , in press.

de Mattos FB, Esquivel V, Kucera D, Tejani S. 2022. The state of the apparel and footwear industry: Employment, automation and their gender dimensions. *Backgr Pap N3* **GLO/20/82/EUR[ILO_REF]**. Available at https://www.ilo.org/employment/Whatwedo/Projects/building-partnerships-on-the-future-of-work/WCMS_835423/lang--en/index.htmç.

Matusiak Malgorzata, Sikorski Renata. 2011. Influence_of_the_Structure_of_Woven_Fabrics_on_The.pdf.

Maya Forstater. 2010 Jan 6. Sectoral coverage of the global economic crisis. Implications of the global financial and economic crisis on the textile and clothing sector. *Int Labour Organ*: 32.

McKinsey & Company. 2022. Scaling textile recycling in europe turning waste into value. McKinsey Apparel, Fashion & Luxury Group. Available at https://www.mckinsey.com/industries/retail/our-insights/scaling-textile-recycling-in-europe-turning-waste-into-value.

McKinsey & Company. 2024. Reimagining the apparel value chain amid volatility. Available at https://www.mckinsey.com/industries/retail/our-insights/reimagining-the-apparel-value-chain-amid-volatility#/.

McKinsey & Company, BOF. 2016. The State of Fashion 2017. The Business of Fashion and McKinsey & Company. Available at https://www.mckinsey.com/~/media/McKinsey/Industries/Retail/Our%20Insights/The%20state%20of%20fashion/The-state-of-fashion-2017-McK-BoF-report.pdf. Accessed 2023 Dec 8.

McLaren A, Goworek H, Cooper T, Oxborrow L, Hill H. 2015. Clothing longevity perspectives: exploring consumer expectations, consumption and use. 2015. PLATE conference - Nottingham Trent University, 17/19 June 2015. Available at http://irep.ntu.ac.uk/id/eprint/17978/1/220768_PubSub2644_McLaren.pdf. Accessed 2023 Oct 30.

McLaren A, Goworek H, Cooper T, Oxborrow L, Hill H. 2016. The effect of consumer attitudes on design for product longevity: The case of the fashion industry. 2016 Jun 25. Design Research Society Conference 2016. doi: 10.21606/drs.2016.456

McNeill L, Moore R. 2015. Sustainable fashion consumption and the fast fashion conundrum: fashionable consumers and attitudes to sustainability in clothing choice: Sustainable fashion consumption and the fast fashion conundrum. *Int J Consum Stud* **39**(3): 212–222. doi: 10.1111/ijcs.12169

McQueen RH, Jain A, McNeill LS, Kozlowski A. 2023. The role of resources in repair practice: Engagement with self, paid and unpaid clothing repair by young consumers. *Text Res J* **93**(3–4): 576–591. doi: 10.1177/00405175221123067

MEErP. 2011. MEErP : Methodology for Ecodesign of Energy-related Products. European Commission, DG Enterprise and Industry Unit B1 Sustainable Industrial Policy under. Report No.: Final report. Available at https://op.europa.eu/en/publication-detail/-/publication/b7650397-32f1-436c-82c4-df39aef297a3/language-en/format-PDF/source-295028560.

milieu centraal. 2021. Doelgroepverkenningkoplopers reparerenkoplopers repareren.

Ministry of Ecology and Environment, China. 2021. Guideline on available techniques of pollution prevention and control for textile industry. Available at https://www.mee.gov.cn/ywgz/fgbz/bz/bzwb/kxxjszn/202106/W020210809521494726861. pdf.

Mishra M, Kushwaha R, Gupta N, Sinha A, Dwivedi H. 2023. Survey data to evaluate consumer behaviour and consumption pattern of sustainable apparel: A study on consumer awareness level. *Data Brief* **49**: 109350. doi: 10.1016/j.dib.2023.109350

Mishra SP. 2000. *A Text Book of Fibre Science and Technology*. New Age International.

Mobarak Hossain M. 2016. A Review on Different Factors of Woven Fabrics' Strength Prediction. *Sci Res* **4**(3): 88. doi: 10.11648/j.sr.20160403.13

Mohapatra P, Gaonkar O. 2021. An overview of toxic chemicals in textiles. New Delhi: Toxics Links. Available at https://toxicslink.org/Publication/ToxicsChemicalinTextileReport.

Monitor, Cotton Incorporated Lifestyle. 2018. Price, Quality and Style: Consumers Seek Shopping Symmetry. Available at https://lifestylemonitor.cottoninc.com/price-quality-and-style/. Accessed 2023 Nov 15.

Morell-Delgado G, Talens Peiró L, Toboso-Chavero S. 2024. Revealing the management of municipal textile waste and citizen practices: The case of Catalonia. *Sci Total Environ* **907**: 168093. doi: 10.1016/j.scitotenv.2023.168093

Morgan L R, Birtwistle G. 2009a. An investigation of young fashion consumers' disposal habits. *Wiley Online Libr* **33**(2): 190–198. doi: https://doi.org/10.1111/j.1470-6431.2009.00756.x

Morgan L R, Birtwistle G. 2009b. An investigation of young fashion consumers' disposal habits. **33**: 190–198. doi: https://doi.org/10.1111/j.1470-6431.2009.00756.x

Munasinghe P, Druckman A, Dissanayake DGK. 2021. A systematic review of the life cycle inventory of clothing. *J Clean Prod* **320**: 128852. doi: 10.1016/j.jclepro.2021.128852

Murakami S, Oguchi M, Tasaki T, Daigo I, Hashimoto S. 2010. Lifespan of Commodities, Part I - The Creation of a Database and Its Review. *Journal of Industrial Ecology* **14**(4): 529–684, i–xi. doi: 0.1111/j.1530-9290.2010.00250.x

Mustia DI, Edy S, Nurul A. 2021. Analysis of waste composition as a source of refuse-derived fuel in Cilacap. *IOP Conf Ser Earth Environ Sci* **896**(1): 012063. doi: 10.1088/1755-1315/896/1/012063

Muthu SS. 2015. *Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing*. Elsevier. (Woodhead Publishing Series in Textiles; Vol. 172). doi: 10.1016/C2014-0-00761-7

Muthu SS. 2020. *Assessing the Environmental Impact of Textiles and the Clothing Supply Chain*. Second edition. Elsevier. doi: 10.1016/B978-0-12-819783-7.00001-6

Nayak R, Padhye R. 2015. 17 - Care labelling of clothing. In: Nayak Rajkishore, Padhye Rajiv, editors. *Garment Manufacturing Technology*. Woodhead Publishing. p. 427–446. doi: 10.1016/B978-1-78242-232-7.00017-5

Nayak R, Padhye R. 2018. Introduction to automation in garment manufacturing. In: Nayak R, Padhye R, editors. *Automation in Garment Manufacturing*. Woodhead Publishing. p. 1–27. doi: 10.1016/B978-0-08-101211-6.00001-X

Nayak R, Ratnapandian S. 2018. *Care and Maintenance of Textile Products Including Apparel and Protective Clothing*. 1st ed. CRC Press. doi: 10.1201/b22481

Neuß J, Schlich M. 2019. A SELECTIVE SERVICE LIFE ANALYSIS OF DENIM FABRICS WITH A FOCUS ON WASHING AND DRYING DEGRADATION TO OPTIMIZE THEIR RECYCLING EFFICIENCY.

Neuwahl F, Cusano G, Gómez Benavides J, Holbrook S, Serge R. 2019. Best Available Techniques (BAT) reference document for waste incineration: Industrial Emissions Directive 2010/75/EU (Integrated Pollution Prevention and Control). LU: Publications Office. Available at https://data.europa.eu/doi/10.2760/761437. Accessed 2024 Dec 4.

Newbold T, Hudson LN, Arnell AP, Contu S, De Palma A, Ferrier S, Hill SLL, Hoskins AJ, Lysenko I, Phillips HRP, et al. 2016. Has land use pushed terrestrial biodiversity beyond the planetary boundary? A global assessment. *Science* **353**(6296): 288–291. doi: 10.1126/science.aaf2201

Niinimäki K. 2011. *From Disposable to Sustainable: The Complex Interplay between Design and Consumption of Textiles and Clothing*. Helsinki: Aalto University School of Art and Design. Available at https://aaltodoc.aalto.fi/handle/123456789/13770.

Niinimäki K, Armstrong C. 2013. From pleasure in use to preservation of meaningful memories: a closer look at the sustainability of clothing via longevity and attachment. *Int J Fash Des Technol Educ* **6**(3): 190–199. doi: 10.1080/17543266.2013.825737

Niinimäki K, Peters G, Dahlbo H, Perry P, Rissanen T, Gwilt A. 2020. The environmental price of fast fashion. *Nat Rev Earth Environ* **1**(4): 189–200. doi: 10.1038/s43017-020-0039-9

Nordic Ecolabelling. 2022. Background document of Nordic Swan Ecolabelled Textiles, hides/skins, and leather - Version 5.6, 01 March 2022 to 31 December 2026. Available at https://www.nordic-swan-ecolabel.org/4a7d17/contentassets/2a4b1e9ce1d04ad0a820553f8b716cd9/background-document_039_manufacturing-of-textiles-hidesskins-and-leather-039_english2.pdf. Accessed 2024 Nov 27.

Nørup N, Pihl K, Damgaard A, Scheutz C. 2019. Replacement rates for second-hand clothing and household textiles – A survey study from Malawi, Mozambique and Angola. *J Clean Prod* **235**: 1026–1036. doi: 10.1016/j.jclepro.2019.06.177

NRF, APPRISS RETAIL. 2023. 2023 Consumer Returns in the Retail Industry. Available at https://cdn.nrf.com/sites/default/files/2024-01/Customer_Returns_Report_2023_Final.pdf.

OCU. 2018. Otro consumo para un futuro mejor - Nuevas economías al servicio de las personas y el planeta. Available at https://www.ocu.org/consumo-familia/consumo-colaborativo/noticias/otro-consumo-es-posible.

OECD. 2022. Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution. Activity 6: Cross Country analysis of BAT and BAT-associated emission and environmental performance levels in the Thermal Power Plants, Cement and Textile industries. *Ser Risk Manag*(71).

Ogugbue CJ, Sawidis T. 2011. Bioremediation and Detoxification of Synthetic Wastewater Containing Triarylmethane Dyes by *Aeromonas hydrophila* Isolated from Industrial Effluent. *Biotechnol Res Int* **2011**: 1–11. doi: 10.4061/2011/967925

OVAM. 2021. Ecodesign criteria for consumer textiles. OVAM. Available at https://circulareconomy.europa.eu/platform/sites/default/files/ecodesign_criteria_for_consumer_textiles.pdf.

OVAM. 2022. Ecodesign criteria for consumer textiles. Available at https://ovam-english.vlaanderen.be/documents/177280/797580/2021+-+Ecodesign+criteria+for+consumer+textiles.pdf/ed47b6c4-a625-300d-64af-8ef88b44cab2?version=2.1&t=1662551112862&download=true. Accessed 2023 Dec 2.

Oxford dictionary. 2023 Sep 13. retail. Oxford dictionary. Available at https://dictionary.cambridge.org/dictionary/english/retail. Accessed 2023 Sep 19.

Page T. 2014. Product attachment and replacement: implications for sustainable design. *Int J Sustain Des* **2**(3): 265. doi: 10.1504/IJSDES.2014.065057

Palacios-Mateo C, van der Meer Y, Seide G. 2021. Analysis of the polyester clothing value chain to identify key intervention points for sustainability. *Environ Sci Eur* **33**(1): 2. doi: 10.1186/s12302-020-00447-x

Piippo R, Niinimäki K, Aakko M. 2022a. Fit for the Future: Garment Quality and Product Lifetimes in a CE Context. *Sustainability* **14**(2): 726. doi: 10.3390/su14020726

Piippo R, Niinimäki K, Aakko M. 2022b. Fit for the Future: Garment Quality and Product Lifetimes in a CE Context. *Sustainability* **14**(2): 726. doi: 10.3390/su14020726

Pinasseau A, Zerger B, Roth J, Canova M, Roudier S. 2018a. Best available techniques (BAT) reference document for waste treatment: Industrial Emissions Directive 2010/75/EU (integrated pollution prevention and control). LU: Publications Office. Available at https://data.europa.eu/doi/10.2760/407967. Accessed 2024 Dec 4.

Pinasseau A, Zerger B, Roth J, Canova M, Roudier S. 2018b. Best Available Techniques (BAT) Reference Document for Waste Treatment. *JRC Publ Repos*, in press.

Pranta AD, Tareque Rahaman Md, Reazuddin Repon Md, Shikder AAR. 2024. Environmentally sustainable apparel merchandising of recycled cotton-polyester blended garments: Analysis of consumer preferences and purchasing behaviors. *J Open Innov Technol Mark Complex* **10**(3): 100357. doi: 10.1016/j.joitmc.2024.100357

Prasannamedha G, Senthilkumar P. 2021. Chemical compliance and regulations in textiles and fashion. In: *Chemical Management in Textiles and Fashion*. Elsevier. p. 135–154. doi: 10.1016/B978-0-12-820494-8.00007-1

Quantis. 2018. Measuring Fashion, 2018. Environmental impact of the global apparel and footwear industries study. Full report and methodological considerations. Available at https://quantis.com/report/measuring-fashion-report/.

Quantis. 2021. Measuring fashion: Environmental Impact of the Global Apparel and Footwear Industries Study. Quantis. Available at https://quantis.com/wp-content/uploads/2018/03/measuringfashion_globalimpactstudy_full-report_quantis_cwf_2018a.pdf. Accessed 2023 Sep 12.

Quantis Q. 2022. Draft Product Environmental footprint category 2 rules . Apparel and footwear (PEFCR). Switzerland. Report No.: Version 1.3. Available at https://green-business.ec.europa.eu/environmental-footprint-methods_en.

Quantis Q. 2024. Draft product environmental footprint- representative product (PEF-RP) study report version 2.0. Switzerland. Report No.: Version 2.0.

Rahman Khan MdM, Chen Y, Belsham T, Laguë C, Landry H, Peng Q, Zhong W. 2011. Fineness and tensile properties of hemp (*Cannabis sativa L.*) fibres. *Biosyst Eng* **108**(1): 9–17. doi: 10.1016/j.biosystemseng.2010.10.004

Rahman Md. Mizanur, Mashud M, Rahman Md. Mostafizur, editors. 2023. *Advanced Technology in Textiles: Fibre to Apparel*. Singapore: Springer Nature Singapore. (Textile Science and Clothing Technology). doi: 10.1007/978-981-99-2142-3

Raj A, Chowdhury A, Ali SW. 2022. Green chemistry: its opportunities and challenges in colouration and chemical finishing of textiles. *Sustain Chem Pharm* **27**: 100689. doi: 10.1016/j.scp.2022.100689

Ramey HH. 2018. THE MEANING AND ASSESSMENT OF COTTON FIBRE FINENESS. *South Reg Res Cent US Dep Agric*, in press.

Ranasinghe L, Jayasooriya VM. 2021. Ecolabelling in textile industry: A review. *Resour Environ Sustain* **6**: 100037. doi: 10.1016/j.resenv.2021.100037

Ray S. 2012. Warp knitting machines and knitting elements. p. 144–150. doi: 10.1533/9780857095558.144

Refashion. 2023. Characterisation study of the incoming and outgoing streams from sorting facilities. France: Refashion. Available at https://refashion.fr/pro/sites/default/files/rapport-etude/Overview_Characterisation_study_Refashion_2023_EN.pdf. Accessed 2024 Dec 3.

Ribeiro PR, Batista P, Mendes-Palma F, Pintado M, Oliveira-Silva P. 2023. Consumers' Engagement and Perspectives on Sustainable Textile Consumption. *Sustainability* **15**(22): 15812. doi: 10.3390/su152215812

Roberts H, Milios L, Mont O, Dalhammar C. 2023. Product destruction: Exploring unsustainable production-consumption systems and appropriate policy responses. *Sustain Prod Consum* **35**: 300–312. doi: 10.1016/j.spc.2022.11.009

Roichman R, Sprecher B, Blass V, Meshulam T, Makov T. 2024. The convenience economy: Product flows and GHG emissions of returned apparel in the EU. *Resour Conserv Recycl* **210**: 107811. doi: 10.1016/j.resconrec.2024.107811

Roos S, Jönsson C, Posner S, Arvidsson R, Svanström M. 2019. An inventory framework for inclusion of textile chemicals in life cycle assessment. *Int J Life Cycle Assess* **24**(5): 838–847. doi: 10.1007/s11367-018-1537-6

Roos S, Sandin G, Zamani B, Peters G. 2015. Environmental assessment of Swedish fashion consumption. Mistra Future Fashion. Available at http://mistrafuturefashion.com/life-cycle-assessment-gives-new-understanding-of-fashions-environmental-impact/.

Roth J, Zerger B, De GD, Gómez BJ, Roudier S. 2023 Jan 16. Best available techniques (BAT) reference document for the Textiles Industry. *JRC Publ Repos*, in press. doi: 10.2760/355887

Rowen JW, Gagliardi D. 1947. Properties of water-repellent fabrics. *J Res Natl Bur Stand* **38**(1): 103. doi: 10.6028/jres.038.002

Roy Choudhury AK. 2017. 7 - Repellent finishes. In: Roy Choudhury AK, editor. *Principles of Textile Finishing*. Woodhead Publishing. p. 149–194. doi: 10.1016/B978-0-08-100646-7.00007-2

Rulikova M. 2020. "I would never wear those old clodhoppers!": Age differences and used clothing consumption in the Czech Republic. *J Consum Cult* **20**(2): 175–193. doi: 10.1177/1469540519891274

Saleeshya PG, Raghuram P, Vamsi N. 2012. Lean manufacturing practices in textile industries - a case study. *Int J Collab Enterp* **3**(1): 18. doi: 10.1504/IJCENT.2012.052367

Sandin G, Peters GM. 2018. Environmental impact of textile reuse and recycling – A review. *J Clean Prod* **184**: 353–365. doi: 10.1016/j.jclepro.2018.02.266

Sandin G, Roos S, Spak B, Zamani B, Peters G. 2019. Environmental assessment of Swedish clothing consumption - six garments, sustainable futures. Mistra Future Fashion. Available at http://mistrafuturefashion.com/impact-of-swedish-clothing-consumption/.

Sandin G, Roos S, Spak, Björn, Zamani B, Peters GM. 2019. Environmental assessment of Swedish clothing consumption - six garments, sustainable futures. Mistra Future Fashion Consortium. Available at http://mistrafuturefashion.com/wp-content/uploads/2019/08/G.Sandin-Environmental-assessment-of-Swedish-clothing-consumption.MistraFutureFashionReport-2019.05.pdf.

Schäfer R, Preuschoff PM, Borchers J. 2023. Investigating Visual Countermeasures Against Dark Patterns in User Interfaces. Mensch und Computer 2023: 161–172. ACM. doi: 10.1145/3603555.3603563

Schmitz A, Stamminger R. 2014. Usage behaviour and related energy consumption of European consumers for washing and drying. *Energy Effic* **7**(6): 937–954. doi: 10.1007/s12053-014-9268-4

Sekhri S. 2016. *Textbook of Fabric Science Fundamentals to Finishing*. Prentice Hall India Pvt., Limited.

Shirvanimoghaddam K, Motamed B, Ramakrishna S, Naebe M. 2020. Death by waste: Fashion and textile circular economy case. *Sci Total Environ*, in press.

Shishoo RL. 1994. Environmental Issues Facing the Technical Textile Industry in Europe. *J Coat Fabr* **24**(2): 117–128. doi: 10.1177/152808379402400204

Singh HB, Bharati KA. 2014 Jan 1. Handbook of Natural Dyes and Pigments. : 1–299.

Sinha SK, Chattopadhyay R. 2007. A STUDY ON SPINNING LIMITS AND YARN PROPERTIES WITH PROGRESSIVE CHANGE IN YARN COUNT IN FRICTION SPINNING. *AUTEX Res J* **7**(1): 1–8. doi: 10.1515/aut-2007-070101

SMED. 2016. Plockanalyser av textilier i hushållens restavfall. Available at https://www.naturvardsverket.se/globalassets/amnen/kretslopp-avlopp-avfall/avfallsslag/textil/plockanalyser-av-textilier-i-hushallens-restavfall-smed-rapport-2016-06-17.pdf.

Sohail Y, Sun D. 2019. Life Cycle Assessment of Technical Textile Waste: Pilot Evaluation of Environmental Impacts. 2019. 2nd International Forum on Textiles for Graduate Students 2018; Tianjin Polytechnic University, Tianjin, China. Tianjin Polytechnic University. Available at https://hal.science/hal-02133644. Accessed 2023 Feb 17.

Solis M, Huygens D, Tonini D, Fruergaard Astrup T. 2024. Management of textile waste in Europe: An environmental and a socio-economic assessment of current and future scenarios. *Resour Conserv Recycl* **207**: 107693. doi: 10.1016/j.resconrec.2024.107693

Spaepen V, J. Van Camp M, Lenaerts. 2021. One Size Does Not Fit All: Consumer Attitudes towards Circular Business Models in Fashion. , in press. Available at https://orcid.org/0000-0002-8603-7028.

Stephen MacDonald. 2006 Jan 2. The World Bids Farewell to the Multifiber Arrangement - USDA ERS. Economic Research Service U.S. Deparment of Agriculture. Available at https://www.ers.usda.gov/amber-waves/2006/february/the-world-bids-farewell-to-the-multifiber-arrangement/. Accessed 2023 Aug 17.

Svensson-Hoglund S, Luth Richter J, Maitre-Ekern E, Russell J, Pihlajarinne T, Dalhammar C. 2021. Barriers, enablers and market governance: A review of the policy landscape for repair of consumer electronics in the EU and the U.S. *J Clean Prod*, in press.

Sveriges Konsumenter. 2020. Ny undersökning: konsumenter oroade för kemikalier. Available at https://www.sverigeskonsumenter.se/nyheter-press/nyheter-och-pressmeddelanden/ny-undersokning-konsumenter-oroade-for-kemikalier/. Accessed 2024 May 21.

Szczepanski M. 2019. A decade on from the crisis: Main responses and remaining challenges. EPRS | European Parliamentary Research Service. Report No.: PE 642.253. Available at https://www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2019)642253.

Tahvildar A, Ezazshahabi N, Mousazadegan F. 2019. Appearance and comfort properties considering yarn-spinning system and weave structure in worsted woven fabrics. *J Eng Fibers Fabr* **14**: 155892501984597. doi: 10.1177/1558925019845978

TAUW. 2023. Performance requirements for textiles Input on EU sustainable design criteria for textiles. Utrecht. Report No.: R001- 1288851BUM-V03- los- NL. Available at https://www.rijksoverheid.nl/documenten/rapporten/2023/09/26/bijlage-eindrapport-onderzoek-designeisen-textiel. Accessed 2024 Feb 20.

Terzioğlu N. 2021. Repair motivation and barriers model: Investigating user perspectives related to product repair towards a circular economy. *J Clean Prod* **289**: 125644. doi: 10.1016/j.jclepro.2020.125644

Textile Exchange. 2020. Preferred fiber & Materials Market Report 2020. Textile Exchange. Available at https://textileexchange.org/app/uploads/2021/04/Textile-Exchange_Preferred-Fiber-Material-Market-Report_2020.pdf.

Textile Exchange. 2021. Preferred Fiber and Materials Market Report 2021. Textile Exchange.

Textile Exchange. 2022a. Preferred Fiber & Materials Market Report 2022. Textile Exchange.

Textile Exchange. 2022b. Material Change Insights 2021. The state of fiber and materials sourcing. Textile Exchange. Available at https://textileexchange.org/app/uploads/2022/06/Textile-Exchange_Material-Change-Insights_Report_2021.pdf. Accessed 2023 Jul 6.

Textile Exchange. 2023. Materials Market Report. Textile Exchange. Available at https://textileexchange.org/knowledge-center/documents/materials-market-report-2023/. Accessed 2023 Dec 19.

Thredup. 2023. thredUP's annual Resale Report. Available at https://cf-assets-tup.thredup.com/resale_report/2023/thredUP_2023_Resale_Report_FINAL.pdf.

Trzepacz S, Bekkevold Lingås D, Asscherickx L, Peeters K, van Duijn H, Akerboom M. 2023. LCA-based assessment of the management of European used textiles. NORION CONSULT and EuRIC TEXTILES. Available at https://circulareconomy.europa.eu/platform/sites/default/files/2023-02/LCA-based%20assessment%20of%20the%20management%20of%20European%20used%20textiles_corrected.pdf.

Turunen LLM, Gossen M. 2024. From Preloved to Reloved: How Second-Hand Clothing Companies Facilitate the Transaction of Used Garments. *J Sustain Res* **6**(1). doi: 10.20900/jsr20240002

Tyagi GK. 2010. 5 - Yarn structure and properties from different spinning techniques. In: Lawrence CA, editor. *Advances in Yarn Spinning Technology*. Woodhead Publishing. p. 119–154. doi: 10.1533/9780857090218.1.119

UNECE. 2022. Enhancing traceability and transparency of sustainable value chains in the garment and footwear sector. Recommendation n°46. Geneva: United Nations Centre for Trade facilitation and Electronic Business. Report No.: ECE/TRADE/463.

UNECE, ECLAC. 2024. Reversing direction in the used clothing crisis: Global, European and Chilean perspectives. Geneva. Report No.: ECE/TRADE/484. Available at https://unece.org/trade/publications/reversing-direction-used-clothing-crisis-global-european-and-chilean. Accessed 2024 Dec 7.

UNECE, UNTRADE. 2020. Accelerating action for a sustainable and circular garment and footwear industry: which role for transparency and traceability of value chains? Geneva: United Nations Economic

Commission for Europe. Report No.: ECE/TRADE/449. Available at https://unece.org/DAM/trade/Publications/ECE_TRADE_449-AcceleratingTanspRraceabilityTextile.pdf. Accessed 2023 Dec 7.

UNEP. 2020. Sustainability and Circularity in the Textile Value Chain - Global Stocktaking. Nairobi, Kenya.: United Nation Environment Programme. Available at https://www.unep.org/resources/publication/sustainability-and-circularity-textile-value-chain-global-stocktaking. Accessed 2023 Jun 12.

UNEP. 2023a. Sustainability and Circularity in the Textile Value Chain - A Global Roadmap. Paris: United Nations Environment Programme (UNEP). Available at https://www.unep.org/resources/publication/sustainability-and-circularity-textile-value-chain-global-roadmap.

UNEP. 2023b. Environmental labels in Ukraine. Information for Producers in the EU's Eastern Neighbourhood. UNEP, OECD, UNECE, UN, UNIDO, The World Bank. Available at https://www.eu4environment.org/app/uploads/2023/06/Ecolabelling-PPT_Ukraine_EN.pdf. Accessed 2024 Jan 22.

Ungerth L, Carlsson A. 2011. Vad händer sen med våra kläder Enkätundersökning. Available at https://docplayer.se/344015-Konsumentforeningen-stockholm-vad-hander-sen-med-vara-klader-enkatundersokning-april-2011.html.

Van den Bergen J, Parker G. 2023. Textile Processing Guide: Pretreatment, colouration & finishing. Available at https://reports.fashionforgood.com/wp-content/uploads/2022/01/Textile-Processing-Guide-3.pdf.

Van Rensburg ML, Nkomo SL, Mkhize NM. 2020. Life cycle and End-of-Life management options in the footwear industry: A review. *Waste Manag Res* **38**(6): 599–613. doi: 10.1177/0734242X20908938

Vanacker H, Lemieux A-A, Bonnier S. 2022. Different dimensions of durability in the luxury fashion industry: An analysis framework to conduct a literature review. *J Clean Prod* **377**: 134179. doi: 10.1016/j.jclepro.2022.134179

Vargas F, Yuleimy Ramírez YR. 2014. Potential of Municipal Solid Waste Calorific Energy as Coal Replacement. *Tek Rev Científica* **14**(2): 23. doi: 10.25044/25392190.467

Vet JMD, Nigohosyan D, Ferrer JN, Gross A-K, Kuehl S, Flickenschild M. 2021 Mar. Impacts of the COVID-19 pandemic on EU industries. , in press.

Vilumsone-Nemes I, Pešić M, Csanák E. 2023. Flexible Design of Garment Styles to Support the Minimal Waste Concept in the Fashion Industry. *Fibres Text East Eur* **31**(3): 64–73. doi: 10.2478/ftee-2023-0029

Vinted. 2021. Climate Change Impact Report - Understanding the avoided emissions of second-hand shopping on Vinted. Available at https://press-center-static.vinted.com/Vaayu_x_Vinted_Full_Climate_Impact_Report_2021_045f9e5c4b.pdf.

Vladimirova D, Boniolo L, Botta V. 2024. ECOS Working paper - Exploring sufficiency approaches to textiles policy.

Vladimirova K, Henninger CE, Joyner-Martinez C, Iran S, Diddi S, Durrani M, Iyer K, Jestratijevic I, McCormick H, Niinimäki K, et al. 2022. Fashion consumption during COVID-19: Comparative analysis of changing acquisition practices across nine countries and implications for sustainability. *Clean Responsible Consum* **5**: 100056. doi: 10.1016/j.clrc.2022.100056

VZBV. 2022. Verbraucherbereitschaft zu klimaschonendem Konsum und Einstellungen zu wahren Preisen. Projekt „Was kostet es wirklich? Internalisierung externer Kosten als elementarer Baustein beim Klimaschutz. Available at https://www.vzbv.de/meldungen/umdenken-am-black-friday-bewusster-konsum-statt-schnaeppchenjagd. Accessed 2024 May 21.

Wakes S, Dunn L, Penty D, Kitson K, Jowett T. 2020a. Is Price an Indicator of Garment Durability and Longevity? *Sustainability* **12**(21): 8906. doi: 10.3390/su12218906

Wakes S, Dunn L, Penty D, Kitson K, Jowett T. 2020b. Is Price an Indicator of Garment Durability and Longevity? *Sustainability* **12**(21): 8906. doi: 10.3390/su12218906

Wang X, Disney SM. 2016. The bullwhip effect: Progress, trends and directions. *Eur J Oper Res* **250**(3): 691–701. doi: 10.1016/j.ejor.2015.07.022

Watson D, Trzepacz S, Gravgård Pedersen O. 2018. Mapping of textile flows in Denmark. The Danish Environmental Protection Agency. Available at https://www2.mst.dk/Udgiv/publications/2018/08/978-87-93710-48-1.pdf.

Wei W, Wargocki P, Zirngibl J, Bendžalová J, Mandin C. 2020. Review of parameters used to assess the quality of the indoor environment in Green Building certification schemes for offices and hotels. *Energy Build* **209**: 109683. doi: 10.1016/j.enbuild.2019.109683

Williams L, Ackerman J. 2011. Please touch the merchandise. Harvard Business Review. Available at https://hbr.org/2011/12/please-touch-the-merchandise.

WRAP. 2017a. Sustainable clothing: A practical guide to enhancing clothing durability and quality. UK. Available at https://wrap.org.uk/resources/guide/sustainable-clothing-guide.

WRAP. 2017b. Valuing Our Clothes: the cost of UK fashion. Available at WRAP. (2017). Valuing Our Clothes: the cost of UK fashion. http://www.wrap.org.uk/sites/files/wrap/valuing-our-clothes-the-cost-of-uk-fashion_WRAP.pdf.

WRAP. 2017c. An Economic and Financial Sustainability Assessment of F2F Recycling.

WRAP. 2019. Consumer Research for ECAP 2016-2019. Available at http://www.ecap.eu.com/wp-content/uploads/2019/12/Consumer-Research-for-ECAP.pdf.

WRAP. 2022. Citizen Insights: Clothing Longevity and Circular Business Models Receptivity in the UK. Available at https://wrap.org.uk/resources/report/citizen-insights-clothing-longevity-and-circular-business-modelsreceptivity- uk.

WRAP Cymru. 2022. Composition of Textiles in Wales: Waste composition analysis of kerbside and HWRC collected textiles. Report No.: COL202- 016. Available at https://wrapcymru.org.uk/sites/default/files/2022-12/COL202-016%20Textiles%20Composition%20Summary%20Report%20FINAL_0.pdf.

WTO. 2020. World Trade Statistical Review 2020. Geneva: World Trade Organization. Available at https://www.wto.org/english/res_e/statis_e/wts2020_e/wts2020_e.pdf.

Xiang Y, Jiang L, Zhou Y, Luo Z, Zhi D, Yang J, Lam SS. 2022. Microplastics and environmental pollutants: Key interaction and toxicology in aquatic and soil environments. *J Hazard Mater* **422**: 126843. doi: 10.1016/j.jhazmat.2021.126843

Yada Y, Feng J, Matsumoto T, Fukushima N, Kido F, Yamana H. 2022. Dark patterns in e-commerce: a dataset and its baseline evaluations. 2022 IEEE International Conference on Big Data (Big Data): 3015–3022. IEEE. doi: 10.1109/BigData55660.2022.10020800

Yan R, Yurchisin J, Watchravesringkan K. 2008. Use of care labels: linking need for cognition with consumer confidence and perceived risk. *J Fash Mark Manag Int J* **12**(4): 532–544. doi: 10.1108/13612020810906173

Yassen HA. 2017. Study of the Relationship between Sewing and Fabric Parameters and Seam Strength. *Int Des J* **7**(2): 125–129. doi: 10.12816/0046559

Yates L, Evans D. 2016. Dirtying Linen: Re-evaluating the sustainability of domestic laundry: Dirtying Linen: Re-Evaluating the Sustainability of Domestic Laundry. *Environ Policy Gov* **26**(2): 101–115. doi: 10.1002/eet.1704

YouGov. 2019. Fast fashion: il continuo rinnovo del guardaroba. YouGov. Available at https://it.yougov.com/society/articles/23537-fast-fashion-il-rinnovo-del-guardaroba?redirect_from=%2Fnews%2F2019%2F05%2F27%2Ffast-fashion-il-rinnovo-del-guardaroba%2F.

YouGov. 2021. European Fashion Report. Available at https://business.yougov.com/content/39089-european-fashion-report-2021-1.

Yuille P. 2015. Exploring the Relationship between the Presumed Quality and Durability of Fast-Fashion Garments by the Generation-Y Consumer. 2015. PLATE Conference, Nottingham, UK, 17–19 June 2015; Nottingham, UK,. Available at https://www.plateconference.org/pdf/plate_2015_proceedings.pdf.

Yun C, Patwary S, LeHew MLA, Kim J. 2017. Sustainable care of textile products and its environmental impact: Tumble-drying and ironing processes. *Fibers Polym* **18**(3): 590–596. doi: 10.1007/s12221-017-6957-6

Zambrano MC, Pawlak JJ, Daystar J, Ankeny M, Venditti RA. 2021. Impact of dyes and finishes on the microfibers released on the laundering of cotton knitted fabrics. *Environ Pollut* **272**: 115998. doi: 10.1016/j.envpol.2020.115998

Zhang L, Hale J. 2022. Extending the Lifetime of Clothing through Repair and Repurpose: An Investigation of Barriers and Enablers in UK Citizens. *Sustainability* **14**(17): 10821. Multidisciplinary Digital Publishing Institute. doi: 10.3390/su141710821

Zhang L, Leung MY, Boriskina S, Tao X. 2022. Advancing life cycle sustainability of textiles through technological innovations. *Nat Sustain* **6**(3): 243–253. doi: 10.1038/s41893-022-01004-5

Zhao L, Kim K. 2021. Responding to the COVID-19 Pandemic: Practices and Strategies of the Global Clothing and Textile Value Chain. *Cloth Text Res J* **39**(2): 157–172. doi: 10.1177/0887302X21994207

Zimmermann T, Hauschke F, Memelink R, Reitz A, Pelke N, John R, Eberle U, Ninnemann J. 2021. Die Ökologisierung des Onlinehandels. Neue Herausforderungen für die umweltpolitische Förderung eines nachhaltigen Konsums Report No.: 142/2021. Available at https://www.umweltbundesamt.de/sites/default/files/medien/479/publikationen/texte_142-2021_die_oekologisierung_des_onlinehandels.pdf.

List of abbreviations

DPP	Digital Product Passport
EC	European Commission
ESPR	Ecodesign for Sustainable Product Regulation
EU	European Union
GPP	Green Public Procurement
MEErP	Methodology for Ecodesign of Energy-related Products
PEFCR A&F	Product Environmental Footprint Category Rules for Apparel and Footwear
PS	Preparatory Study on textile products
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
SVHC	Substance(s) of Very High Concern
TLR	Textile Labelling Regulation (Regulation (EU) No 1007/2011)

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10 Annexes

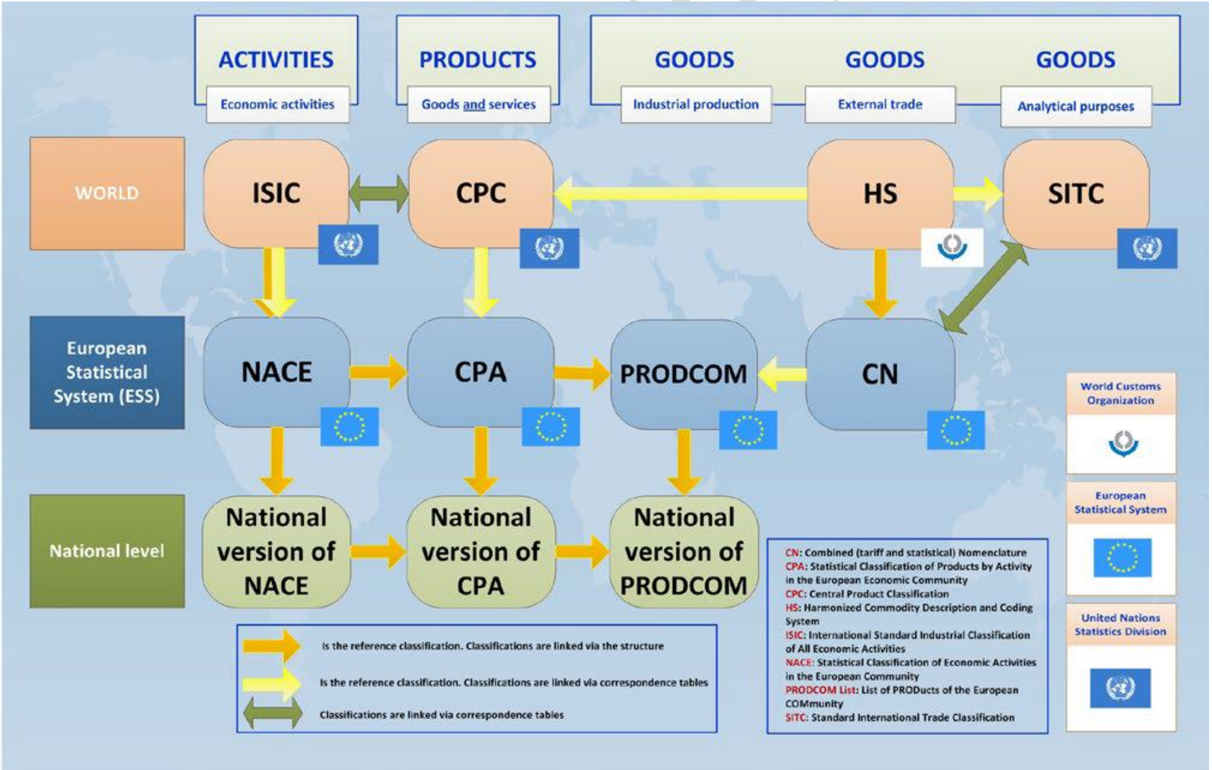
10.1 PRODCOM and market analysis

10.1.1 General description

PRODCOM is the classification of goods used for statistics in value and quantity on industrial production in the EU. It is abbreviated from the French Production Communautaire and it is regulated by the Commission Implementing Regulation (EU) 2020/1197 ([173]). **Figure 28** shows the classification of activities, products and goods at level of world, EU and Member States. **Figure 28** describes how PRODCOM classification relates to the other classifications.

PRODCOM was developed in a close relationship with Combined (tariff and statistical) Nomenclature (CN) for external trades, which is strictly related to Harmonised System used in the World Custom Organization. The basic building blocks of PRODCOM are the European Classification of Economic Activities (NACE) ([174]) and the European Classification of Products by Activity (CPA) ([175]). Products are identified in PRODCOM via their eight-digit code, the PRODCOM List ([176]). The first four digits of a PRODCOM code refer to the NACE classification, the first six digits refer to the CPA classification, and the last two digits are created specifically for PRODCOM.

Figure 28. Statistical classifications



Source: (Eurostat, 2023)

[173] European business statistics. COMMISSION IMPLEMENTING REGULATION (EU) 2020/1197 of 30 July 2020 laying down technical specifications and arrangements pursuant to Regulation (EU) 2019/2152 of the European Parliament and of the Council on European business statistics repealing 10 legal acts in the field of business statistics. Available at this link.

[174] The statistical classification of economic activities NACE Revision 2. Regulation (EC) No 1893/2006. Available at this link.

[175] Statistical Classification of Products by Activity. COMMISSION REGULATION (EU) No 1209/2014 of 29 October 2014 amending Regulation (EC) No 451/2008 of the European Parliament and of the Council establishing a new statistical classification of products by activity (CPA) and repealing Council Regulation (EEC) No 3696/93. Available at this link.

[176] PRODCOM list 2022. Available at this link. Last accessed on 1 December 2023.

NACE is based on the International Standard Industrial Classification of All Economic Activities (ISIC), which is a standard classification of economic activities used by the United Nations ([177]). Both NACE and ISIC are four-digit codes, which define four levels of description from the first to the last digit: sections, divisions, groups and classes. At the level of division (the first two digits), NACE and ISIC are identical and refer to the same activity. At level of group and classes (the third and the fourth digits), NACE and ISIC refer to different products/activities ([178]).

The NACE codes were established in 1970. Along with the evolution of the industrial scenery, the NACE codes were subjected to several revisions resulting in changes over time. From 1995 to 2007, the PRODCOM data were based on NACE Rev. 1.1, whereas from 2008 onwards the PRODCOM data were based on NACE Rev. 2. The NACE Rev. 1.1 classification has 21 sections and 88 divisions, whereas the NACE Rev. 2 counts with 17 sections and 62 divisions. The changes between different versions of NACE are supported by conversion tables, which can show sometimes (1) lack of direct correspondence between the old and new codes, and (2) merging of two or more codes into one ([178]).

Approximately every 2 or 3 years, the PRODCOM Working Group updates the PRODCOM list to reflect changes in the production of goods in the European Union. These changes occur with a frequency set by the technological developments in the industries and as driven by the related nomenclatures (Eurostat, 2023).

10.1.2 Features of PRODCOM data influencing market analysis

PRODCOM dataset DS-056120 includes several indicators ([28]). In the PS, the following indicators were used:

- PRODVAL: value of sold production
- PRODQNT: quantity of sold production
- EXPVAL: value of export
- EXPQNT: quantity of export
- IMPVAL: value of import
- IMPQNT: quantity of import
- QNTUNIT: unit used to report quantities

The PRODCOM user's manual reports the following features (Eurostat, 2023).

PRODQNT

When a PRODCOM code does not report the unit in QNTUNIT, the figure of PRODQNT is not required to be reported. Additionally, figures could be missing due to confidentiality.

EXPQNT and IMPQNT

Comext ([179]) is the dataset disseminating the international trades in goods statistics. PRODCOM extracts information from Comext. Most of PRODCOM codes have a complete reference to CN, meaning that there is full comparability between data from PRODCOM and data from CN. However, data could be missing from PRODCOM when:

- the corresponding trade data on quantity cannot be provided for PRODCOM codes for which unit of measure is not consistent with unit of measure given in CN, even if a PRODCOM code has a complete CN reference and/or;
- If there is no clear link between PRODCOM and CN.

Apparent consumption

The apparent consumption is obtained summing the production to the import and then subtracting the export. The use of this economic indicator should consider the following aspects:

[177] The UNSTATS webpage is available at this link. Last accessed on 26 September 2023.
[178] The introductory guidelines to NACE Rev. 2. Available at this link. Last accessed on 29 September 2023.
[179] Comext dataset. Available at this link. Last accessed on 2 December 2023.

1. The integration of production and trade data is challenged by the possible heterogeneity between the PRODCOM codes and the trade data reported by Comext.
2. The thresholds above which businesses are represented in PRODCOM and Comext could differ.
3. Data reported in PRODCOM refer to a specific year, but there are temporal delays in production, import and exports. However, the delays are reduced when data are considered over several years.
4. The value of exports cannot always be compared directly with that of sold production.
   (a) Sold production is based on the ex-work selling price ([180]), whereas exports are evaluated at the time the goods cross the border.
   (b) Imported goods can be exported again with a different value, either without being modified or after industrial processing.
5. Some figures of quantity of sold production could be missing because of confidentiality or because Member States are exempted to report them when quantity units are not specified for the specific PRODCOM code.

10.1.3 Market analysis for the selection of the scope

The market analysis reported in Section 3.1.2 used the PRODCOM codes reporting about the NACE activities specified in **Table 54**.

Table 54. NACE codes describing the product group of textiles and footwear

Subgroup	NACE codes
Textile apparel	C1412 - Manufacture of workwear C1413 - Manufacture of other outerwear C1414 - Manufacture of underwear C1419 - Manufacture of other wearing apparel and accessories C1431 - Manufacture of knitted and crocheted hosiery C1439 - Manufacture of other knitted and crocheted apparel
Home/interior textiles	C1392 - Manufacture of made-up textile articles, except apparel C1393 - Manufacture of carpets and rugs
Footwear	C1520 - Manufacture of footwear
Technical textiles	C1394 - Manufacture of cordage, rope, twine and netting C1395 - Manufacture of non-wovens and articles made from non-wovens, except apparel C1396 - Manufacture of other technical and industrial textiles C1399 - Manufacture of other textiles n.e.c.

Table 55, **Table 56**, **Table 57**, and **Table 58** report all the PRODCOM codes used for the analysis of amount of sales and trades in EU. They also report the conversion factors used for the quantification of quantities expressed in mass.

[180] Ex-work selling price does not include any transportation cost, which are addressed by the buyer.

Table 55. PRODCOM codes describing the subgroup of textile apparel in 2019

PRODCOM code	Description of the PRODCOM code	QNT UNIT	Type	Conversion factor to kg
14121120	Men’s or boys’ ensembles, of cotton or man-made fibres, for industrial and occupational wear	p/st	S	0.5
14121130	Men’s or boys’ jackets and blazers, of cotton or man-made fibres, for industrial and occupational wear	p/st	S	0.95
14121240	Men’s or boys’ trousers and breeches, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.45
14121250	Men’s or boys’ bib and brace overalls, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.45
14122120	Women’s or girls’ ensembles, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.5
14122130	Women’s or girls’ jackets and blazers, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.95
14122240	Women’s or girls’ trousers and breeches, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.45
14122250	Women’s or girls’ bib and brace overalls, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.45
14123013	Men’s or boys’ other garments, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.5
14123023	Women’s or girls’ other garments, of cotton or man-made fibres, for industrial or occupational wear	p/st	S	0.5
14131110	Men’s or boys’ overcoats, car-coats, capes, cloaks and similar articles, of knitted or crocheted textiles (excluding jackets and blazers, anoraks, wind-cheaters and wind-jackets)	p/st	S	0.95
14131120	Men’s or boys’ waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	p/st	S	0.95
14131230	Men’s or boys’ jackets and blazers, of knitted or crocheted textiles	p/st	S	0.95
14131260	Men’s or boys’ suits and ensembles, of knitted or crocheted textiles	p/st	S	0.5
14131270	Men’s or boys’ trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles	p/st	S	0.45
14131310	Women’s or girls’ overcoats, car-coats, capes, cloaks and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	p/st	S	0.95
14131320	Women’s or girls’ waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	p/st	S	0.95
14131430	Women’s or girls’ jackets and blazers, of knitted or crocheted textiles	p/st	S	0.95
14131460	Women’s or girls’ suits and ensembles, of knitted or crocheted textiles	p/st	S	0.5
14131470	Women’s or girls’ dresses, of knitted or crocheted textiles	p/st	S	0.3
14131480	Women’s or girls’ skirts and divided skirts, of knitted or crocheted textiles	p/st	S	0.25
14131490	Women’s or girls’ trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles	p/st	S	0.45
14132110	Men's or boys' raincoats	NA	NA	0.5
14132115	Men’s or boys’ raincoats, overcoats, car-coats, capes, etc.	p/st	NA	0.5
14132116	Men's or boys' overcoats, car coats, capes, cloaks, anoraks (including ski-jackets), wind cheaters, wind-jackets and similar articles (excluding suits, ensembles, jackets, blazers, trousers, bib and brace overalls, breeches and shorts)	NA	S	NA
14132120	Men's or boys' overcoats, car-coats, capes, etc.	NA	NA	0.95
14132130	Men’s or boys’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	p/st	NA	0.95
14132200	Men’s or boys’ suits & ensembles (excluding knitted or crocheted)	p/st	S	0.5
14132210	Men's or boys' suits (excluding knitted or crocheted)	NA	NA	1.4
14132220	Men's or boys' ensembles (excluding knitted or crocheted)	NA	NA	1
14132300	Men’s or boys’ jackets and blazers (excluding knitted or crocheted)	p/st	S	0.95
14132442	Men’s or boys’ trousers and breeches, of denim (excluding for industrial or occupational wear)	p/st	S	0.45

PRODCOM code	Description of the PRODCOM code	QNT UNIT	Type	Conversion factor to kg
14132444	Men’s or boys’ trousers, breeches and shorts, of wool or fine animal hair (excluding knitted or crocheted, for industrial or occupational wear)	p/st	S	0.45
14132445	Men’s or boys’ trousers and breeches, of man-made fibres (excluding knitted or crocheted, for industrial or occupational wear)	p/st	S	0.45
14132448	Men’s or boys’ trousers and breeches, of cotton (excluding denim, knitted or crocheted)	p/st	S	0.45
14132449	Men’s or boys’ trousers, breeches, shorts and bib and brace overalls (excluding of wool, cotton and man-made fibres, knitted or crocheted)	p/st	S	0.45
14132455	Men’s or boys’ bib and brace overalls (excluding knitted or crocheted, for industrial or occupational wear)	p/st	S	0.45
14132460	Men’s or boys’ shorts, of cotton or man-made fibres (excluding knitted or crocheted)	p/st	S	0.45
14133110	Woman's or girls' raincoats	NA	NA	0.5
14133115	Woman’s or girls’ raincoats and overcoats, etc.	p/st	NA	0.5
14133116	Women's or girls' overcoats, car-coats, capes, cloaks, anoraks (including ski jackets), wind-cheaters, wind-jackets and similar articles (excluding suits, ensembles, jackets, blazers, dresses, skirts, divided skirts, trousers, bib and brace overalls, breeches and shorts)	NA	S	NA
14133120	Woman's or girls' overcoats, etc.	NA		0.95
14133130	Women’s or girls’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	p/st	NA	0.95
14133200	Women’s or girls’ suits & ensembles (excluding knitted or crocheted)	p/st	S	0.5
14133210	Women's or girls' suits (excluding knitted or crocheted)	NA	NA	1.4
14133220	Women's or girls' ensembles (excluding knitted or crocheted)	NA	NA	1
14133330	Women’s or girls’ jackets and blazers (excluding knitted or crocheted)	p/st	S	0.95
14133470	Women’s or girls’ dresses (excluding knitted or crocheted)	p/st	S	0.3
14133480	Women’s or girls’ skirts and divided skirts (excluding knitted or crocheted)	p/st	S	0.25
14133542	Women’s or girls’ trousers and breeches, of denim (excluding for industrial or occupational wear)	p/st	S	0.45
14133548	Women’s or girls’ trousers and breeches, of cotton (excluding denim, for industrial or occupational wear)	p/st	S	0.45
14133549	Women’s or girls’ trousers and breeches, of wool or fine animal hair or man-made fibres (excluding knitted or crocheted and for industrial and occupational wear)	p/st	S	0.45
14133551	Women’s or girls’ bib and brace overalls, of cotton (excluding knitted or crocheted, for industrial or occupational wear)	p/st	S	0.45
14133561	Women’s or girls’ shorts, of cotton (excluding knitted and crocheted)	p/st	S	0.45
14133563	Women's or girls' bib and brace overalls, of wool or fine animal hair and man-made fibres (excluding cotton, knitted or crocheted, for industrial or occupational wear) and women's or girls' shorts, of wool or fine animal hair (excluding knitted or crocheted)	p/st	S	0.45
14133565	Women’s or girls’ shorts, of man-made fibres (excluding knitted or crocheted)	p/st	S	0.45
14133569	Women’s or girls’ trousers, breeches, bib and brace overalls, of textiles (excluding cotton, wool or fine animal hair, man-made fibres, knitted or crocheted)	p/st	S	0.45
14141100	Men's or boys' shirts, knitted or crocheted	p/st	S	0.25
14141220	Men’s or boys’ underpants and briefs, of knitted or crocheted textiles (including boxer shorts)	p/st	S	0.08
14141230	Men’s or boys’ nightshirts and pyjamas, of knitted or crocheted textiles	p/st	S	0.15
14141240	Men’s or boys’ dressing gowns, bathrobes and similar articles, of knitted or crocheted textiles	p/st	S	0.3
14141310	Women’s or girls’ blouses, shirts and shirt-blouses, of knitted or crocheted textiles	p/st	S	0.25
14141420	Women’s or girls’ briefs and panties, of knitted or crocheted textiles (including boxer shorts)	p/st	S	0.08
14141430	Women’s or girls’ nighties and pyjamas, of knitted or crocheted textiles	p/st	S	0.15
14141440	Women’s or girls’ negligees, bathrobes, dressing gowns and similar articles, of knitted or crocheted textiles	p/st	S	0.3
14141450	Women’s or girls’ slips and petticoats, of knitted or crocheted textiles	p/st	S	0.5

PRODCOM code	Description of the PRODCOM code	QNT UNIT	Type	Conversion factor to kg
14142100	Men’s or boys’ shirts (excluding knitted or crocheted)	p/st	S	0.25
14142220	Men’s or boys’ underpants and briefs (including boxer shorts) (excluding knitted or crocheted)	p/st	S	0.08
14142230	Men’s or boys’ nightshirts and pyjamas (excluding knitted or crocheted)	p/st	S	0.15
14142240	Men’s or boys’ singlets, vests, bathrobes, dressing gowns and similar articles (excluding knitted or crocheted)	p/st	S	0.3
14142300	Women’s or girls’ blouses, shirts and shirt-blouses (excluding knitted or crocheted)	p/st	S	0.25
14142430	Women’s or girls’ nightdresses and pyjamas (excluding knitted or crocheted)	p/st	S	0.3
14142450	Women’s or girls’ slips and petticoats (excluding knitted or crocheted)	p/st	S	0.5
14142460	Women’s or girls’ singlets and other vests, briefs, panties, negligees, bathrobes, dressing gowns, housecoats and similar articles of cotton (excluding knitted or crocheted)	p/st	S	0.08
14142480	Women's or girls' negligees, bathrobes, dressing gowns, singlets, vests, briefs and panties (including boxer shorts), of man-made fibres (excluding knitted or crocheted)	p/st	S	0.08
14142489	Women’s or girls’ singlets, vests, briefs, panties, negligees, bathrobes, dressing gowns and similar articles, of textiles (excluding cotton, man-made fibres, knitted or crocheted)	p/st	S	0.08
14142530	Brassieres	p/st	S	0.05
14142550	Girdles, panty-girdles and corselettes (including bodies with adjustable straps)	p/st	S	0.5
14142570	Braces, suspenders, garters and similar articles and parts thereof	NA	S	NA
14143000	T-shirts, singlets and vests, knitted or crocheted	p/st	S	0.17
14191100	Babies’ garments and clothing accessories, knitted or crocheted including vests, rompers, underpants, stretch-suits, gloves or mittens or mitts, outerwear (for children of height <= 86 cm)	NA	S	NA
14191210	Track-suits, of knitted or crocheted textiles	p/st	S	0.5
14191230	Ski-suits, of knitted or crocheted textiles	p/st	S	0.5
14191240	Men’s or boys’ swimwear, of knitted or crocheted textiles	p/st	S	0.12
14191250	Women’s or girls’ swimwear, of knitted or crocheted textiles	p/st	S	0.12
14191290	Other garments, knitted or crocheted (including bodies with a proper sleeve)	kg	S	1
14191300	Gloves, mittens and mitts, of knitted or crocheted textiles	pa	S	0.1
14191930	Shawls, scarves, mufflers, mantillas, veils and the like, of knitted or crocheted textiles	p/st	S	0.1
14191960	Clothing accessories and parts thereof, of knitted or crocheted textiles (excluding gloves, mittens, shawls, scarves, mufflers, mantillas and veils)	NA	S	NA
14192100	Babies' clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, napkins, gloves, mittens and outerwear	NA	NA	NA
14192150	Babies clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, gloves, mittens and outerwear (excluding sanitary towels and napkins and similar articles)	NA	S	NA
14192210	Other men’s or boys’ apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	p/st	S	0.5
14192220	Other women’s or girls’ apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	p/st	S	0.5
14192230	Ski-suits (excluding of knitted or crocheted textiles)	p/st	S	0.5
14192240	Men’s or boys’ swimwear (excluding of knitted or crocheted textiles)	p/st	S	0.12
14192250	Women’s or girls’ swimwear (excluding of knitted or crocheted textiles)	p/st	S	0.12
14192310	Handkerchiefs	p/st	S	0.5
14192333	Shawls, scarves, mufflers, mantillas, veils and the like (excluding articles of silk or silk waste, knitted or crocheted)	p/st	S	0.15
14192338	Shawls, scarves, mufflers, mantillas, veils and the like, of silk or silk waste (excluding knitted or crocheted)	p/st	S	0.15

PRODCOM code	Description of the PRODCOM code	QNT UNIT	Type	Conversion factor to kg
14192353	Ties, bow ties and cravats (excluding articles of silk or silk waste, knitted or crocheted)	p/st	S	0.15
14192358	Ties, bow ties and cravats, of silk or silk waste (excluding knitted or crocheted)	p/st	S	0.15
14192370	Gloves, mittens and mitts (excluding knitted or crocheted)	pa	S	0.1
14192393	Clothing accessories of textiles (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts, knitted or crocheted)	NA	NA	NA
14192395	Parts of garments or of clothing accessories, of textiles (excluding bras, girdles and corsets, braces, suspenders and garters, knitted or crocheted)	NA	NA	NA
14192396	Clothing accessories, parts of garments or of clothing accessories, of textiles, n.e.c. and parts thereof, (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts and parts thereof; bras, girdles and corsets, braces, suspenders and garters, knitted or crocheted)	NA	S	NA
14193200	Garments made up of felt or non-wovens, textile fabrics impregnated or coated	p/st	S	0.1
14194130	Hat-forms, hat bodies and hoods, plateaux and manchons of felt (including slit manchons) (excluding those blocked to shape, those with made brims)	p/st	S	0.1
14194150	Hat-shapes, plaited or made by assembling strips of any material (excluding those blocked to shape, those with made brims, those lined or trimmed)	p/st	S	0.1
14194230	Felt hats and other felt headgear, made from hat bodies or hoods and plateaux	p/st	S	0.1
14194250	Hats and other headgear, plaited or made by assembling strips of any material	p/st	S	0.1
14194270	Hats and other headgear, knitted or crocheted or made-up from lace, felt or other textile fabric in the piece (but not in strips); hair-nets of any material	p/st	S	0.1
14194300	Other headgear (except headgear of rubber or of plastics, safety headgear and asbestos headgear); headbands, linings, covers, hat foundations, hat frames, peaks and chinstraps, for headgear	NA	S	NA
14311033	Panty hose and tights, of knitted or crocheted synthetic fibres, measuring per single yarn < 67 decitex	p/st	S	0.07
14311035	Panty hose and tights, of knitted or crocheted synthetic fibres, measuring per single yarn >= 67 decitex	p/st	S	0.07
14311037	Pantyhose and tights of textile materials, knitted or crocheted (excl. graduated compression hosiery, those of synthetic fibres and hosiery for babies)	p/st	S	0.07
14311050	Women’s full-length or knee-length knitted or crocheted hosiery, measuring per single yarn < 67 decitex	pa	S	0.01
14311090	Knitted or crocheted hosiery and footwear (including socks; excluding women’s full-length/knee-length hosiery, measuring <67decitex, panty-hose and tights, footwear with applied soles)	pa	S	0.07
14391031	Men’s or boys’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of wool or fine animal hair (excluding jerseys and pullovers containing >= 50 % of wool and weighing >= 600 g)	p/st	S	0.5
14391032	Women’s or girls’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of wool or fine animal hair (excluding jerseys and pullovers containing >= 50 % of wool and weighing >= 600 g)	p/st	S	0.5
14391033	Jerseys and pullovers, containing >= 50 % by weight of wool and weighing >= 600 g per article	p/st	S	0.3
14391053	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of cotton	p/st	S	0.5
14391055	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of man-made fibres	p/st	S	0.5
14391061	Men’s or boys’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of cotton (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	S	0.5
14391062	Women’s or girls’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of cotton (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	S	0.5
14391071	Men’s or boys’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of man-made fibres (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	S	0.5

PRODCOM code	Description of the PRODCOM code	QNT UNIT	Type	Conversion factor to kg
14391072	Women's or girls' jerseys, pullovers, sweatshirts, waistcoats and cardigans, of man-made fibres (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	p/st	S	0.5
14391090	Jerseys, pullovers, sweatshirts, waistcoats and cardigans, of textile materials (excluding those of wool or fine animal hair, cotton, man-made fibres)	p/st	S	0.5

QNTUNIT: PRODCOM indicator about unit used to report quantities.
kg = kilogram; p/st = number of items; pa = number of pairs; NA = data not available

Source: own elaboration based on Eurostat data set DS-056120 (data extracted on 15 November 2023). Conversion factors used to convert the unit reported in EUROSTAT to kg based on (Huygens et al., 2023)

Table 56. PRODCOM codes describing the subgroup of home/interior textiles in 2019

PRODCOM code	Description of the PRODCOM code	QNTUNIT	TYPE	Conversion Factor to kg
13921130	Blankets and travelling rugs of wool or fine animal hair (excluding electric blankets)	p/st	S	0.5
13921150	Blankets and travelling rugs of synthetic fibres (excluding electric blankets)	p/st	S	0.5
13921190	Blankets (excluding electric blankets) and travelling rugs of textile materials (excluding of wool or fine animal hair, of synthetic fibres)	p/st	S	0.5
13921230	Bed linen of knitted or crocheted textiles	kg	S	1
13921253	Bed linen of cotton (excluding knitted or crocheted)	kg	S	1
13921255	Bed linen of flax or ramie (excluding knitted or crocheted)	kg	S	1
13921259	Bed linen of woven textiles (excluding of cotton, of flax or ramie)	kg	S	1
13921270	Bed linen of non-woven man-made fibres (excluding knitted or crocheted)	kg	S	1
13921330	Table linen of knitted or crocheted textiles	kg	S	1
13921353	Table linen of cotton (excluding knitted or crocheted)	kg	S	1
13921355	Table linen of flax (excluding knitted or crocheted)	kg	S	1
13921359	Table linen of woven man-made fibres and of other woven or non-woven textiles (excluding of cotton, of flax)	kg	S	1
13921370	Table linen of non-woven man-made fibres	kg	S	1
13921430	Toilet linen and kitchen linen, of terry towelling or similar terry fabrics of cotton	kg	S	1
13921450	Woven toilet linen and kitchen linen, of textiles (excluding terry towelling or similar terry fabrics of cotton)	kg	S	1
13921470	Toilet linen and kitchen linen, of non-woven man-made fibres	kg	S	1
13921530	Curtains and interior blinds, curtain or bed valances, of knitted or crocheted materials	m^2	S	0.25
13921550	Curtains and interior blinds, curtain or bed valances, of woven materials	m^2	S	0.25
13921570	Curtains and interior blinds, curtain or bed valances, of non-woven materials	m^2	S	0.25
13921620	Hand-woven tapestries of the type Gobelins, Flanders, Aubusson, Beauvais, and needle-worked tapestries (including petit point, cross-stitch) whether or not made up	NA	S	NA
13921640	Bedspreads (excluding eiderdowns)	p/st	S	0.5
13921660	Furnishing articles including furniture and cushion covers as well as cushion covers, etc. for car seats (excluding blankets, travelling rugs, bed linen, table linen, toilet linen, kitchen linen, curtains, blinds, valances and bedspreads)	NA	S	NA
13921680	Sets of woven fabrics and yarns for making up into rugs, tapestries, embroidered table cloths, serviettes, or similar textile articles, p.r.s.	NA	S	NA
13922130	Sacks and bags, of cotton, used for packing goods	kg	S	1

PRODCOM code	Description of the PRODCOM code	QNTUNIT	TYPE	Conversion Factor to kg
13922150	Sacks and bags, of knitted or crocheted polyethylene or polypropylene strip, used for packing goods	kg	S	1
13922170	Sacks and bags, of polyethylene or polypropylene strip, used for packing goods (excluding knitted or crocheted)	kg	S	1
13922173	Sacks and bags, of polyethylene or polypropylene strip, weighing <= 120 g/m2, used for packing goods (excluding knitted or crocheted)	NA	NA	NA
13922175	Sacks and bags, of polyethylene or polypropylene strip, weighing > 120 g/m2, used for packing goods (excluding knitted or crocheted)	NA	NA	NA
13922190	Sacks and bags, used for packing goods (excluding of cotton, polyethylene or polypropylene strip)	kg	S	1
13922210	Tarpaulins, awnings and sunblinds (excluding caravan awnings)	kg	S	1
13922230	Tents (including caravan awnings)	kg	S	1
13922250	Sails	kg	S	1
13922270	Pneumatic mattresses and other camping goods (excluding caravan awnings, tents, sleeping bags)	kg	S	1
13922300	Parachutes and rotochutes, parts and accessories (including dirigible parachutes)	kg	S	1
13922430	Sleeping bags	p/st	S	0.5
13922493	Articles of bedding of feathers or down (including quilts and eiderdowns, cushions, pouffes, pillows) (excluding mattresses, sleeping bags)	p/st	S	0.5
13922499	Articles of bedding filled other than with feathers or down (including quilts and eiderdowns, cushions, pouffes, pillows) (excluding mattresses, sleeping bags)	p/st	S	0.5
13922953	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, of non-woven textiles	kg	S	1
13922957	Floor-cloths, dish-cloths, dusters and similar cleaning cloths (excluding knitted or crocheted, articles of non-woven textiles)	kg	S	1
13922990	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, knitted or crocheted; life-jackets, life-belts and other made up articles	NA	NA	NA
13922993	Sanitary towels, tampons and similar article of textile materials (excluding wadding)	NA	NA	NA
13922997	Napkins and napkin liners for babies and similar article of textile materials (excluding wadding)	NA	NA	NA
13922998	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, knitted or crocheted; life-jackets, life-belts and other made up articles (excluding protective face masks, sanitary towels and napkins and similar articles)	NA	S	NA
13922999	Floor-cloths, dish-cloths, dusters and similar cleaning cloths, knitted or crocheted; life-jackets, life-belts and other made up articles (excluding sanitary towels and napkins and similar articles)	kg	NA	1
13931100	Knotted carpets and other knotted textile floor coverings	m^2	S	1.6
13931200	Woven carpets and other woven textile coverings (excluding tufted or flocked)	m^2	S	1.6
13931300	Tufted carpets and other tufted textile floor coverings	m^2	S	1.38
13931930	Needlefelt carpets and other needlefelt textile floor coverings (excluding tufted or flocked)	m^2	S	1.6
13931990	Carpets and other textile floor coverings (excluding knotted, woven, tufted, needlefelt)	m^2	S	1.6

QNTUNIT: PRODCOM indicator about unit used to report quantities.
kg = kilogram; p/st = number of items; NA = data not available, m^2=square metres

Source: own elaboration based on Eurostat data set DS-056120 (data extracted on 15 November 2023). Conversion factors used to convert the unit reported in EUROSTAT to kg based on (Huygens et al., 2023)

Table 57. PRODCOM codes describing the subgroup of footwear in 2019

PRODCOM code	Description of the PRODCOM code	QNTUNIT	TYPE	Conversion Factor to kg
15201100	Waterproof footwear, with uppers in rubber or plastics (excluding incorporating a protective metal toecap)	pa	S	0.9
15201210	Sandals with rubber or plastic outer soles and uppers (including thong-type sandals, flip flops)	pa	S	0.5
15201231	Town footwear with rubber or plastic uppers	pa	S	0.9

PRODCOM code	Description of the PRODCOM code	QNTUNIT	TYPE	Conversion Factor to kg
15201237	Slippers and other indoor footwear with rubber or plastic outer soles and plastic uppers (including bedroom and dancing slippers, mules)	pa	S	0.35
15201330	Footwear with a wooden base and leather uppers (including clogs) (excluding with an inner sole or a protective metal toe-cap)	pa	S	0.9
15201351	Men’s town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	pa	S	0.9
15201352	Women’s town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	pa	S	0.9
15201353	Children’s town footwear with leather uppers (including boots and shoes; excluding waterproof footwear, footwear with a protective metal toe-cap)	pa	S	0.9
15201361	Men’s sandals with leather uppers (including thong type sandals, flip flops)	pa	S	0.5
15201362	Women’s sandals with leather uppers (including thong type sandals, flip flops)	pa	S	0.5
15201363	Children’s sandals with leather uppers (including thong type sandals, flip flops)	pa	S	0.5
15201370	Slippers and other indoor footwear with rubber, plastic or leather outer soles and leather uppers (including dancing and bedroom slippers, mules)	pa	S	0.35
15201380	Footwear with wood, cork or other outer soles and leather uppers (excluding outer soles of rubber, plastics or leather)	pa	S	0.9
15201444	Slippers and other indoor footwear (including dancing and bedroom slippers, mules) with uppers of textile materials	pa	S	0.35
15201445	Footwear with rubber, plastic or leather outer soles and textile uppers (excluding slippers and other indoor footwear, sports footwear)	pa	S	0.9
15201446	Footwear with textile uppers (excluding slippers and other indoor footwear as well as footwear with outer soles of rubber, plastics, leather or composition leather)	pa	S	0.9
15202100	Sports footwear with rubber or plastic outer soles and textile uppers (including tennis shoes, basketball shoes, gym shoes, training shoes and the like)	pa	S	0.9
15202900	Other sports footwear, except snow-ski footwear and skating boots	pa	S	0.9
15203120	Footwear (including waterproof footwear), incorporating a protective metal toecap, with outer soles and uppers of rubber or of plastics	pa	S	0.9
15203150	Footwear with rubber, plastic or leather outer soles and leather uppers, and with a protective metal toe-cap	pa	S	0.9
15203200	Wooden footwear, miscellaneous special footwear and other footwear n.e.c.	pa	S	0.9
15204020	Leather uppers and parts thereof of footwear (excluding stiffeners)	NA	S	NA
15204050	Uppers and parts thereof of footwear (excluding stiffeners, of leather)	NA	S	NA
15204080	Parts of footwear (excluding uppers) other materials	NA	S	NA

QNTUNIT: PRODCOM indicator about unit used to report quantities.
pa = number of pairs; NA = data not available

Source: own elaboration based on Eurostat data set DS-056120 (data extracted on 15 November 2023). Conversion factors used to convert the unit reported in EUROSTAT to kg based on *(Huygens et al., 2023)*.

Table 58. PRODCOM codes describing the subgroup of technical textiles in 2019

PRODCOM code	Description of the PRODCOM code	QNTUNIT	TYPE	Conversion Factor to kg
13941130	Twine, cordage, rope or cables, of sisal or other textile fibres of ‘agave’, of jute or other textile bast fibres and hard leaf fibres (excluding binder or baler twine)	kg	S	1
13941133	Twine, cordage, rope or cables, of sisal or other textile fibres of 'agave' measuring >100,000 decitex, of jute or other textile bast fibres and hard leaf fibres (excluding binder or baler twine)	NA	NA	NA
13941135	Twines of sisal measuring <= 100,000 decitex (10 g/m) (excluding binder or baler twine)	NA	NA	NA
13941153	Sisal binder or baler (agricultural) twines	kg	S	1
13941155	Polyethylene or polypropylene binder or baler (agricultural) twines	kg	S	1
13941160	Cordage, ropes or cables of polyethylene, polypropylene, nylon or other polyamides or of polyesters measuring > 50 000 decitex, of other synthetic fibres (excluding binder or baler twine)	kg	S	1
13941170	Twines of polyethylene or polypropylene, of nylon or other polyamides or polyesters measuring <= 50 000 decitex (5 g/m) (excluding binder or baler twine)	kg	S	1
13941190	Twines, cordage, rope and cables of textile materials (excluding jute and other textile bast fibres, sisal, abaca or other hard leaf fibres, synthetic fibres)	kg	S	1
13941233	Made-up fishing nets from twine, cordage or rope of man-made fibres (excluding fish landing nets)	kg	S	1
13941235	Made-up fishing nets from yarn of man-made fibres (excluding fish landing nets)	kg	S	1
13941253	Made-up nets from twine, cable or rope of nylon or other polyamides (excluding netting in the piece produced by crochet, hairnets, sports and fishing nets)	kg	S	1
13941255	Made-up nets of nylon or other polyamides (excluding netting in the piece produced by crochet, hairnets, sports and fishing nets, those made from twine, cable or rope)	kg	S	1
13941259	Knotted netting of textile materials (excluding made-up fishing nets of man-made textiles, other made-up nets of nylon or other polyamides)	kg	S	1
13941280	Articles of twine, cordage, rope or cables	kg	S	1
13951010	Non-wovens of a weight <= 25 g/m^2 (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	kg	S	1
13951020	Non-wovens of a weight of > 25 g/m^2 but <= 70 g/m^2 (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	kg	S	1
13951030	Non-wovens of a weight of > 70 g/m^2 but <= 150 g/m^2 (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	kg	S	1
13951050	Non-wovens of a weight of > 150 g/m^2 (including articles made from non-wovens) (excluding articles of apparel, coated or covered)	kg	S	1
13951070	Non-wovens, coated or covered (including articles made from non-wovens) (excluding articles of apparel)	kg	S	1
13961100	Metallised yarn or metallised gimped yarn	kg	S	1
13961200	Woven fabrics of metal thread and woven fabrics of metallised yarn, used in apparel, as furnishing fabrics or similar purposes	kg	S	1
13961300	Rubber thread and cord, textile covered; textile yarn and strip impregnated, coated, covered or sheathed with rubber or plastics	kg	S	1
13961400	Textile fabrics, impregnated, coated or covered n.e.c.	m^2	S	0.25
13961500	Tyre cord fabrics of high tenacity yarn, of nylon, other polyamides, polyesters or viscose rayon	m^2	S	0.25
13961620	Textile hosepiping and similar textile tubing, whether or not impregnated or coated, with or without lining, armour or accessories of other materials	kg	S	1
13961650	Textile wicks, conveyor belts or belting (including reinforced with metal or other material)	kg	S	1
13961680	Textile fabrics and felts, for paper-making machines or similar machines (including for pulp or asbestos-cement)	kg	S	1
13961730	Narrow woven fabrics other than labels, badges and other similar articles	NA	S	NA
13961750	Labels, badges and similar articles in textile materials (excluding embroidered)	NA	S	NA

PRODCOM code	Description of the PRODCOM code	QNTUNIT	TYPE	Conversion Factor to kg
13961770	Braids in the piece; tassels and pompons, ornamental trimmings (excluding knitted or crocheted)	NA	S	NA
13991130	Tulles and other net fabrics (excluding woven, knitted or crocheted)	NA	S	NA
13991150	Machine-made lace in the piece, in strips or in motifs	NA	S	NA
13991170	Hand-made lace in the piece, in strips or in motifs	NA	S	NA
13991230	Embroidery (without visible ground) in the piece, in strips or in motifs	NA	S	NA
13991250	Cotton embroidery in the piece, in strips or in motifs (excluding embroidery without visible ground)	NA	S	NA
13991270	Embroidery of textiles in the piece, in strips or in motifs (excluding without visible ground, cotton)	NA	S	NA
13991300	Felt, whether or not impregnated, coated, covered or laminated, n.e.c.	kg	S	1
13991400	Textile flock and dust and mill neps	kg	S	1
13991500	Gimped yarn and gimped strip and the like, of man-made textile materials of an apparent width <= 5 mm; chenille yarn; loop wale-yarn	kg	S	1
13991600	Quilted textile products in the piece (excluding embroidery)	m^2	S	0.25
13991900	Powder-puffs and pads for the application of cosmetics or toilet preparations	p/st	S	0.5

QNTUNIT: PRODCOM indicator about unit used to report quantities.
kg = kilogram; p/st = number of items; NA = data not available, m^2=square metres
Source: own elaboration based on Eurostat data set DS-056120 (data extracted on 15 November 2023). Conversion factors used to convert the unit reported in EUROSTAT to kg based on (Huygens et al., 2023).

10.1.4 PRODCOM codes included in the scope

Table 59. List and description of PRODCOM codes included in the scope

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
1. T-shirts	14143000	T-shirts, singlets and vests, knitted or crocheted	100	p/st	0.17
	14142240	Men's or boys' singlets, vests, bathrobes, dressing gowns and similar articles (excluding knitted or crocheted)	75	p/st	0.3
	14142460	Women's or girls' singlets and other vests, briefs, panties, negligees, bathrobes, dressing gowns, housecoats and similar articles of cotton (excluding knitted or crocheted)	40	p/st	0.08
	14142480	Women's or girls' negligees, bathrobes, dressing gowns, singlets, vests, briefs and panties (including boxer shorts), of man-made fibres (excluding knitted or crocheted)	40	p/st	0.08
	14142489	Women's or girls' singlets, vests, briefs, panties, negligees, bathrobes, dressing gowns and similar articles, of textiles (excluding cotton, man-made fibres, knitted or crocheted)	40	p/st	0.08
	14123013	Men's or boys' other garments, of cotton or man-made fibres, for industrial or occupational wear	25	p/st	0.5
	14123023	Women's or girls' other garments, of cotton or man-made fibres, for industrial or occupational wear	25	p/st	0.5
	14391053	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of cotton	20	p/st	0.5
	14142430	Women's or girls' nightdresses and pyjamas (excluding knitted or crocheted)	25	p/st	0.3
	14142230	Men's or boys' nightshirts and pyjamas (excluding knitted or crocheted)	25	p/st	0.15
	14141430	Women's or girls' nighties and pyjamas, of knitted or crocheted textiles	25	p/st	0.15

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
	14391055	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of man-made fibres	20	p/st	0.5
	14141230	Men’s or boys’ nightshirts and pyjamas, of knitted or crocheted textiles	25	p/st	0.15
	14191290	Other garments, knitted or crocheted (including bodies with a proper sleeve)	100	kg	1
2. Shirts and blouses	14141100	Men's or boys' shirts, knitted or crocheted	100	p/st	0.25
	14141310	Women’s or girls’ blouses, shirts and shirt-blouses, of knitted or crocheted textiles	100	p/st	0.25
	14142100	Men’s or boys’ shirts (excluding knitted or crocheted)	100	p/st	0.25
	14142300	Women’s or girls’ blouses, shirts and shirt-blouses (excluding knitted or crocheted)	100	p/st	0.25
	14123013	Men’s or boys’ other garments, of cotton or man-made fibres, for industrial or occupational wear	25	p/st	0.5
	14123023	Women’s or girls’ other garments, of cotton or man-made fibres, for industrial or occupational wear	25	p/st	0.5
	14141230	Men’s or boys’ nightshirts and pyjamas, of knitted or crocheted textiles	25	p/st	0.15
	14142430	Women’s or girls’ nightdresses and pyjamas (excluding knitted or crocheted)	25	p/st	0.3
	14142230	Men’s or boys’ nightshirts and pyjamas (excluding knitted or crocheted)	25	p/st	0.15
	14141430	Women’s or girls’ nighties and pyjamas, of knitted or crocheted textiles	25	p/st	0.15
	14391053	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of cotton	40	p/st	0.5
	14391055	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of man-made fibres	40	p/st	0.5
3. Sweaters and mid-layers	14391031	Men’s or boys’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of wool or fine animal hair (excluding jerseys and pullovers containing >= 50 % of wool and weighing >= 600 g)	100	p/st	0.5
	14391032	Women’s or girls’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of wool or fine animal hair (excluding jerseys and pullovers containing >= 50 % of wool and weighing >= 600 g)	100	p/st	0.5
	14391033	Jerseys and pullovers, containing >= 50 % by weight of wool and weighing >= 600 g per article	100	p/st	0.3
	14391053	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of cotton	40	p/st	0.5
	14391055	Lightweight fine knit roll, polo or turtle neck jumpers and pullovers, of man-made fibres	40	p/st	0.5
	14391061	Men’s or boys’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of cotton (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	100	p/st	0.5
	14391062	Women’s or girls’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of cotton (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	100	p/st	0.5
	14132130	Men’s or boys’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	20	p/st	0.95
	14133130	Women’s or girls’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	20	p/st	0.95
	14391071	Men’s or boys’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of man-made fibres (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	100	p/st	0.5
	14391072	Women’s or girls’ jerseys, pullovers, sweatshirts, waistcoats and cardigans, of man-made fibres (excluding lightweight fine knit roll, polo or turtle neck jumpers and pullovers)	100	p/st	0.5

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
	14391090	Jerseys, pullovers, sweatshirts, waistcoats and cardigans, of textile materials (excluding those of wool or fine animal hair, cotton, man-made fibres)	100	p/st	0.5
	14131120	Men’s or boys’ waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	20	p/st	0.95
	14131320	Women’s or girls’ waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	20	p/st	0.95
4. Jackets and coats	14121130	Men’s or boys’ jackets and blazers, of cotton or man-made fibres, for industrial and occupational wear	100	p/st	0.95
	14122130	Women’s or girls’ jackets and blazers, of cotton or man-made fibres, for industrial or occupational wear	100	p/st	0.95
	14131110	Men’s or boys’ overcoats, car-coats, capes, cloaks and similar articles, of knitted or crocheted textiles (excluding jackets and blazers, anoraks, wind-cheaters and wind-jackets)	100	p/st	0.95
	14131120	Men’s or boys’ waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	80	p/st	0.95
	14131230	Men’s or boys’ jackets and blazers, of knitted or crocheted textiles	100	p/st	0.95
	14131310	Women’s or girls’ overcoats, car-coats, capes, cloaks and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	100	p/st	0.95
	14131320	Women’s or girls’ waistcoats, anoraks, ski-jackets, wind-cheaters, wind-jackets and similar articles, of knitted or crocheted textiles (excluding jackets and blazers)	80	p/st	0.95
	14131430	Women’s or girls’ jackets and blazers, of knitted or crocheted textiles	100	p/st	0.95
	14132115	Men’s or boys’ raincoats, overcoats, car-coats, capes, etc.	100	p/st	0.5
	14132130	Men’s or boys’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	80	p/st	0.95
	14132300	Men’s or boys’ jackets and blazers (excluding knitted or crocheted)	100	p/st	0.95
	14133110	Woman's or girls' raincoats	100	p/st	0.5
	14133115	Woman’s or girls’ raincoats and overcoats, etc.	100	p/st	0.5
	14133120	Woman's or girls' overcoats, etc.	100	p/st	0.95
	14133130	Women’s or girls’ waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	80	p/st	0.95
	14133330	Women’s or girls’ jackets and blazers (excluding knitted or crocheted)	100	p/st	0.95
	14192230	Ski-suits (excluding of knitted or crocheted textiles)	50	p/st	0.5
	14191230	Ski-suits, of knitted or crocheted textiles	50	p/st	0.5
	14191100	Babies’ garments and clothing accessories, knitted or crocheted including vests, rompers, underpants, stretch-suits, gloves or mittens or mitts, outerwear (for children of height <= 86 cm)	20	kg	1
	14192150	Babies clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, gloves, mittens and outerwear (excluding sanitary towels and napkins and similar articles)	20	kg	1
	14131260	Men’s or boys’ suits and ensembles, of knitted or crocheted textiles	40	p/st	0.5

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
	14131460	Women’s or girls’ suits and ensembles, of knitted or crocheted textiles	40	p/st	0.5
	14132200	Men’s or boys’ suits & ensembles (excluding knitted or crocheted)	40	p/st	0.5
	14133200	Women’s or girls’ suits & ensembles (excluding knitted or crocheted)	40	p/st	0.5
	14132110	Men's or boys' raincoats	100	p/st	0.5
	14132120	Men's or boys' overcoats, car-coats, capes, etc.	100	p/st	0.95
	14132210	Men's or boys' suits (excluding knitted or crocheted)	50	p/st	1.4
	14132220	Men's or boys' ensembles (excluding knitted or crocheted)	50	p/st	1
	14133210	Women's or girls' suits (excluding knitted or crocheted)	50	p/st	1.4
	14133220	Women's or girls' ensembles (excluding knitted or crocheted)	50	p/st	1
	14192100	Babies' clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, napkins, gloves, mittens and outerwear	20	kg	1
5. Pants and shorts	14131270	Men’s or boys’ trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles	100	p/st	0.45
	14131490	Women’s or girls’ trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles	100	p/st	0.45
	14132442	Men’s or boys’ trousers and breeches, of denim (excluding for industrial or occupational wear)	100	p/st	0.45
	14132444	Men’s or boys’ trousers, breeches and shorts, of wool or fine animal hair (excluding knitted or crocheted, for industrial or occupational wear)	100	p/st	0.45
	14132445	Men’s or boys’ trousers and breeches, of man-made fibres (excluding knitted or crocheted, for industrial or occupational wear)	100	p/st	0.45
	14132448	Men’s or boys’ trousers and breeches, of cotton (excluding denim, knitted or crocheted)	100	p/st	0.45
	14132449	Men’s or boys’ trousers, breeches, shorts and bib and brace overalls (excluding of wool, cotton and man-made fibres, knitted or crocheted)	100	p/st	0.45
	14141230	Men’s or boys’ nightshirts and pyjamas, of knitted or crocheted textiles	50	p/st	0.15
	14132455	Men’s or boys’ bib and brace overalls (excluding knitted or crocheted, for industrial or occupational wear)	100	p/st	0.45
	14132460	Men’s or boys’ shorts, of cotton or man-made fibres (excluding knitted or crocheted)	100	p/st	0.45
	14133542	Women’s or girls’ trousers and breeches, of denim (excluding for industrial or occupational wear)	100	p/st	0.45
	14133548	Women’s or girls’ trousers and breeches, of cotton (excluding denim, for industrial or occupational wear)	100	p/st	0.45
	14133549	Women’s or girls’ trousers and breeches, of wool or fine animal hair or man-made fibres (excluding knitted or crocheted and for industrial and occupational wear)	100	p/st	0.45
	14133551	Women’s or girls’ bib and brace overalls, of cotton (excluding knitted or crocheted, for industrial or occupational wear)	100	p/st	0.45
	14142430	Women’s or girls’ nightdresses and pyjamas (excluding knitted or crocheted)	30	p/st	0.3
	14133561	Women’s or girls’ shorts, of cotton (excluding knitted and crocheted)	100	p/st	0.45

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
	14133563	Women's or girls' bib and brace overalls, of wool or fine animal hair and man-made fibres (excluding cotton, knitted or crocheted, for industrial or occupational wear) and women's or girls' shorts, of wool or fine animal hair (excluding knitted or crocheted)	100	p/st	0.45
	14133565	Women’s or girls’ shorts, of man-made fibres (excluding knitted or crocheted)	100	p/st	0.45
	14133569	Women’s or girls’ trousers, breeches, bib and brace overalls, of textiles (excluding cotton, wool or fine animal hair, man-made fibres, knitted or crocheted)	100	p/st	0.45
	14121240	Men’s or boys’ trousers and breeches, of cotton or man-made fibres, for industrial or occupational wear	100	p/st	0.45
	14121250	Men’s or boys’ bib and brace overalls, of cotton or man-made fibres, for industrial or occupational wear	100	p/st	0.45
	14122240	Women’s or girls’ trousers and breeches, of cotton or man-made fibres, for industrial or occupational wear	100	p/st	0.45
	14141430	Women’s or girls’ nighties and pyjamas, of knitted or crocheted textiles	30	p/st	0.15
	14142230	Men’s or boys’ nightshirts and pyjamas (excluding knitted or crocheted)	50	p/st	0.15
	14122250	Women’s or girls’ bib and brace overalls, of cotton or man-made fibres, for industrial or occupational wear	100	p/st	0.45
	14192230	Ski-suits (excluding of knitted or crocheted textiles)	50	p/st	0.5
	14191230	Ski-suits, of knitted or crocheted textiles	50	p/st	0.5
	14131260	Men’s or boys’ suits and ensembles, of knitted or crocheted textiles	40	p/st	0.5
	14131460	Women’s or girls’ suits and ensembles, of knitted or crocheted textiles	40	p/st	0.5
	14132200	Men’s or boys’ suits & ensembles (excluding knitted or crocheted)	40	p/st	0.5
	14133200	Women’s or girls’ suits & ensembles (excluding knitted or crocheted)	40	p/st	0.5
	14123013	Men’s or boys’ other garments, of cotton or man-made fibres, for industrial or occupational wear	50	p/st	0.5
	14123023	Women’s or girls’ other garments, of cotton or man-made fibres, for industrial or occupational wear	50	p/st	0.5
	14132210	Men's or boys' suits (excluding knitted or crocheted)	50	p/st	1
	14132220	Men's or boys' ensembles (excluding knitted or crocheted)	50	p/st	1
	14133210	Women's or girls' suits (excluding knitted or crocheted)	25	p/st	1
	14133220	Women's or girls' ensembles (excluding knitted or crocheted)	25	p/st	1
6. Dresses, Skirts and jumpsuits	14131470	Women’s or girls’ dresses, of knitted or crocheted textiles	100	p/st	0.3
	14131480	Women’s or girls’ skirts and divided skirts, of knitted or crocheted textiles	100	p/st	0.25
	14133470	Women’s or girls’ dresses (excluding knitted or crocheted)	100	p/st	0.3
	14133480	Women’s or girls’ skirts and divided skirts (excluding knitted or crocheted)	100	p/st	0.25
	14131260	Men’s or boys’ suits and ensembles, of knitted or crocheted textiles	20	p/st	0.5
	14121120	Men’s or boys’ ensembles, of cotton or man-made fibres, for industrial and occupational wear	100	p/st	0.5
	14191210	Track-suits, of knitted or crocheted textiles	100	p/st	0.5
	14141430	Women’s or girls’ nighties and pyjamas, of knitted or crocheted textiles	20	p/st	0.15
	14132200	Men’s or boys’ suits & ensembles (excluding knitted or crocheted)	20	p/st	0.5

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
	14142489	Women's or girls' singlets, vests, briefs, panties, negligees, bathrobes, dressing gowns and similar articles, of textiles (excluding cotton, man-made fibres, knitted or crocheted)	30	p/st	0.08
	14142450	Women's or girls' slips and petticoats (excluding knitted or crocheted)	100	p/st	0.5
	14142480	Women's or girls' negligees, bathrobes, dressing gowns, singlets, vests, briefs and panties (including boxer shorts), of man-made fibres (excluding knitted or crocheted)	30	p/st	0.08
	14142430	Women's or girls' nightdresses and pyjamas (excluding knitted or crocheted)	20	p/st	0.3
	14142240	Men's or boys' singlets, vests, bathrobes, dressing gowns and similar articles (excluding knitted or crocheted)	25	p/st	0.3
	14141440	Women's or girls' negligees, bathrobes, dressing gowns and similar articles, of knitted or crocheted textiles	100	p/st	0.3
	14141450	Women's or girls' slips and petticoats, of knitted or crocheted textiles	100	p/st	0.5
	14141240	Men's or boys' dressing gowns, bathrobes and similar articles, of knitted or crocheted textiles	100	p/st	0.3
	14192210	Other men's or boys' apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	100	p/st	0.5
	14192220	Other women's or girls' apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	100	p/st	0.5
	14122120	Women's or girls' ensembles, of cotton or man-made fibres, for industrial or occupational wear	100	p/st	0.5
	14131460	Women's or girls' suits and ensembles, of knitted or crocheted textiles	20	p/st	0.5
	14133200	Women's or girls' suits & ensembles (excluding knitted or crocheted)	20	p/st	0.5
	14142460	Women's or girls' singlets and other vests, briefs, panties, negligees, bathrobes, dressing gowns, housecoats and similar articles of cotton (excluding knitted or crocheted)	30	p/st	0.08
	14133210	Women's or girls' suits (excluding knitted or crocheted)	25	p/st	1
	14133220	Women's or girls' ensembles (excluding knitted or crocheted)	25	p/st	1
7. Leggings, Stockings, Tights and socks	14311033	Panty hose and tights, of knitted or crocheted synthetic fibres, measuring per single yarn < 67 decitex	100	p/st	0.07
	14311035	Panty hose and tights, of knitted or crocheted synthetic fibres, measuring per single yarn >= 67 decitex	100	p/st	0.07
	14311037	Pantyhose and tights of textile materials, knitted or crocheted (excl. graduated compression hosiery, those of synthetic fibres and hosiery for babies)	100	p/st	0.07
	14311050	Women's full-length or knee-length knitted or crocheted hosiery, measuring per single yarn < 67 decitex	100	pa	0.01
	14311090	Knitted or crocheted hosiery and footwear (including socks; excluding women's full-length/knee-length hosiery, measuring <67decitex, panty-hose and tights, footwear with applied soles)	95	pa	0.07
8. Underwear	14141220	Men's or boys' underpants and briefs, of knitted or crocheted textiles (including boxer shorts)	100	p/st	0.08
	14141420	Women's or girls' briefs and panties, of knitted or crocheted textiles (including boxer shorts)	100	p/st	0.08
	14142220	Men's or boys' underpants and briefs (including boxer shorts) (excluding knitted or crocheted)	100	p/st	0.08

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
	14142530	Brassieres	100	p/st	0.05
	14142550	Girdles, panty-girdles and corselettes (including bodies with adjustable straps)	100	p/st	0.5
	14191100	Babies’ garments and clothing accessories, knitted or crocheted including vests, rompers, underpants, stretch-suits, gloves or mittens or mitts, outerwear (for children of height <= 86 cm)	50	kg	1
	14192150	Babies clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, gloves, mittens and outerwear (excluding sanitary towels and napkins and similar articles)	50	kg	1
	14142460	Women’s or girls’ singlets and other vests, briefs, panties, negligees, bathrobes, dressing gowns, housecoats and similar articles of cotton (excluding knitted or crocheted)	30	p/st	0.08
	14142480	Women's or girls' negligees, bathrobes, dressing gowns, singlets, vests, briefs and panties (including boxer shorts), of man-made fibres (excluding knitted or crocheted)	30	p/st	0.08
	14142489	Women’s or girls’ singlets, vests, briefs, panties, negligees, bathrobes, dressing gowns and similar articles, of textiles (excluding cotton, man-made fibres, knitted or crocheted)	30	p/st	0.08
	14192100	Babies' clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, napkins, gloves, mittens and outerwear	50	kg	1
9. Swimwear	14191240	Men’s or boys’ swimwear, of knitted or crocheted textiles	100	p/st	0.12
	14191250	Women’s or girls’ swimwear, of knitted or crocheted textiles	100	p/st	0.12
	14192240	Men’s or boys’ swimwear (excluding of knitted or crocheted textiles)	100	p/st	0.12
	14192250	Women’s or girls’ swimwear (excluding of knitted or crocheted textiles)	100	p/st	0.12
10. Accessories	14191300	Gloves, mittens and mitts, of knitted or crocheted textiles	100	pa	0.1
	14191930	Shawls, scarves, mufflers, mantillas, veils and the like, of knitted or crocheted textiles	100	p/st	0.1
	14191960	Clothing accessories and parts thereof, of knitted or crocheted textiles (excluding gloves, mittens, shawls, scarves, mufflers, mantillas and veils)	100	p/st	1
	14192310	Handkerchiefs	100	p/st	0.5
	14192333	Shawls, scarves, mufflers, mantillas, veils and the like (excluding articles of silk or silk waste, knitted or crocheted)	100	p/st	0.15
	14192338	Shawls, scarves, mufflers, mantillas, veils and the like, of silk or silk waste (excluding knitted or crocheted)	100	p/st	0.15
	14192353	Ties, bow ties and cravats (excluding articles of silk or silk waste, knitted or crocheted)	100	p/st	0.15
	14192358	Ties, bow ties and cravats, of silk or silk waste (excluding knitted or crocheted)	100	p/st	0.15
	14192370	Gloves, mittens and mitts (excluding knitted or crocheted)	100	pa	0.1
	14192393	Clothing accessories of textiles (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts, knitted or crocheted)	100	NA	1
	14192395	Parts of garments or of clothing accessories, of textiles (excluding bras, girdles and corsets, braces, suspenders and garters, knitted or crocheted)	100	NA	1
	14192396	Clothing accessories, parts of garments or of clothing accessories, of textiles, n.e.c. and parts thereof, (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts and parts thereof; bras, girdles and corsets, braces, suspenders and garters, knitted or crocheted)	100	NA	1

Category	PRODCOM code	Description of the PRODCOM code	Allocation of the code in the product category (%)	Reported measure unit in PRODCOM	Conversion Factor to kg
	14194130	Hat-forms, hat bodies and hoods, plateaux and manchons of felt (including slit manchons) (excluding those blocked to shape, those with made brims)	100	p/st	0.1
	14194150	Hat-shapes, plaited or made by assembling strips of any material (excluding those blocked to shape, those with made brims, those lined or trimmed)	100	p/st	0.1
	14194230	Felt hats and other felt headgear, made from hat bodies or hoods and plateaux	100	p/st	0.1
	14194250	Hats and other headgear, plaited or made by assembling strips of any material	100	p/st	0.1
	14194270	Hats and other headgear, knitted or crocheted or made-up from lace, felt or other textile fabric in the piece (but not in strips); hair-nets of any material	100	p/st	0.1

kg=kilogram, p/st= Number of items, pa=Number of pairs, NA= Not available

Some codes were assigned to more than one product category with different allocation percentage. This allocation was an estimation of the authors based on the description of the PRODCOM code.

Source: own elaboration based on Eurostat data set DS-056120 (data extracted on 15 November 2023). Conversion factors used to convert the unit reported in EUROSTAT to kg based on (Huygens, Dries et al., 2023).

Table 60. Characteristics of data used for the market analysis

PRODCOM codes affected by changes	Subgroup	Product category ID and name (share of the code allocated to the category)	Codes description	Implications of the affected codes (rationale) over the existing codes (merging, newly introduced, complementing, etc.)	Affected indicator	Missing data
14123013	Apparel	1.T-shirts (25%) 2.Shirts and blouses (25%) 5.Pants and shorts (50%)	Men's or boys' other garments, of cotton or man-made fibres, for industrial or occupational wear	The 2 affected codes were added in 2001 to complement the codes about industrial and occupational wear: 14121120 14121130 14121240 14121250 14122120 14122130 14122240 14122250	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	NA
14123023	Apparel	1.T-shirts (25%) 2.Shirts and blouses (25%) 5.Pants and shorts (25%)	Women's or girls' other garments, of cotton or man-made fibres, for industrial or occupational wear			NA
14131260	Apparel	4.Jackets and coats (40%) 5.Pants and shorts (40%) 6.Dresses, Skirts and jumpsuits (20%)	Men's or boys' suits and ensembles, of knitted or crocheted textiles	The 4 affected codes were added in 2001 to complement the codes about knitted and crocketed textiles groups: 14131110 14131120 14131230 14131310 14131320	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	NA
14131270	Apparel	5.Pants and shorts (100%)	Men's or boys' trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles			NA

PRODCOM codes affected by changes	Subgroup	Product category ID and name (share of the code allocated to the category)	Codes description	Implications of the affected codes (rationale) over the existing codes (merging, newly introduced, complementing, etc.)	Affected indicator	Missing data
14131460	Apparel	4.Jackets and coats (40%) 5.Pants and shorts (40%) 6.Dresses, Skirts and jumpsuits (20%)	Women's or girls' suits and ensembles, of knitted or crocheted textiles	14131430 14131470 14131480)		NA
14131490	Apparel	5.Pants and shorts (100%)	Women's or girls' trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles			NA
14132115	Apparel	4.Jackets and coats (100%)	Men's or boys' raincoats, overcoats, car-coats, capes, etc.	The affected code was added in 2013, merging the following 2 codes: 14132110 14132120	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	Data missing for 2022 due to updates of the PRODCOM list.
14132200	Apparel	4.Jackets and coats (40%) 5.Pants and shorts (40%) 6.Dresses, Skirts and jumpsuits (20%)	Men's or boys' suits & ensembles (excluding knitted or crocheted)	The affected code was added in 2013, merging the following 2 codes: 14132210 14132220	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	Data missing for 2022.
14132445	Apparel	5.Pants and shorts (100%)	Men's or boys' trousers and breeches, of man-made fibres (excluding knitted or crocheted, for industrial or occupational wear)	The 3 affected codes start in 2001 as to complement the Men's or boys' trousers, breeches, shorts, bib and brace overalls groups divided into specific fibres excluding knitted and crocheted which are complete codes): 14132442 14132444 14132448 14132449 14132460	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	Data missing for time interval 1995-2001 most probably due to introduction of new codes.
14132455	Apparel	5.Pants and shorts (100%)	Men's or boys' bib and brace overalls (excluding knitted or crocheted, for industrial or occupational wear)			Data missing for time interval 1995-2001 most probably due to introduction of new codes.
14131270	Apparel	5.Pants and shorts (100%)	Men's or boys' trousers, breeches, shorts, bib and brace overalls, of knitted or crocheted textiles			Data missing for time interval 1995-2001 most probably due to introduction of new codes.

PRODCOM codes affected by changes	Subgroup	Product category ID and name (share of the code allocated to the category)	Codes description	Implications of the affected codes (rationale) over the existing codes (merging, newly introduced, complementing, etc.)	Affected indicator	Missing data
14133115	Apparel	4.Jackets and coats (100%)	Woman's or girls' raincoats and overcoats, etc.	The affected code was added in 2012, merging the 2 following codes: 14133110 14133120	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	Data missing for 2022 due to updates of the PRODCOM list
14133130	Apparel	3.Sweaters and mid-layers (20%) 4.Jackets and coats (80%)	Women's or girls' waistcoats, anoraks, ski-jackets, wind-jackets and similar articles (excluding jackets and blazers, knitted or crocheted, impregnated, coated, covered, laminated or rubberised)	NA	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	Data missing for 2022 due to updates of the PRODCOM list
14133200	Apparel	4.Jackets and coats (40%) 5.Pants and shorts (40%) 6.Dresses, Skirts and jumpsuits (20%)	Women's or girls' suits & ensembles (excluding knitted or crocheted)	The affected code was added in 2012, merging the following 2 codes: 14133210 14133220	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	NA
14133565	Apparel	5.Pants and shorts (100%)	Women's or girls' shorts, of man-made fibres (excluding knitted or crocheted)	The affected code was added in 2001 as to complement the Women's or girls' shorts groups divided into specific fibres (excluding knitted and crocheted which are complete codes): 14133551 14133561 14133563	PRODQNT EXPQNT IMPQNT PRODVAL EXPVAL IMPVAL	Data missing for time interval 1995-2001 most probably due to introduction of new codes.
14192150	Apparel	4.Jackets and coats (20%) 8.Underwear (50%)	Babies clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, gloves, mittens and outerwear (excluding sanitary towels and napkins and similar articles)	The affected code was added in 2012 to complement Babies clothing and accessories: 14192100	PRODVAL EXPVAL IMPVAL	NA

PRODCOM codes affected by changes	Subgroup	Product category ID and name (share of the code allocated to the category)	Codes description	Implications of the affected codes (rationale) over the existing codes (merging, newly introduced, complementing, etc.)	Affected indicator	Missing data
14192100	Apparel	4.Jackets and coats (20%) 8.Underwear (50%)	Babies' clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, napkins, gloves, mittens and outerwear	NA	PRODVAL EXPVAL IMPVAL	Data missing for 2022
14191100	Apparel	4.Jackets and coats (20%) 8.Underwear (50%)	Babies' garments and clothing accessories, knitted or crocheted including vests, rompers, underpants, stretch-suits, gloves or mittens or mitts, outerwear (for children of height <= 86 cm)	NA	NA	PRODQNT EXPQNT
14142240	Apparel	1.T-shirts (75%) 6.Dresses, Skirts and jumpsuits (25%)	Men's or boys' singlets, vests, bathrobes, dressing gowns and similar articles (excluding knitted or crocheted)	NA	NA	EXPQNT IMPQNT
14142460	Apparel	1.T-shirts (40%) 6.Dresses, Skirts and jumpsuits (30%) 8.Underwear (30%)	Women's or girls' singlets and other vests, briefs, panties, negligees, bathrobes, dressing gowns, housecoats and similar articles of cotton (excluding knitted or crocheted)	NA	NA	EXPQNT IMPQNT
14142480	Apparel	1.T-shirts (40%) 6.Dresses, Skirts and jumpsuits (30%) 8.Underwear (30%)	Women's or girls' negligees, bathrobes, dressing gowns, singlets, vests, briefs and panties (including boxer shorts), of man-made fibres (excluding knitted or crocheted)	NA	NA	EXPQNT
14142489	Apparel	1.T-shirts (40%) 6.Dresses, Skirts and jumpsuits (30%) 8.Underwear (30%)	Women's or girls' singlets, vests, briefs, panties, negligees, bathrobes, dressing gowns and similar articles, of textiles (excluding cotton, man-made fibres, knitted or crocheted)	NA	NA	IMPQNT
14191230	Apparel	4.Jackets and coats (50%) 5.Pants and shorts (50%)	Ski-suits, of knitted or crocheted textiles	NA	NA	EXPQNT

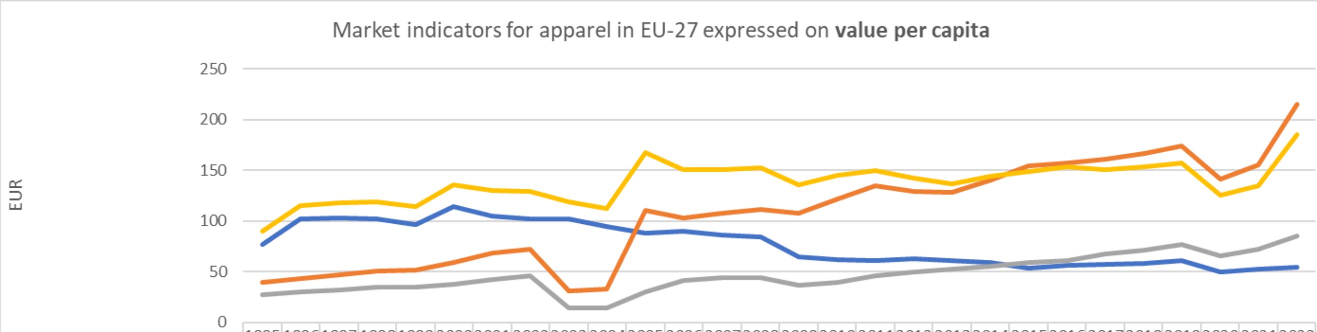
PRODCOM codes affected by changes	Subgroup	Product category ID and name (share of the code allocated to the category)	Codes description	Implications of the affected codes (rationale) over the existing codes (merging, newly introduced, complementing, etc.)	Affected indicator	Missing data
14192150	Apparel	4.Jackets and coats (50%) 5.Pants and shorts (50%)	Babies clothing and accessories, of textiles, not knitted or crocheted (for children of height <= 86 cm) including vests, rompers, underpants, stretch-suits, gloves, mittens and outerwear (excluding sanitary towels and napkins and similar articles)	NA	NA	EXPQNT IMPQNT PRODQNT
14192210	Apparel	6.Dresses, Skirts and jumpsuits (100%)	Other men's or boys' apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	NA	NA	EXPQNT IMPQNT
14192220	Apparel	6.Dresses, Skirts and jumpsuits (100%)	Other women's or girls' apparel n.e.c., including tracksuits and jogging suits (excluding waistcoats, ski-suits, knitted or crocheted)	NA	NA	EXPQNT
14311037	Apparel	7.Leggings, Stockings, Tights and socks (100%)	Pantyhose and tights of textile materials, knitted or crocheted (excl. graduated compression hosiery, those of synthetic fibres and hosiery for babies)	Code included in 2013 complement Hosiery: 14311090	PRODVAL EXPVAL IMPVAL	NA
14192396	Apparel	10. Accessories	Clothing accessories, parts of garments or of clothing accessories, of textiles, n.e.c. and parts thereof, (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts and parts thereof; bras, girdles and corsets, braces, suspenders and garters, knitted or crocheted)	Code included in 2015 to complement accessories: 14192393 14192395	PRODVAL EXPVAL IMPVAL	PRODQNT IMPQNT EXPQNT
14192393	Apparel	10. Accessories	Clothing accessories of textiles (excluding shawls, scarves and mufflers, mantillas and veils, ties, bow-ties and cravats, gloves, mittens and mitts, knitted or crocheted)	NA	NA	PRODQNT IMPQNT EXPQNT

PRODCOM codes affected by changes	Subgroup	Product category ID and name (share of the code allocated to the category)	Codes description	Implications of the affected codes (rationale) over the existing codes (merging, newly introduced, complementing, etc.)	Affected indicator	Missing data
14192395	Apparel	10. Accessories	Parts of garments or of clothing accessories, of textiles (excluding bras, girdles and corsets, braces, suspenders and garters, knitted or crocheted)	NA	NA	PRODQNT IMPQNT EXPQNT
14194270	Apparel	10. Accessories	Hats and other headgear, knitted or crocheted or made-up from lace, felt or other textile fabric in the piece (but not in strips); hair-nets of any material	NA	NA	IMPQNT EXPQNT
14191930	Apparel	10. Accessories	Shawls, scarves, mufflers, mantillas, veils and the like, of knitted or crocheted textiles	NA	NA	EXPQNT
14191960	Apparel	10. Accessories	Clothing accessories and parts thereof, of knitted or crocheted textiles (excluding gloves, mittens, shawls, scarves, mufflers, mantillas and veils)	NA	NA	EXPQNT

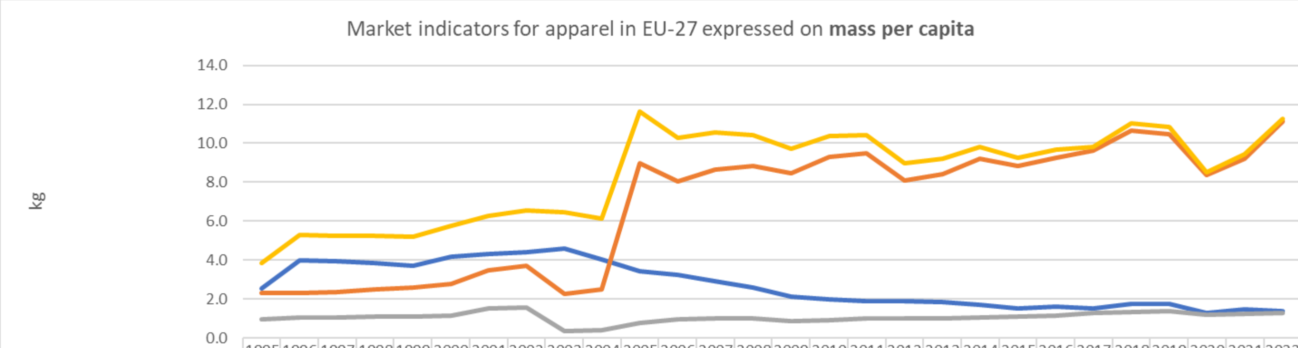
NA: not applicable
The changes of the affected PRODCOM codes should be understood as merged, changed or newly introduced due to NACE list revision and they are considered complete in the analysis and used.

10.1.5 Supplementary information about the EU market

Figure 29. Market indicators per capita for textile apparel in EU-27



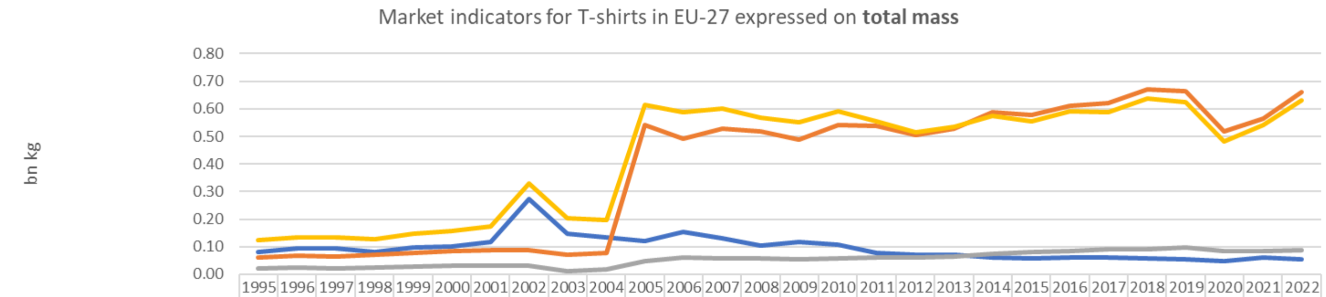
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	77	102	103	102	96	114	105	102	102	94	88	90	86	84	65	62	61	63	61	59	54	56	57	58	61	49	52	55
Import	40	43	47	51	52	59	68	73	31	33	110	103	108	112	108	122	135	129	128	141	155	157	161	167	174	141	155	215
Export	27	30	32	35	35	37	42	46	15	15	31	42	44	44	37	39	46	50	53	56	59	61	67	71	77	66	72	85
Apparent consumption	90	115	118	119	114	135	130	129	119	112	168	151	150	152	136	145	150	142	137	144	149	153	151	153	157	125	135	185



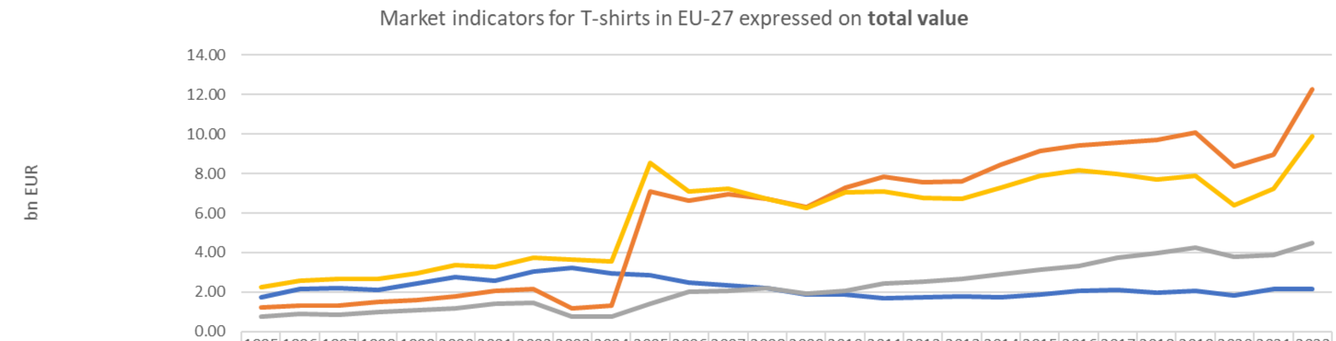
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	2.5	4.0	3.9	3.8	3.7	4.2	4.3	4.4	4.6	4.1	3.4	3.2	2.9	2.6	2.1	2.0	1.9	1.9	1.8	1.7	1.5	1.6	1.5	1.7	1.8	1.3	1.5	1.4
Import	2.3	2.3	2.4	2.5	2.6	2.8	3.5	3.7	2.3	2.5	9.0	8.0	8.7	8.9	8.5	9.3	9.5	8.1	8.4	9.2	8.8	9.2	9.6	10.6	10.5	8.4	9.2	11.1
Export	0.9	1.0	1.1	1.1	1.1	1.1	1.5	1.6	0.4	0.4	0.8	1.0	1.0	1.0	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.2	1.3	1.4	1.4	1.2	1.2	1.3
Apparent consumption	3.9	5.3	5.2	5.2	5.2	5.8	6.3	6.5	6.5	6.1	11.6	10.3	10.6	10.4	9.7	10.4	10.4	9.0	9.2	9.8	9.2	9.7	9.8	11.0	10.8	8.5	9.5	11.2

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 30. Market indicators for T-shirts in EU-27



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.08	0.09	0.09	0.08	0.10	0.10	0.12	0.27	0.15	0.14	0.12	0.15	0.13	0.11	0.12	0.11	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.05
Import	0.06	0.07	0.06	0.07	0.08	0.08	0.09	0.09	0.07	0.08	0.54	0.49	0.53	0.52	0.49	0.54	0.54	0.51	0.53	0.59	0.58	0.61	0.62	0.67	0.67	0.52	0.56	0.66
Export	0.02	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.01	0.02	0.05	0.06	0.06	0.06	0.05	0.06	0.06	0.06	0.06	0.07	0.08	0.08	0.09	0.09	0.10	0.08	0.08	0.09
Apparent consumption	0.12	0.13	0.14	0.13	0.15	0.16	0.17	0.33	0.20	0.20	0.61	0.59	0.60	0.57	0.55	0.59	0.55	0.52	0.54	0.57	0.55	0.59	0.59	0.64	0.62	0.48	0.54	0.63

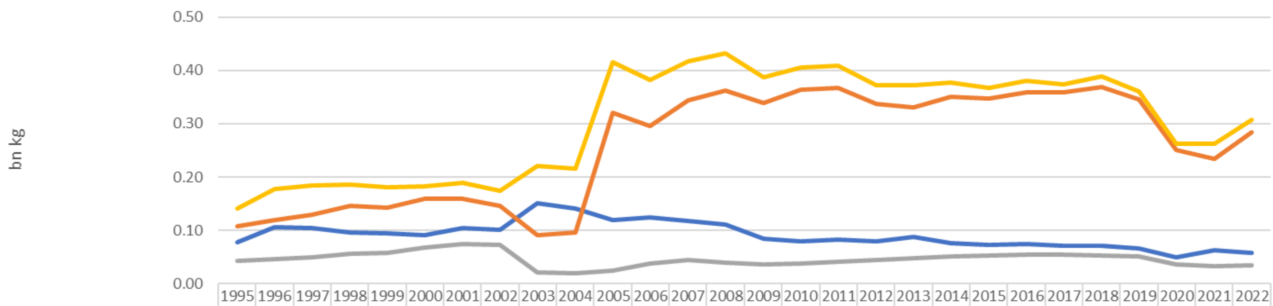


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	1.76	2.15	2.21	2.13	2.42	2.75	2.59	3.05	3.25	2.95	2.88	2.48	2.36	2.20	1.89	1.87	1.69	1.72	1.78	1.74	1.88	2.05	2.13	1.96	2.08	1.81	2.16	2.14
Import	1.23	1.30	1.32	1.52	1.58	1.81	2.08	2.14	1.16	1.33	7.07	6.65	6.96	6.74	6.30	7.27	7.84	7.58	7.61	8.43	9.15	9.41	9.57	9.71	10.08	8.37	8.94	12.25
Export	0.75	0.89	0.85	1.00	1.07	1.19	1.41	1.46	0.76	0.74	1.42	2.04	2.07	2.22	1.93	2.07	2.42	2.53	2.65	2.88	3.13	3.32	3.74	3.97	4.26	3.77	3.86	4.49
Apparent consumption	2.24	2.56	2.69	2.65	2.93	3.37	3.27	3.73	3.65	3.54	8.53	7.09	7.25	6.71	6.26	7.06	7.11	6.78	6.74	7.29	7.90	8.15	7.96	7.70	7.90	6.42	7.24	9.91

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

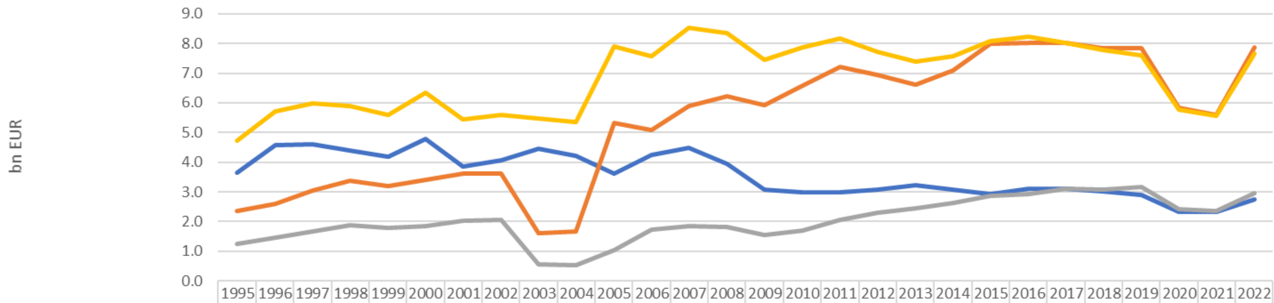
Figure 31. Market indicators for shirts and blouses in EU-27

Market indicators for shirts and blouses in EU-27 expressed on **total mass**



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.08	0.11	0.10	0.10	0.09	0.09	0.10	0.10	0.15	0.14	0.12	0.12	0.12	0.11	0.08	0.08	0.08	0.08	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.05	0.06	0.06
Import	0.11	0.12	0.13	0.15	0.14	0.16	0.16	0.15	0.09	0.10	0.32	0.30	0.34	0.36	0.34	0.36	0.37	0.34	0.33	0.35	0.35	0.36	0.36	0.37	0.35	0.25	0.23	0.28
Export	0.04	0.05	0.05	0.06	0.06	0.07	0.07	0.07	0.02	0.02	0.02	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.05	0.05	0.06	0.05	0.05	0.04	0.03	0.04
Apparent consumption	0.14	0.18	0.18	0.19	0.18	0.18	0.19	0.17	0.22	0.22	0.42	0.38	0.42	0.43	0.39	0.41	0.41	0.37	0.37	0.38	0.37	0.38	0.37	0.39	0.36	0.26	0.26	0.31

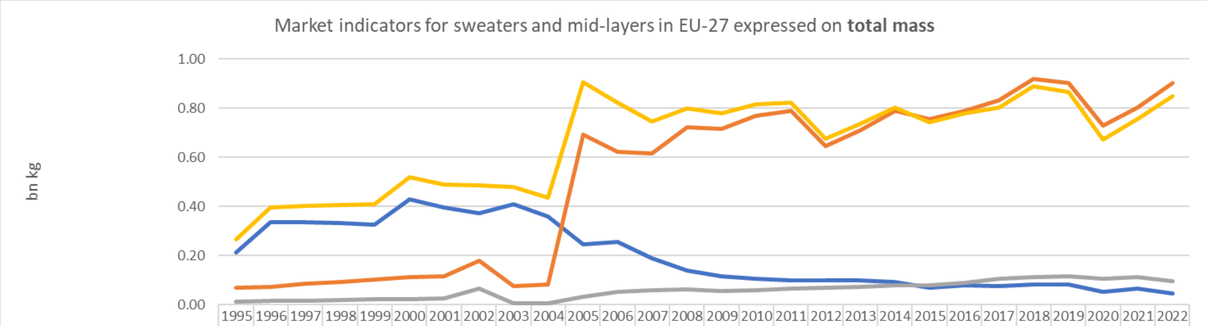
Market indicators for shirts and blouses in EU-27 expressed on **total value**



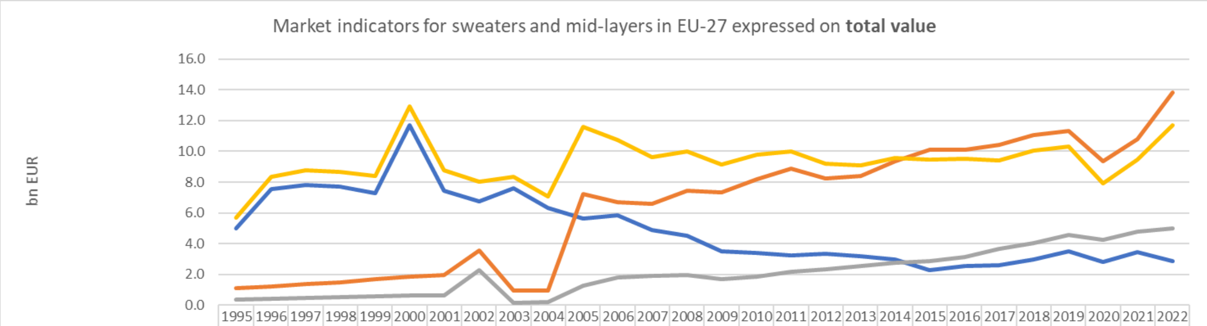
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	3.6	4.6	4.6	4.4	4.2	4.8	3.8	4.1	4.4	4.2	3.6	4.2	4.5	4.0	3.1	3.0	3.0	3.1	3.2	3.1	2.9	3.1	3.1	3.0	2.9	2.3	2.3	2.8
Import	2.3	2.6	3.1	3.4	3.2	3.4	3.6	3.6	1.6	1.7	5.3	5.1	5.9	6.2	5.9	6.6	7.2	6.9	6.6	7.1	8.0	8.0	8.0	7.9	7.8	5.8	5.6	7.9
Export	1.2	1.5	1.7	1.9	1.8	1.8	2.0	2.1	0.6	0.5	1.0	1.7	1.9	1.8	1.6	1.7	2.0	2.3	2.4	2.6	2.9	2.9	3.1	3.1	3.2	2.4	2.3	2.9
Apparent consumption	4.7	5.7	6.0	5.9	5.6	6.3	5.4	5.6	5.5	5.3	7.9	7.6	8.5	8.4	7.4	7.9	8.2	7.7	7.4	7.6	8.1	8.2	8.0	7.8	7.6	5.8	5.6	7.7

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 32. Market indicators for sweaters and mid-layers in EU-27



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.21	0.34	0.34	0.33	0.33	0.43	0.39	0.37	0.41	0.36	0.25	0.26	0.19	0.14	0.12	0.11	0.10	0.10	0.10	0.09	0.07	0.08	0.08	0.08	0.08	0.05	0.07	0.05
Import	0.07	0.07	0.09	0.09	0.10	0.11	0.12	0.18	0.07	0.08	0.69	0.62	0.62	0.72	0.72	0.77	0.79	0.65	0.71	0.79	0.75	0.79	0.83	0.92	0.90	0.73	0.80	0.90
Export	0.01	0.02	0.02	0.02	0.02	0.02	0.03	0.07	0.01	0.01	0.03	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.12	0.11	0.11	0.10
Apparent consumption	0.27	0.40	0.40	0.40	0.41	0.52	0.49	0.49	0.48	0.44	0.91	0.82	0.75	0.80	0.78	0.82	0.82	0.68	0.73	0.80	0.74	0.78	0.80	0.89	0.87	0.67	0.75	0.85

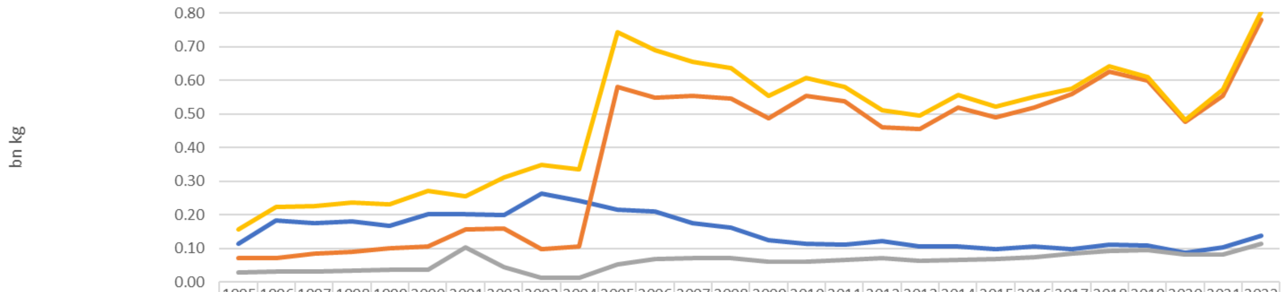


	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	5.0	7.5	7.8	7.7	7.3	11.7	7.5	6.7	7.6	6.3	5.6	5.9	4.9	4.5	3.5	3.4	3.2	3.3	3.2	3.0	2.3	2.6	2.6	3.0	3.5	2.8	3.4	2.9
Import	1.1	1.2	1.4	1.5	1.7	1.9	2.0	3.6	0.9	0.9	7.2	6.7	6.6	7.4	7.3	8.2	8.9	8.2	8.4	9.3	10.1	10.1	10.4	11.1	11.3	9.4	10.8	13.8
Export	0.4	0.4	0.4	0.5	0.5	0.6	0.6	2.3	0.2	0.2	1.3	1.8	1.9	1.9	1.7	1.8	2.2	2.3	2.5	2.8	2.9	3.1	3.6	4.0	4.6	4.3	4.8	5.0
Apparent consumption	5.7	8.3	8.8	8.6	8.4	12.9	8.8	8.0	8.3	7.1	11.6	10.8	9.6	10.0	9.2	9.8	10.0	9.2	9.1	9.6	9.5	9.5	9.4	10.0	10.3	7.9	9.4	11.7

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

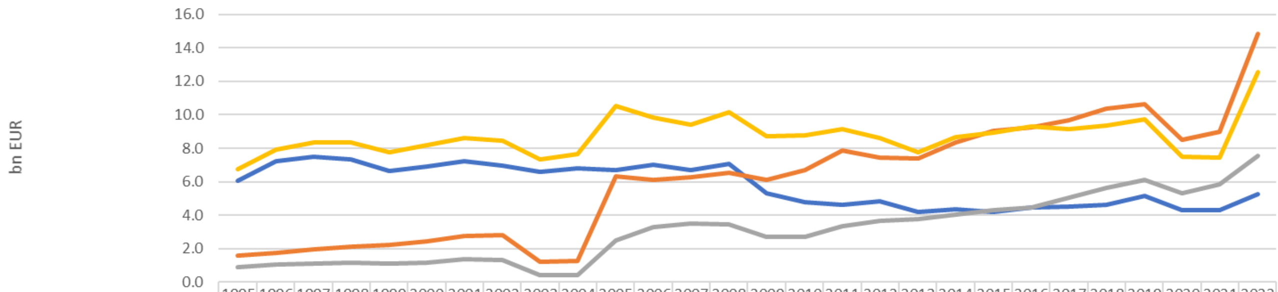
Figure 33. Market indicators for jackets and coats in EU-27

Market indicators for jackets and coats in EU-27 expressed on **total mass**



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.11	0.18	0.17	0.18	0.17	0.20	0.20	0.20	0.26	0.24	0.22	0.21	0.17	0.16	0.13	0.11	0.11	0.12	0.11	0.10	0.10	0.11	0.10	0.11	0.11	0.09	0.10	0.14
Import	0.07	0.07	0.08	0.09	0.10	0.11	0.16	0.16	0.10	0.11	0.58	0.55	0.55	0.55	0.49	0.55	0.54	0.46	0.45	0.52	0.49	0.52	0.56	0.63	0.60	0.48	0.55	0.78
Export	0.03	0.03	0.03	0.03	0.04	0.04	0.10	0.05	0.01	0.01	0.05	0.07	0.07	0.07	0.06	0.06	0.07	0.07	0.06	0.07	0.07	0.07	0.09	0.09	0.10	0.08	0.08	0.11
Apparent consumption	0.16	0.22	0.23	0.24	0.23	0.27	0.25	0.31	0.35	0.34	0.74	0.69	0.66	0.64	0.55	0.61	0.58	0.51	0.50	0.56	0.52	0.55	0.57	0.64	0.61	0.48	0.57	0.80

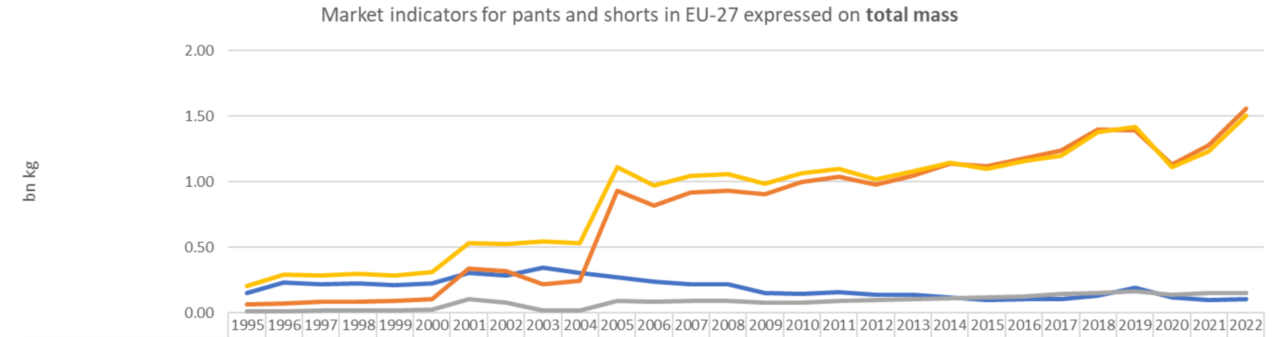
Market indicators for jackets and coats in EU-27 expressed on **total value**



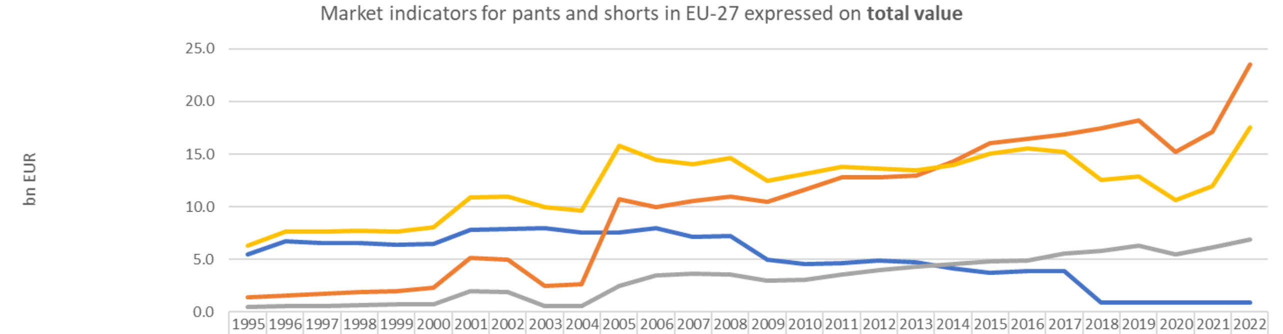
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	6.1	7.2	7.5	7.3	6.6	6.9	7.2	7.0	6.6	6.8	6.7	7.0	6.7	7.0	5.3	4.8	4.6	4.8	4.2	4.3	4.2	4.4	4.5	4.6	5.1	4.3	4.3	5.3
Import	1.6	1.7	2.0	2.1	2.2	2.4	2.8	2.8	1.2	1.3	6.3	6.1	6.2	6.5	6.1	6.7	7.9	7.5	7.4	8.4	9.0	9.3	9.7	10.4	10.7	8.5	9.0	14.8
Export	0.9	1.0	1.1	1.1	1.1	1.1	1.3	1.3	0.4	0.4	2.5	3.3	3.5	3.4	2.7	2.7	3.3	3.7	3.8	4.0	4.3	4.4	5.0	5.6	6.1	5.3	5.9	7.5
Apparent consumption	6.8	7.9	8.4	8.3	7.7	8.2	8.6	8.5	7.3	7.6	10.5	9.8	9.4	10.2	8.7	8.8	9.1	8.6	7.8	8.7	8.9	9.3	9.2	9.4	9.7	7.5	7.4	12.6

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 34. Market indicators for pants and shorts in EU-27



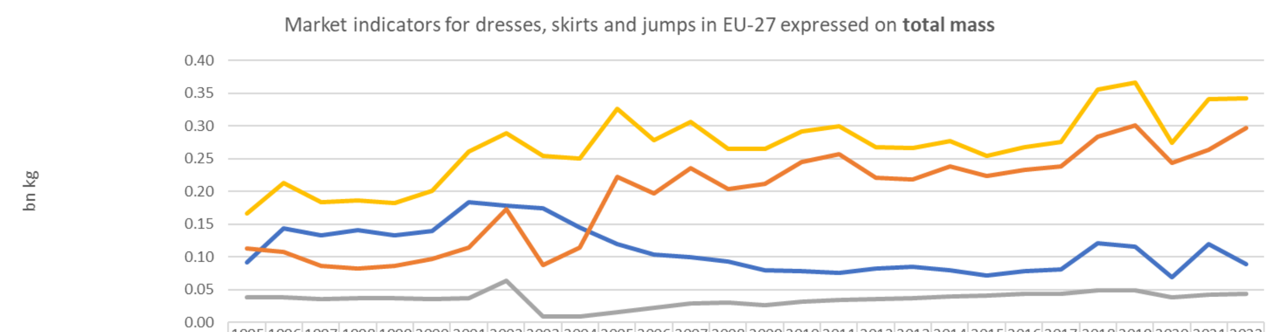
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.15	0.23	0.22	0.23	0.21	0.22	0.30	0.28	0.35	0.31	0.27	0.24	0.22	0.22	0.16	0.15	0.16	0.14	0.14	0.12	0.10	0.11	0.10	0.13	0.19	0.12	0.10	0.10
Import	0.07	0.07	0.08	0.09	0.09	0.11	0.34	0.32	0.22	0.24	0.93	0.82	0.92	0.93	0.90	1.00	1.04	0.98	1.04	1.14	1.12	1.18	1.24	1.40	1.39	1.13	1.28	1.56
Export	0.01	0.02	0.02	0.02	0.02	0.02	0.11	0.08	0.02	0.02	0.09	0.09	0.09	0.09	0.08	0.08	0.09	0.10	0.10	0.11	0.12	0.13	0.15	0.15	0.17	0.14	0.15	0.15
Apparent consumption	0.21	0.29	0.28	0.30	0.29	0.31	0.53	0.53	0.55	0.53	1.11	0.97	1.04	1.06	0.98	1.06	1.10	1.02	1.08	1.15	1.10	1.16	1.20	1.38	1.42	1.11	1.23	1.51



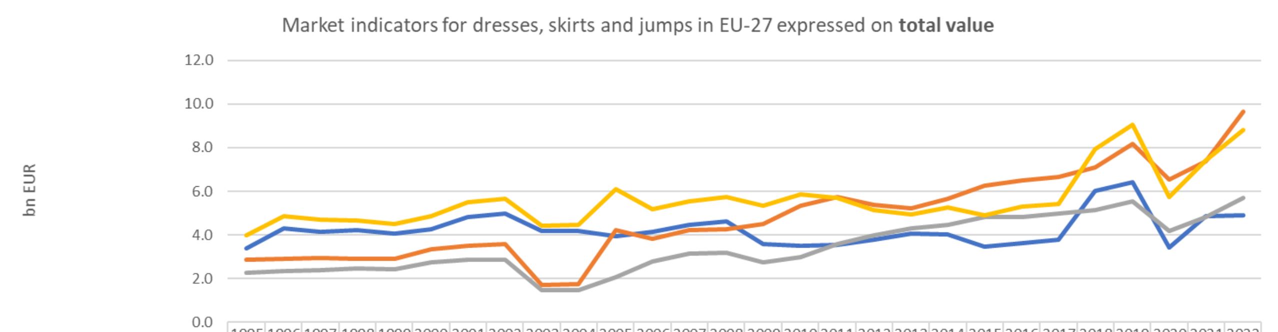
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	5.4	6.7	6.5	6.5	6.4	6.5	7.8	7.8	8.0	7.6	7.5	8.0	7.1	7.2	5.0	4.6	4.6	4.9	4.7	4.1	3.7	3.9	3.9	0.9	0.9	0.9	0.9	0.9
Import	1.4	1.5	1.7	1.9	2.0	2.3	5.1	5.0	2.5	2.6	10.7	10.0	10.5	11.0	10.5	11.6	12.8	12.8	13.0	14.3	16.1	16.5	16.9	17.4	18.2	15.2	17.1	23.5
Export	0.5	0.6	0.6	0.7	0.7	0.8	2.0	1.9	0.6	0.6	2.5	3.5	3.6	3.6	3.0	3.0	3.6	4.0	4.3	4.5	4.8	4.8	5.5	5.8	6.3	5.5	6.1	6.9
Apparent consumption	6.3	7.7	7.7	7.7	7.6	8.0	10.9	10.9	9.9	9.6	15.8	14.4	14.1	14.6	12.4	13.2	13.8	13.7	13.4	13.9	15.0	15.5	15.2	12.5	12.9	10.6	11.9	17.5

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 35. Market indicators for dresses, skirts and jumps in EU-27



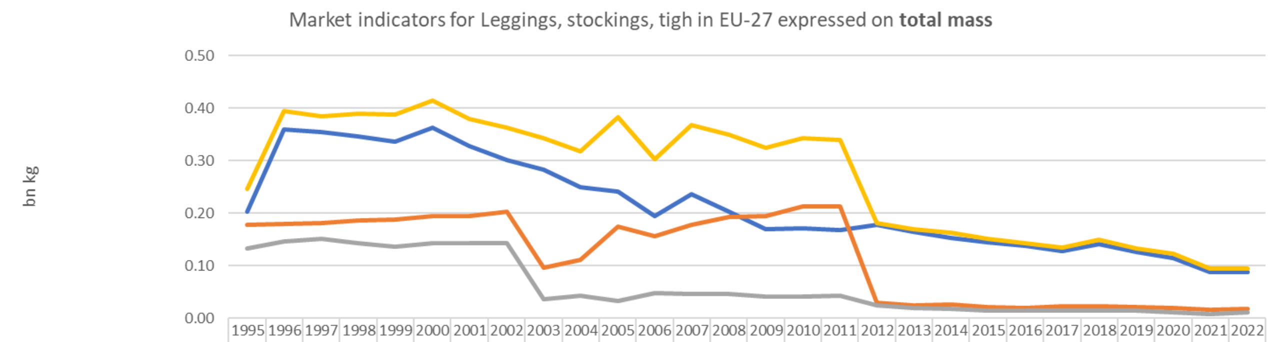
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.09	0.14	0.13	0.14	0.13	0.14	0.18	0.18	0.17	0.14	0.12	0.10	0.10	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.08	0.12	0.12	0.07	0.12	0.09
Import	0.11	0.11	0.09	0.08	0.09	0.10	0.11	0.17	0.09	0.11	0.22	0.20	0.24	0.20	0.21	0.24	0.26	0.22	0.22	0.24	0.22	0.23	0.24	0.28	0.30	0.24	0.26	0.30
Export	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.05	0.04	0.04	0.04
Apparent consumption	0.17	0.21	0.18	0.19	0.18	0.20	0.26	0.29	0.25	0.25	0.33	0.28	0.31	0.27	0.26	0.29	0.30	0.27	0.27	0.28	0.25	0.27	0.28	0.36	0.37	0.27	0.34	0.34



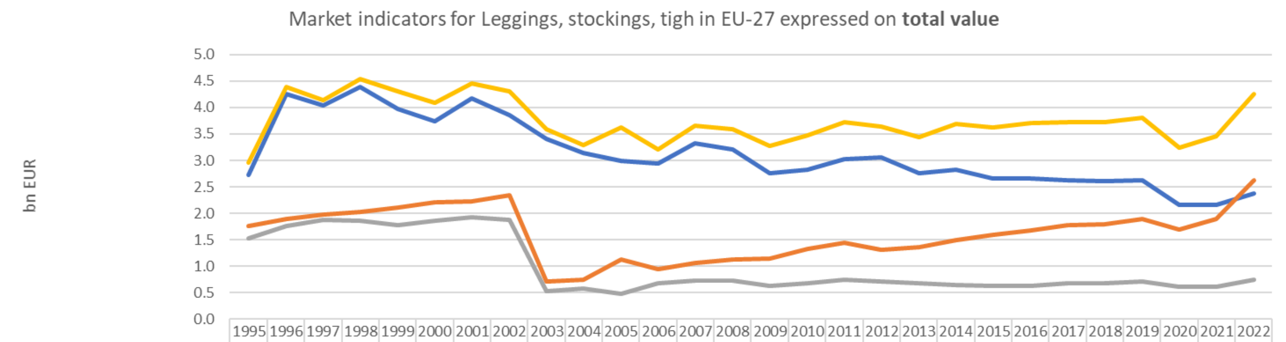
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	3.4	4.3	4.2	4.2	4.0	4.3	4.8	5.0	4.2	4.2	3.9	4.1	4.5	4.6	3.6	3.5	3.5	3.8	4.0	4.0	3.5	3.6	3.8	6.0	6.4	3.4	4.9	4.9
Import	2.9	2.9	3.0	2.9	2.9	3.3	3.5	3.6	1.7	1.7	4.2	3.8	4.2	4.3	4.5	5.3	5.7	5.4	5.2	5.7	6.3	6.5	6.6	7.1	8.2	6.5	7.4	9.6
Export	2.3	2.4	2.4	2.5	2.4	2.7	2.9	2.9	1.5	1.5	2.1	2.8	3.1	3.2	2.8	3.0	3.6	4.0	4.3	4.4	4.8	4.8	5.0	5.2	5.5	4.2	4.8	5.7
Apparent consumption	4.0	4.9	4.7	4.7	4.5	4.9	5.5	5.7	4.4	4.4	6.1	5.2	5.5	5.7	5.4	5.9	5.7	5.1	4.9	5.2	4.9	5.3	5.4	7.9	9.0	5.7	7.4	8.8

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 36. Market indicators for leggings, stockings and tights in EU-27



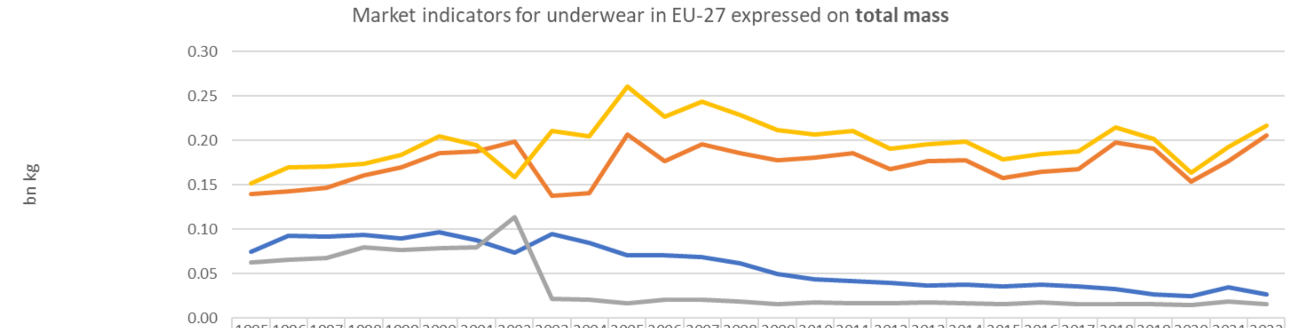
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.20	0.36	0.35	0.35	0.34	0.36	0.33	0.30	0.28	0.25	0.24	0.20	0.24	0.20	0.17	0.17	0.17	0.18	0.16	0.15	0.15	0.14	0.13	0.14	0.13	0.11	0.09	0.09
Import	0.18	0.18	0.18	0.19	0.19	0.20	0.19	0.20	0.10	0.11	0.18	0.16	0.18	0.19	0.19	0.21	0.21	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Export	0.13	0.15	0.15	0.14	0.14	0.14	0.14	0.14	0.04	0.04	0.03	0.05	0.05	0.05	0.04	0.04	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01
Apparent consumption	0.25	0.39	0.38	0.39	0.39	0.41	0.38	0.36	0.34	0.32	0.38	0.30	0.37	0.35	0.32	0.34	0.34	0.18	0.17	0.16	0.15	0.14	0.14	0.15	0.13	0.12	0.10	0.09



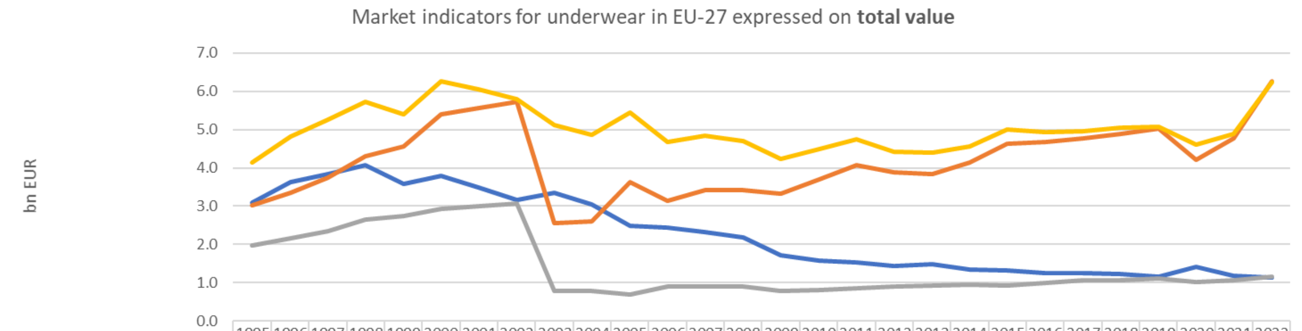
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	2.7	4.3	4.0	4.4	4.0	3.7	4.2	3.9	3.4	3.1	3.0	2.9	3.3	3.2	2.8	2.8	3.0	3.1	2.8	2.8	2.7	2.7	2.6	2.6	2.6	2.2	2.2	2.4
Import	1.8	1.9	2.0	2.0	2.1	2.2	2.2	2.3	0.7	0.7	1.1	0.9	1.1	1.1	1.1	1.3	1.4	1.3	1.4	1.5	1.6	1.7	1.8	1.8	1.9	1.7	1.9	2.6
Export	1.5	1.8	1.9	1.9	1.8	1.9	1.9	1.9	0.5	0.6	0.5	0.7	0.7	0.7	0.6	0.7	0.8	0.7	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.7
Apparent consumption	3.0	4.4	4.1	4.5	4.3	4.1	4.5	4.3	3.6	3.3	3.6	3.2	3.7	3.6	3.3	3.5	3.7	3.6	3.4	3.7	3.6	3.7	3.7	3.7	3.8	3.2	3.5	4.3

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 37. Market indicators for underwear in EU-27



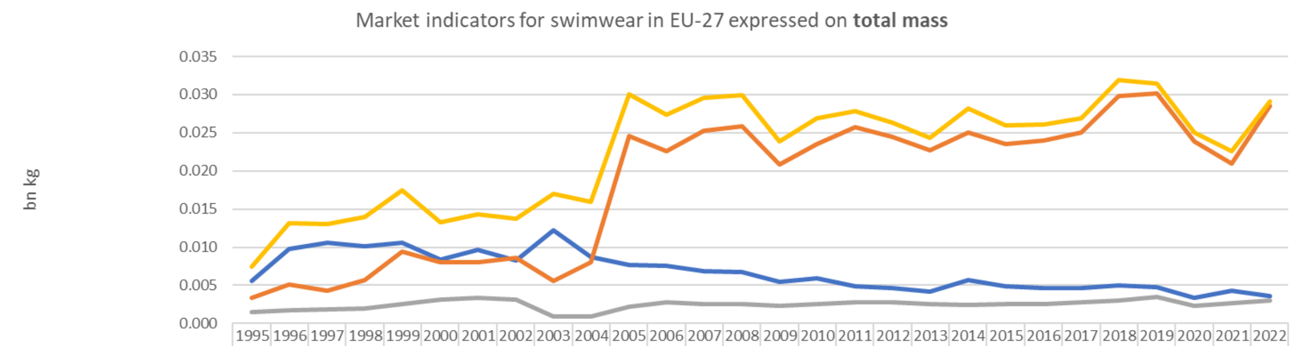
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.07	0.09	0.09	0.09	0.09	0.10	0.09	0.07	0.10	0.08	0.07	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0.03	0.03
Import	0.14	0.14	0.15	0.16	0.17	0.19	0.19	0.20	0.14	0.14	0.21	0.18	0.20	0.19	0.18	0.18	0.19	0.17	0.18	0.18	0.16	0.17	0.17	0.20	0.19	0.15	0.18	0.21
Export	0.06	0.07	0.07	0.08	0.08	0.08	0.08	0.11	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02
Apparent consumption	0.15	0.17	0.17	0.17	0.18	0.20	0.19	0.16	0.21	0.20	0.26	0.23	0.24	0.23	0.21	0.21	0.21	0.19	0.20	0.20	0.18	0.19	0.19	0.21	0.20	0.16	0.19	0.22



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	3.1	3.6	3.8	4.1	3.6	3.8	3.5	3.2	3.4	3.0	2.5	2.4	2.3	2.2	1.7	1.6	1.5	1.4	1.5	1.4	1.3	1.2	1.3	1.2	1.2	1.4	1.2	1.1
Import	3.0	3.3	3.8	4.3	4.6	5.4	5.6	5.7	2.5	2.6	3.6	3.1	3.4	3.4	3.3	3.7	4.1	3.9	3.8	4.1	4.6	4.7	4.8	4.9	5.0	4.2	4.8	6.3
Export	2.0	2.2	2.3	2.7	2.8	2.9	3.0	3.1	0.8	0.8	0.7	0.9	0.9	0.9	0.8	0.8	0.9	0.9	0.9	0.9	0.9	1.0	1.1	1.1	1.1	1.0	1.1	1.2
Apparent consumption	4.1	4.8	5.2	5.7	5.4	6.3	6.1	5.8	5.1	4.9	5.4	4.7	4.8	4.7	4.2	4.5	4.8	4.4	4.4	4.6	5.0	4.9	5.0	5.0	5.1	4.6	4.9	6.2

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

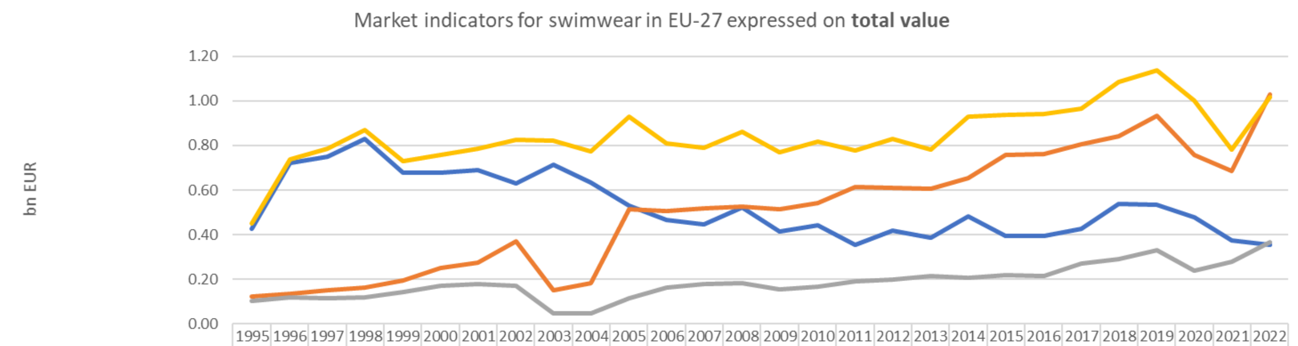
5477 **Figure 38**. Market indicators for swimwear in EU-27



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Production	0.006	0.010	0.011	0.010	0.011	0.008	0.010	0.008	0.012	0.009	0.008	0.008	0.007	0.007
Import	0.003	0.005	0.004	0.006	0.009	0.008	0.008	0.009	0.006	0.008	0.025	0.023	0.025	0.026
Export	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.001	0.001	0.002	0.003	0.003	0.003
Apparent consumption	0.007	0.013	0.013	0.014	0.018	0.013	0.014	0.014	0.017	0.016	0.030	0.027	0.030	0.030

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.005	0.006	0.005	0.005	0.004	0.006	0.005	0.005	0.005	0.005	0.005	0.003	0.004	0.004
Import	0.021	0.024	0.026	0.024	0.023	0.025	0.024	0.024	0.025	0.030	0.030	0.024	0.021	0.029
Export	0.002	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.004	0.002	0.003	0.003
Apparent consumption	0.024	0.027	0.028	0.026	0.024	0.028	0.026	0.026	0.027	0.032	0.031	0.025	0.023	0.029

5478



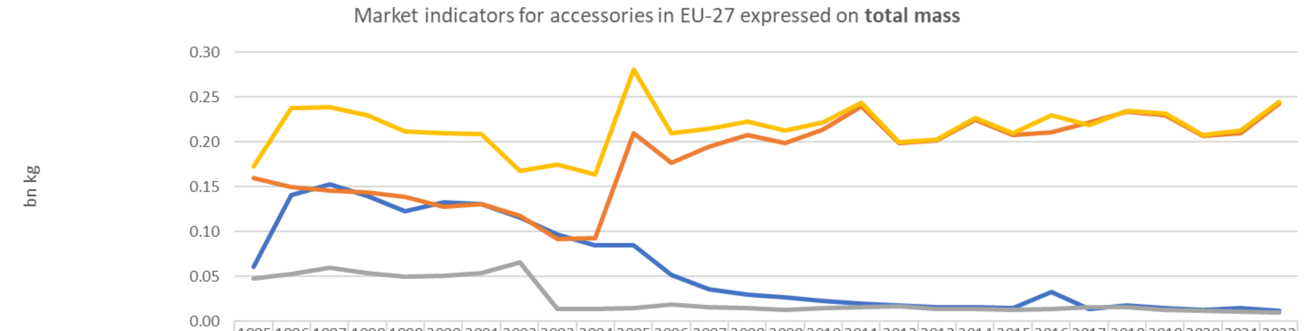
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Production	0.43	0.72	0.75	0.83	0.68	0.68	0.69	0.63	0.71	0.63	0.53	0.47	0.45	0.52
Import	0.12	0.14	0.15	0.16	0.19	0.25	0.27	0.37	0.15	0.18	0.52	0.50	0.52	0.52
Export	0.10	0.12	0.11	0.12	0.14	0.17	0.18	0.17	0.05	0.04	0.12	0.16	0.18	0.18
Apparent consumption	0.45	0.74	0.78	0.87	0.73	0.76	0.79	0.83	0.82	0.77	0.93	0.81	0.79	0.86

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.41	0.44	0.35	0.42	0.39	0.48	0.39	0.39	0.43	0.54	0.53	0.48	0.37	0.35
Import	0.51	0.54	0.61	0.61	0.61	0.65	0.76	0.76	0.81	0.84	0.93	0.76	0.69	1.03
Export	0.16	0.17	0.19	0.20	0.21	0.21	0.22	0.21	0.27	0.29	0.33	0.24	0.28	0.37
Apparent consumption	0.77	0.82	0.78	0.83	0.78	0.93	0.94	0.94	0.96	1.09	1.14	1.00	0.78	1.02

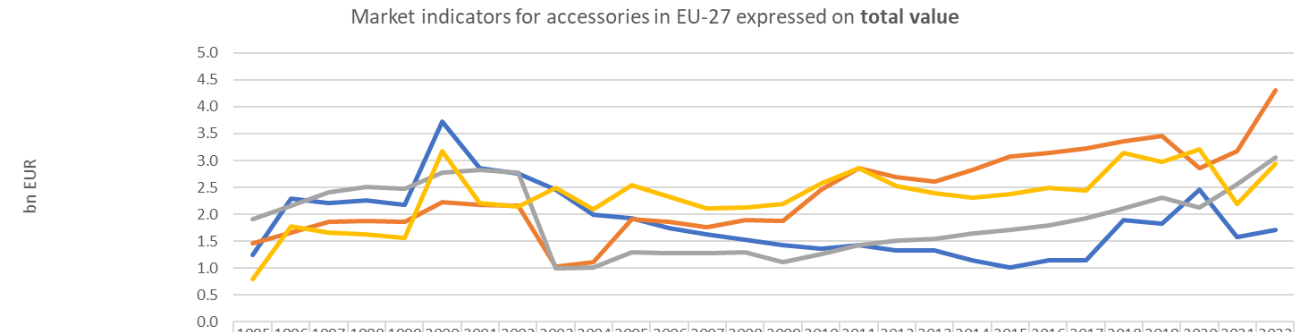
5479
5480 *Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)*

5481

Figure 39. Market indicators for accessories in EU-27



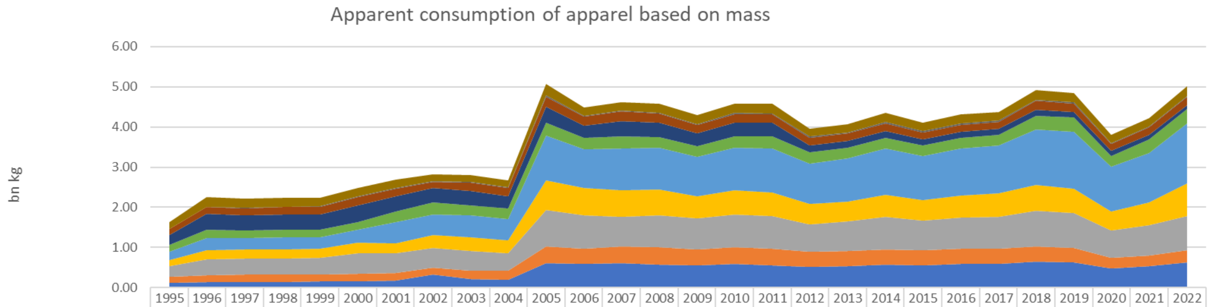
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	0.06	0.14	0.15	0.14	0.12	0.13	0.13	0.12	0.10	0.08	0.08	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.01	0.02	0.02	0.01	0.01	0.01
Import	0.16	0.15	0.15	0.14	0.14	0.13	0.13	0.12	0.09	0.09	0.21	0.18	0.19	0.21	0.20	0.21	0.24	0.20	0.20	0.22	0.21	0.21	0.22	0.23	0.23	0.21	0.21	0.24
Export	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.07	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.01	0.01
Apparent consumption	0.17	0.24	0.24	0.23	0.21	0.21	0.21	0.17	0.17	0.16	0.28	0.21	0.21	0.22	0.21	0.22	0.24	0.20	0.20	0.23	0.21	0.23	0.22	0.24	0.23	0.21	0.21	0.24



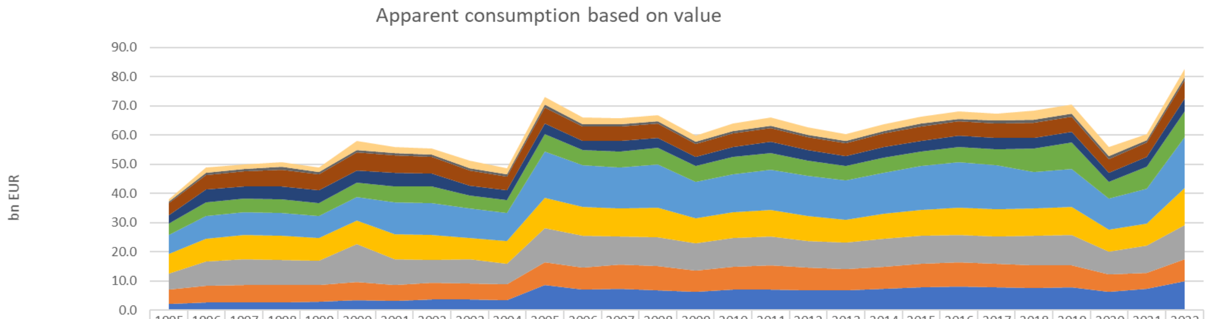
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Production	1.2	2.3	2.2	2.3	2.2	3.7	2.9	2.8	2.5	2.0	1.9	1.7	1.6	1.5	1.4	1.4	1.4	1.3	1.3	1.1	1.0	1.1	1.1	1.9	1.8	2.5	1.6	1.7
Import	1.5	1.7	1.9	1.9	1.9	2.2	2.2	2.2	1.0	1.1	1.9	1.9	1.8	1.9	1.9	2.5	2.9	2.7	2.6	2.8	3.1	3.1	3.2	3.4	3.5	2.9	3.2	4.3
Export	1.9	2.2	2.4	2.5	2.5	2.8	2.8	2.8	1.0	1.0	1.3	1.3	1.3	1.3	1.1	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	2.1	2.3	2.1	2.6	3.1
Apparent consumption	0.8	1.8	1.7	1.6	1.6	3.2	2.2	2.1	2.5	2.1	2.5	2.3	2.1	2.1	2.2	2.6	2.9	2.5	2.4	2.3	2.4	2.5	2.4	3.1	3.0	3.2	2.2	2.9

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 40. Apparent consumption of textile apparel categories in EU-27



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10. Accessories	0.17	0.24	0.24	0.23	0.21	0.21	0.21	0.17	0.17	0.16	0.28	0.21	0.21	0.22	0.21	0.22	0.24	0.20	0.20	0.23	0.21	0.23	0.22	0.24	0.23	0.21	0.21	0.24
9. Swimwear	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.03
8. Underwear	0.15	0.17	0.17	0.17	0.18	0.20	0.19	0.16	0.21	0.20	0.26	0.23	0.24	0.23	0.21	0.21	0.21	0.19	0.20	0.20	0.18	0.19	0.19	0.21	0.20	0.16	0.19	0.22
7. Leggings, Stockings, Tights and socks	0.25	0.39	0.38	0.39	0.39	0.41	0.38	0.36	0.34	0.32	0.38	0.30	0.37	0.35	0.32	0.34	0.34	0.18	0.17	0.16	0.15	0.14	0.14	0.15	0.13	0.12	0.10	0.09
6. Dresses, Skirts and jumpsuits	0.17	0.21	0.18	0.19	0.18	0.20	0.26	0.29	0.25	0.25	0.33	0.28	0.31	0.27	0.26	0.29	0.30	0.27	0.27	0.28	0.25	0.27	0.28	0.36	0.37	0.27	0.34	0.34
5. Pants and shorts	0.21	0.29	0.28	0.30	0.29	0.31	0.53	0.53	0.55	0.53	1.11	0.97	1.04	1.06	0.98	1.06	1.10	1.02	1.08	1.15	1.10	1.16	1.20	1.38	1.42	1.11	1.23	1.51
4. Jackets and coats	0.16	0.22	0.23	0.24	0.23	0.27	0.25	0.31	0.35	0.34	0.74	0.69	0.66	0.64	0.55	0.61	0.58	0.51	0.50	0.56	0.52	0.55	0.57	0.64	0.61	0.48	0.57	0.80
3. Sweaters and mid-layers	0.27	0.40	0.40	0.40	0.41	0.52	0.49	0.49	0.48	0.44	0.91	0.82	0.75	0.80	0.78	0.82	0.82	0.68	0.73	0.80	0.74	0.78	0.80	0.89	0.87	0.67	0.75	0.85
2. Shirts and blouses	0.14	0.18	0.18	0.19	0.18	0.18	0.19	0.17	0.22	0.22	0.42	0.38	0.42	0.43	0.39	0.41	0.41	0.37	0.37	0.38	0.37	0.38	0.37	0.39	0.36	0.26	0.26	0.31
1.T-shirts	0.12	0.13	0.14	0.13	0.15	0.16	0.17	0.33	0.20	0.20	0.61	0.59	0.60	0.57	0.55	0.59	0.55	0.52	0.54	0.57	0.55	0.59	0.59	0.64	0.62	0.48	0.54	0.63



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10.Accessories	0.8	1.8	1.7	1.6	1.6	3.2	2.2	2.1	2.5	2.1	2.5	2.3	2.1	2.1	2.2	2.6	2.9	2.5	2.4	2.3	2.4	2.5	2.4	3.1	3.0	3.2	2.2	2.9
9. Swimwear	0.4	0.7	0.8	0.9	0.7	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.9	0.9	0.9	1.0	1.1	1.1	1.0	0.8	1.0
8. Underwear	4.1	4.8	5.2	5.7	5.4	6.3	6.1	5.8	5.1	4.9	5.4	4.7	4.8	4.7	4.2	4.5	4.8	4.4	4.4	4.6	5.0	4.9	5.0	5.0	5.1	4.6	4.9	6.2
7. Leggings, Stockings, Tights and socks	3.0	4.4	4.1	4.5	4.3	4.1	4.5	4.3	3.6	3.3	3.6	3.2	3.7	3.6	3.3	3.5	3.7	3.6	3.4	3.7	3.6	3.7	3.7	3.7	3.8	3.2	3.5	4.3
6. Dresses, Skirts and jumpsuits	4.0	4.9	4.7	4.7	4.5	4.9	5.5	5.7	4.4	4.4	6.1	5.2	5.5	5.7	5.4	5.9	5.7	5.1	4.9	5.2	4.9	5.3	5.4	7.9	9.0	5.7	7.4	8.8
5. Pants and shorts	6.3	7.7	7.7	7.7	7.6	8.0	10.9	10.9	9.9	9.6	15.8	14.4	14.1	14.6	12.4	13.2	13.8	13.7	13.4	13.9	15.0	15.5	15.2	12.5	12.9	10.6	11.9	17.5
4. Jackets and coats	6.8	7.9	8.4	8.3	7.7	8.2	8.6	8.5	7.3	7.6	10.5	9.8	9.4	10.2	8.7	8.8	9.1	8.6	7.8	8.7	8.9	9.3	9.2	9.4	9.7	7.5	7.4	12.6
3. Sweaters and mid-layers	5.7	8.3	8.8	8.6	8.4	12.9	8.8	8.0	8.3	7.1	11.6	10.8	9.6	10.0	9.2	9.8	10.0	9.2	9.1	9.6	9.5	9.5	9.4	10.0	10.3	7.9	9.4	11.7
2. Shirts and blouses	4.7	5.7	6.0	5.9	5.6	6.3	5.4	5.6	5.5	5.3	7.9	7.6	8.5	8.4	7.4	7.9	8.2	7.7	7.4	7.6	8.1	8.2	8.0	7.8	7.6	5.8	5.6	7.7
1.T-shirts	2.2	2.6	2.7	2.7	2.9	3.4	3.3	3.7	3.7	3.5	8.5	7.1	7.2	6.7	6.3	7.1	7.1	6.8	6.7	7.3	7.9	8.1	8.0	7.7	7.9	6.4	7.2	9.9

(A) Total mass; (B) Total value

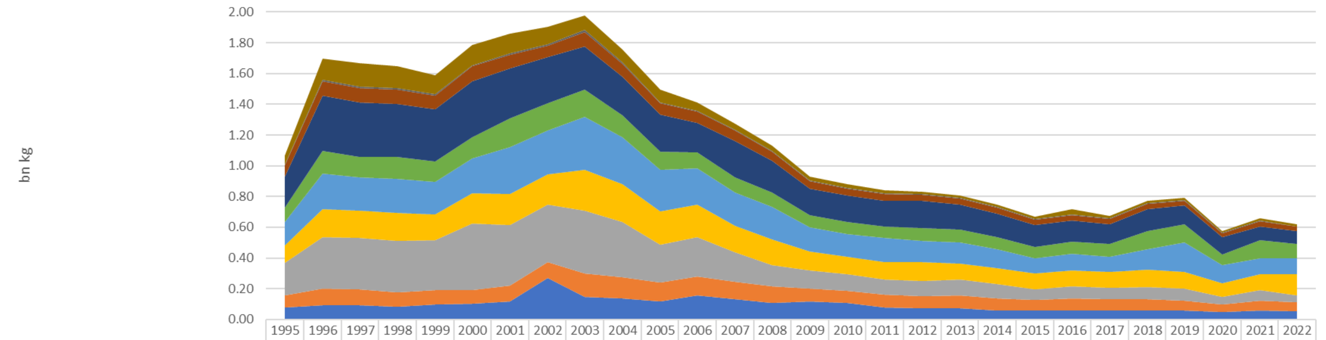
Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Table 61. Change of apparent consumption after the removal of EU import quota in 2005

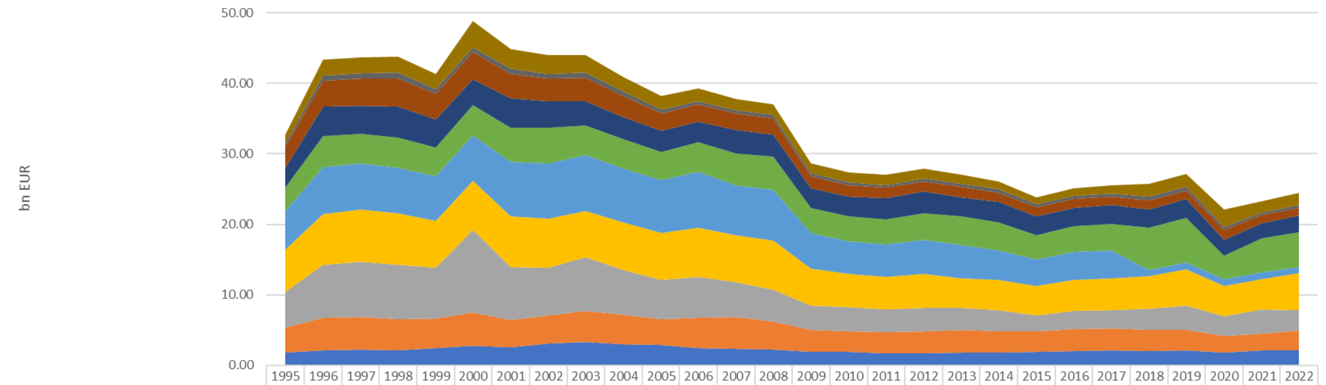
Textile apparel category	Mass (bn kg)		Change in mass (%)	Value (bn EUR)		Change in value (%)
	Average value in 1995-2004	Average value in 2005-2019		Average value in 1995-2004	Average value in 2005-2019	
1.T-shirts	0.17	0.58	236	3.15	7.36	133
2. Shirts and blouses	0.19	0.39	110	5.71	7.88	38
3. Sweaters and mid-layers	0.43	0.80	86	8.81	9.83	12
4. Jackets and coats	0.26	0.60	129	8.07	9.21	14
5. Pants and shorts	0.38	1.12	194	8.90	14.03	58
6. Dresses, Skirts and jumpsuits	0.22	0.29	33	4.85	5.83	20
7. Leggings, Stockings, Tights and socks	0.36	0.24	-33	4.13	3.59	-13
8. Underwear	0.18	0.21	15	5.48	4.77	-13
9. Swimwear	0.01	0.03	100	0.79	0.89	13
10. Accessories	0.20	0.22	11	2.08	2.49	20

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 41. Production of textile apparel categories in EU-27



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10. Accessories	0.06	0.14	0.15	0.14	0.12	0.13	0.13	0.12	0.10	0.08	0.08	0.05	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.01	0.02	0.02	0.01	0.01	0.01
9. Swimwear	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8. Underwear	0.07	0.09	0.09	0.09	0.09	0.10	0.09	0.07	0.10	0.08	0.07	0.07	0.07	0.06	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.02	0.03	0.03
7. Leggings, Stockings, Tights and socks	0.20	0.36	0.35	0.35	0.34	0.36	0.33	0.30	0.28	0.25	0.24	0.20	0.24	0.20	0.17	0.17	0.17	0.18	0.16	0.15	0.15	0.14	0.13	0.14	0.13	0.11	0.09	0.09
6. Dresses, Skirts and jumpsuits	0.09	0.14	0.13	0.14	0.13	0.14	0.18	0.18	0.17	0.14	0.12	0.10	0.10	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.07	0.08	0.08	0.12	0.12	0.07	0.12	0.09
5. Pants and shorts	0.15	0.23	0.22	0.23	0.21	0.22	0.30	0.28	0.35	0.31	0.27	0.24	0.22	0.22	0.16	0.15	0.16	0.14	0.14	0.12	0.10	0.11	0.10	0.13	0.19	0.12	0.10	0.10
4. Jackets and coats	0.11	0.18	0.17	0.18	0.17	0.20	0.20	0.20	0.26	0.24	0.22	0.21	0.17	0.16	0.13	0.11	0.11	0.12	0.11	0.10	0.10	0.11	0.10	0.11	0.11	0.09	0.10	0.14
3. Sweaters and mid-layers	0.21	0.34	0.34	0.33	0.33	0.43	0.39	0.37	0.41	0.36	0.25	0.26	0.19	0.14	0.12	0.11	0.10	0.10	0.10	0.09	0.07	0.08	0.08	0.08	0.08	0.05	0.07	0.05
2. Shirts and blouses	0.08	0.11	0.10	0.10	0.09	0.09	0.10	0.10	0.15	0.14	0.12	0.12	0.12	0.11	0.08	0.08	0.08	0.08	0.09	0.08	0.07	0.07	0.07	0.07	0.07	0.05	0.06	0.06
1.T-shirts	0.08	0.09	0.09	0.08	0.10	0.10	0.12	0.27	0.15	0.14	0.12	0.15	0.13	0.11	0.12	0.11	0.08	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.05



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10. Accessories	1.24	2.29	2.21	2.26	2.17	3.73	2.86	2.75	2.46	2.00	1.93	1.75	1.62	1.53	1.42	1.37	1.42	1.33	1.33	1.14	1.02	1.14	1.14	1.89	1.82	2.45	1.57	1.70
9. Swimwear	0.43	0.72	0.75	0.83	0.68	0.68	0.69	0.63	0.71	0.63	0.53	0.47	0.45	0.52	0.41	0.44	0.35	0.42	0.39	0.48	0.39	0.39	0.43	0.54	0.53	0.48	0.37	0.35
8. Underwear	3.09	3.64	3.84	4.06	3.59	3.78	3.48	3.16	3.36	3.04	2.49	2.44	2.33	2.19	1.71	1.58	1.54	1.44	1.48	1.35	1.31	1.25	1.26	1.23	1.16	1.43	1.17	1.13
7. Leggings, Stockings, Tights and socks	2.72	4.25	4.04	4.38	3.98	3.74	4.17	3.86	3.42	3.13	2.98	2.94	3.33	3.21	2.76	2.83	3.02	3.05	2.76	2.83	2.66	2.67	2.63	2.61	2.62	2.16	2.17	2.38
6. Dresses, Skirts and jumpsuits	3.38	4.30	4.15	4.22	4.05	4.27	4.83	5.00	4.19	4.18	3.94	4.14	4.48	4.63	3.60	3.52	3.53	3.77	4.04	4.03	3.47	3.63	3.78	6.01	6.41	3.41	4.86	4.89
5. Pants and shorts	5.43	6.71	6.53	6.52	6.37	6.47	7.79	7.84	8.00	7.56	7.55	7.96	7.14	7.22	4.99	4.59	4.61	4.87	4.71	4.13	3.73	3.90	3.92	0.91	0.91	0.91	0.91	0.91
4. Jackets and coats	6.08	7.21	7.48	7.33	6.63	6.93	7.21	6.98	6.57	6.82	6.68	6.99	6.68	7.05	5.30	4.79	4.62	4.85	4.17	4.34	4.19	4.44	4.52	4.63	5.14	4.30	4.32	5.28
3. Sweaters and mid-layers	4.97	7.53	7.82	7.69	7.26	11.68	7.46	6.73	7.59	6.31	5.61	5.86	4.90	4.51	3.51	3.38	3.22	3.32	3.18	2.98	2.27	2.55	2.61	2.99	3.50	2.83	3.43	2.88
2. Shirts and blouses	3.64	4.56	4.62	4.38	4.19	4.77	3.85	4.06	4.44	4.21	3.63	4.23	4.48	3.96	3.07	2.98	2.99	3.08	3.21	3.08	2.94	3.11	3.12	3.03	2.90	2.34	2.33	2.75
1.T-shirts	1.76	2.15	2.21	2.13	2.42	2.75	2.59	3.05	3.25	2.95	2.88	2.48	2.36	2.20	1.89	1.87	1.69	1.72	1.78	1.74	1.88	2.05	2.13	1.96	2.08	1.81	2.16	2.14

(A) Total mass; (B) Total value

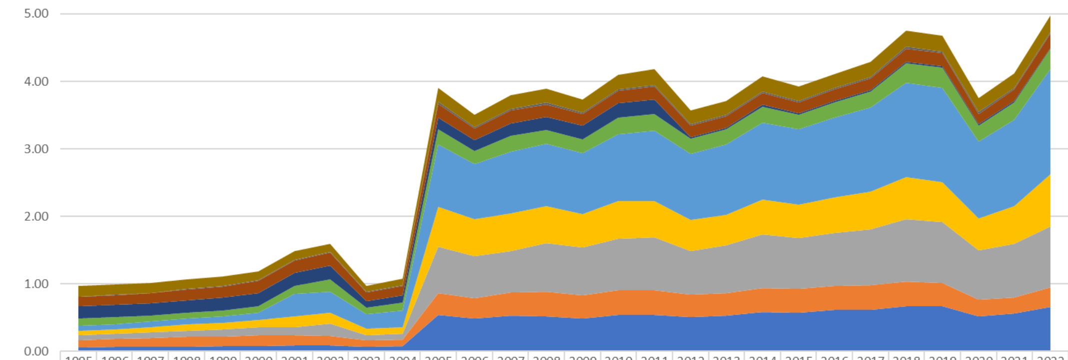
Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Table 62. Change of production after the removal of EU import quota in 2005

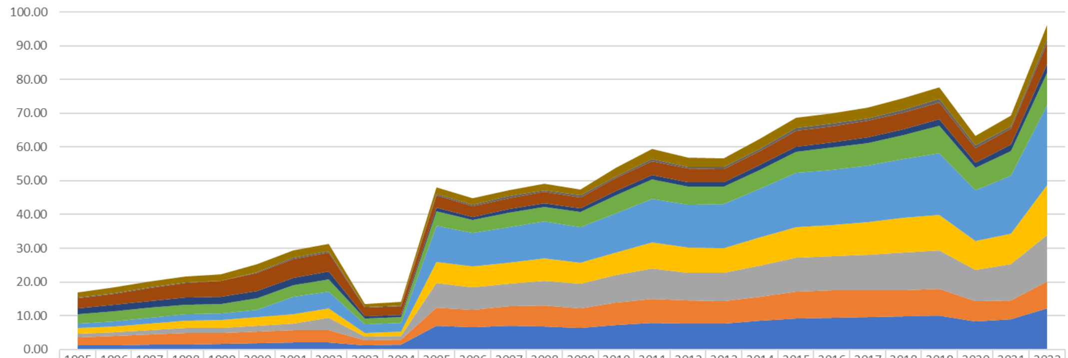
Textile apparel category	Mass (bn kg)		Change in mass (%)	Value (bn EUR)		Change in value (%)
	Average value in 1995-2004	Average value in 2005-2019		Average value in 1995-2004	Average value in 2005-2019	
1.T-shirts	0.12	0.09	-29	2.53	2.05	-19
2. Shirts and blouses	0.11	0.09	-18	4.27	3.32	-22
3. Sweaters and mid-layers	0.35	0.12	-65	7.50	3.63	-52
4. Jackets and coats	0.19	0.13	-32	6.92	5.23	-25
5. Pants and shorts	0.25	0.16	-35	6.92	4.74	-32
6. Dresses, Skirts and jumpsuits	0.15	0.09	-38	4.26	4.20	-1
7. Leggings, Stockings, Tights and socks	0.31	0.17	-45	3.77	2.86	-24
8. Underwear	0.09	0.05	-48	3.50	1.65	-53
9. Swimwear	0.01	0.01	-41	0.68	0.45	-33
10. Accessories	0.12	0.03	-77	2.40	1.46	-39

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 42. Import of textile apparel categories in EU-27



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10. Accessories	0.16	0.15	0.15	0.14	0.14	0.13	0.13	0.12	0.09	0.09	0.21	0.18	0.19	0.21	0.20	0.21	0.24	0.20	0.20	0.22	0.21	0.21	0.22	0.23	0.23	0.21	0.21	0.24
9. Swimwear	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.03	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.02	0.02	0.03
8. Underwear	0.14	0.14	0.15	0.16	0.17	0.19	0.19	0.20	0.14	0.14	0.21	0.18	0.20	0.19	0.18	0.18	0.19	0.17	0.18	0.18	0.16	0.17	0.17	0.20	0.19	0.15	0.18	0.21
7. Leggings, Stockings, Tights and socks	0.18	0.18	0.18	0.19	0.19	0.20	0.19	0.20	0.10	0.11	0.18	0.16	0.18	0.19	0.19	0.21	0.21	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
6. Dresses, Skirts and jumpsuits	0.11	0.11	0.09	0.08	0.09	0.10	0.11	0.17	0.09	0.11	0.22	0.20	0.24	0.20	0.21	0.24	0.26	0.22	0.22	0.24	0.22	0.23	0.24	0.28	0.30	0.24	0.26	0.30
5. Pants and shorts	0.07	0.07	0.08	0.09	0.09	0.11	0.34	0.32	0.22	0.24	0.93	0.82	0.92	0.93	0.90	1.00	1.04	0.98	1.04	1.14	1.12	1.18	1.24	1.40	1.39	1.13	1.28	1.56
4. Jackets and coats	0.07	0.07	0.08	0.09	0.10	0.11	0.16	0.16	0.10	0.11	0.58	0.55	0.55	0.55	0.49	0.55	0.54	0.46	0.45	0.52	0.49	0.52	0.56	0.63	0.60	0.48	0.55	0.78
3. Sweaters and mid-layers	0.07	0.07	0.09	0.09	0.10	0.11	0.12	0.18	0.07	0.08	0.69	0.62	0.62	0.72	0.72	0.77	0.79	0.65	0.71	0.79	0.75	0.79	0.83	0.92	0.90	0.73	0.80	0.90
2. Shirts and blouses	0.11	0.12	0.13	0.15	0.14	0.16	0.16	0.15	0.09	0.10	0.32	0.30	0.34	0.36	0.34	0.36	0.37	0.34	0.33	0.35	0.35	0.36	0.36	0.37	0.35	0.25	0.23	0.28
1.T-shirts	0.06	0.07	0.06	0.07	0.08	0.08	0.09	0.09	0.07	0.08	0.54	0.49	0.53	0.52	0.49	0.54	0.54	0.51	0.53	0.59	0.58	0.61	0.62	0.67	0.67	0.52	0.56	0.66



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10. Accessories	1.46	1.65	1.86	1.88	1.86	2.23	2.18	2.16	1.02	1.10	1.91	1.87	1.75	1.88	1.87	2.47	2.86	2.69	2.60	2.82	3.08	3.14	3.23	3.36	3.46	2.87	3.18	4.30
9. Swimwear	0.12	0.14	0.15	0.16	0.19	0.25	0.27	0.37	0.15	0.18	0.52	0.50	0.52	0.52	0.51	0.54	0.61	0.61	0.61	0.65	0.76	0.76	0.81	0.84	0.93	0.76	0.69	1.03
8. Underwear	3.02	3.34	3.75	4.31	4.57	5.41	5.57	5.72	2.55	2.59	3.64	3.14	3.41	3.41	3.32	3.71	4.08	3.89	3.84	4.14	4.62	4.68	4.77	4.88	5.02	4.20	4.77	6.26
7. Leggings, Stockings, Tights and socks	1.77	1.90	1.98	2.03	2.11	2.21	2.22	2.33	0.70	0.74	1.12	0.95	1.07	1.12	1.14	1.33	1.45	1.31	1.37	1.50	1.60	1.68	1.77	1.79	1.90	1.69	1.90	2.62
6. Dresses, Skirts and jumpsuits	2.86	2.92	2.95	2.92	2.90	3.34	3.50	3.57	1.71	1.74	4.24	3.83	4.21	4.27	4.52	5.33	5.74	5.36	5.21	5.67	6.27	6.48	6.64	7.08	8.16	6.53	7.36	9.64
5. Pants and shorts	1.36	1.52	1.74	1.90	1.96	2.30	5.12	4.98	2.50	2.61	10.73	9.96	10.54	10.95	10.47	11.61	12.80	12.76	12.97	14.32	16.05	16.48	16.87	17.43	18.24	15.17	17.14	23.53
4. Jackets and coats	1.60	1.75	1.97	2.13	2.24	2.41	2.75	2.82	1.19	1.26	6.30	6.12	6.24	6.54	6.09	6.72	7.85	7.45	7.37	8.36	9.03	9.28	9.67	10.36	10.65	8.49	8.99	14.83
3. Sweaters and mid-layers	1.08	1.19	1.38	1.48	1.67	1.86	1.96	3.57	0.92	0.95	7.22	6.70	6.58	7.43	7.34	8.21	8.90	8.24	8.42	9.34	10.08	10.10	10.43	11.08	11.34	9.36	10.80	13.81
2. Shirts and blouses	2.34	2.61	3.06	3.39	3.20	3.40	3.62	3.61	1.61	1.66	5.31	5.09	5.90	6.22	5.93	6.58	7.21	6.93	6.62	7.10	7.99	8.03	8.01	7.85	7.84	5.84	5.58	7.87
1.T-shirts	1.23	1.30	1.32	1.52	1.58	1.81	2.08	2.14	1.16	1.33	7.07	6.65	6.96	6.74	6.30	7.27	7.84	7.58	7.61	8.43	9.15	9.41	9.57	9.71	10.08	8.37	8.94	12.25

(A) Total mass; (B) Total value

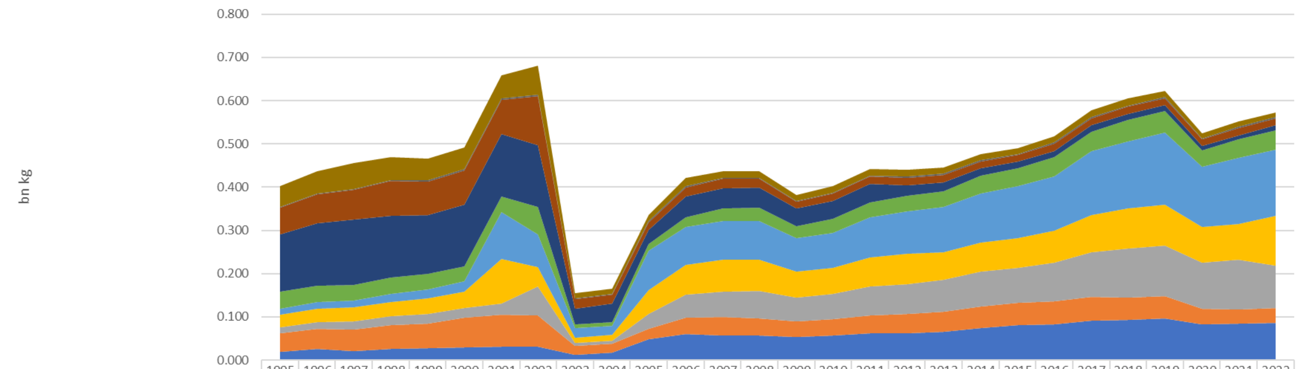
Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Table 63. Change of import after the removal of EU import quota in 2005

Textile apparel category	Mass (bn kg)		Change in mass (%)	Value (bn EUR)		Change in value (%)
	Average value in 1995-2004	Average value in 2005-2019		Average value in 1995-2004	Average value in 2005-2019	
1.T-shirts	0.07	0.56	650	1.55	8.03	419
2. Shirts and blouses	0.13	0.35	168	2.85	6.84	140
3. Sweaters and mid-layers	0.10	0.75	656	1.60	8.76	446
4. Jackets and coats	0.10	0.54	413	2.01	7.87	291
5. Pants and shorts	0.16	1.07	552	2.60	13.48	419
6. Dresses, Skirts and jumpsuits	0.11	0.24	121	2.84	5.53	95
7. Leggings, Stockings, Tights and socks	0.17	0.10	-41	1.80	1.41	-22
8. Underwear	0.16	0.18	12	4.08	4.04	-1
9. Swimwear	0.01	0.02	274	0.20	0.65	225
10. Accessories	0.13	0.21	63	1.74	2.60	49

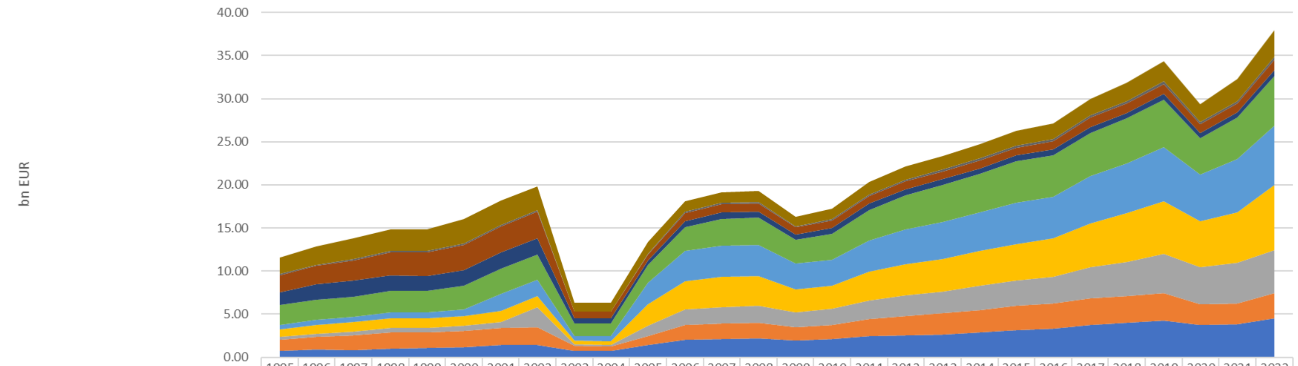
Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Figure 43. Export of textile apparel categories in EU-27



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
10. Accessories	0.048	0.052	0.060	0.054	0.050	0.050	0.053	0.066	0.014	0.013	0.014	0.019	0.016	0.015
9. Swimwear	0.002	0.002	0.002	0.002	0.003	0.003	0.003	0.003	0.001	0.001	0.002	0.003	0.003	0.003
8. Underwear	0.063	0.066	0.068	0.080	0.077	0.078	0.080	0.114	0.022	0.021	0.017	0.021	0.021	0.019
7. Leggings, Stockings, Tights and socks	0.133	0.145	0.151	0.143	0.136	0.143	0.143	0.142	0.036	0.042	0.033	0.048	0.046	0.046
6. Dresses, Skirts and jumpsuits	0.039	0.038	0.036	0.037	0.037	0.035	0.037	0.064	0.009	0.009	0.016	0.023	0.029	0.031
5. Pants and shorts	0.015	0.016	0.017	0.019	0.020	0.023	0.108	0.076	0.022	0.021	0.092	0.087	0.091	0.090
4. Jackets and coats	0.028	0.030	0.033	0.034	0.037	0.038	0.104	0.046	0.013	0.013	0.054	0.069	0.073	0.073
3. Sweaters and mid-layers	0.014	0.015	0.018	0.020	0.021	0.024	0.025	0.066	0.006	0.006	0.034	0.054	0.058	0.064
2. Shirts and blouses	0.043	0.047	0.050	0.055	0.057	0.067	0.074	0.073	0.021	0.020	0.025	0.037	0.044	0.040
1.T-shirts	0.020	0.026	0.022	0.025	0.027	0.030	0.031	0.031	0.013	0.018	0.048	0.060	0.056	0.057

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10. Accessories	0.013	0.014	0.015	0.017	0.014	0.014	0.013	0.013	0.016	0.016	0.013	0.012	0.011	0.010
9. Swimwear	0.002	0.003	0.003	0.003	0.003	0.002	0.003	0.003	0.003	0.003	0.004	0.002	0.003	0.003
8. Underwear	0.016	0.018	0.017	0.017	0.018	0.016	0.016	0.017	0.016	0.016	0.016	0.015	0.019	0.016
7. Leggings, Stockings, Tights and socks	0.041	0.041	0.042	0.025	0.020	0.018	0.016	0.015	0.015	0.014	0.014	0.011	0.009	0.012
6. Dresses, Skirts and jumpsuits	0.027	0.031	0.035	0.036	0.037	0.040	0.041	0.044	0.044	0.049	0.050	0.038	0.043	0.044
5. Pants and shorts	0.077	0.081	0.093	0.098	0.104	0.114	0.119	0.126	0.148	0.155	0.166	0.139	0.152	0.154
4. Jackets and coats	0.060	0.061	0.067	0.071	0.063	0.067	0.070	0.074	0.085	0.094	0.095	0.082	0.083	0.114
3. Sweaters and mid-layers	0.056	0.058	0.067	0.068	0.074	0.080	0.081	0.089	0.105	0.113	0.116	0.106	0.114	0.098
2. Shirts and blouses	0.036	0.037	0.041	0.045	0.047	0.050	0.052	0.054	0.055	0.052	0.052	0.036	0.033	0.035
1.T-shirts	0.053	0.057	0.062	0.062	0.065	0.074	0.080	0.082	0.090	0.092	0.097	0.083	0.084	0.086



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
10. Accessories	1.91	2.16	2.41	2.51	2.48	2.78	2.83	2.78	1.00	1.02	1.30	1.28	1.27	1.29
9. Swimwear	0.10	0.12	0.11	0.12	0.14	0.17	0.18	0.17	0.05	0.04	0.12	0.16	0.18	0.18
8. Underwear	1.97	2.17	2.34	2.65	2.75	2.92	2.99	3.07	0.78	0.78	0.69	0.90	0.91	0.90
7. Leggings, Stockings, Tights and socks	1.53	1.76	1.88	1.86	1.78	1.86	1.93	1.88	0.53	0.58	0.48	0.68	0.73	0.73
6. Dresses, Skirts and jumpsuits	2.25	2.36	2.39	2.48	2.44	2.74	2.85	2.88	1.47	1.48	2.07	2.77	3.15	3.17
5. Pants and shorts	0.52	0.57	0.60	0.67	0.69	0.76	2.00	1.89	0.57	0.56	2.51	3.49	3.61	3.58
4. Jackets and coats	0.91	1.03	1.09	1.13	1.12	1.14	1.35	1.32	0.42	0.43	2.46	3.27	3.51	3.43
3. Sweaters and mid-layers	0.36	0.39	0.45	0.52	0.55	0.60	0.62	2.29	0.17	0.18	1.26	1.80	1.88	1.95
2. Shirts and blouses	1.25	1.45	1.68	1.87	1.79	1.85	2.02	2.06	0.57	0.53	1.03	1.74	1.86	1.82
1.T-shirts	0.75	0.89	0.85	1.00	1.07	1.19	1.41	1.46	0.76	0.74	1.42	2.04	2.07	2.22

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
10. Accessories	1.10	1.27	1.43	1.50	1.54	1.64	1.71	1.79	1.92	2.11	2.31	2.12	2.55	3.06
9. Swimwear	0.16	0.17	0.19	0.20	0.21	0.21	0.22	0.21	0.27	0.29	0.33	0.24	0.28	0.37
8. Underwear	0.79	0.81	0.86	0.91	0.93	0.94	0.93	1.00	1.07	1.07	1.11	1.02	1.06	1.17
7. Leggings, Stockings, Tights and socks	0.63	0.68	0.75	0.72	0.68	0.65	0.62	0.63	0.68	0.68	0.71	0.61	0.61	0.75
6. Dresses, Skirts and jumpsuits	2.76	3.00	3.57	3.99	4.31	4.45	4.84	4.81	5.00	5.16	5.53	4.19	4.81	5.70
5. Pants and shorts	3.01	3.04	3.59	3.97	4.26	4.51	4.77	4.85	5.55	5.82	6.29	5.47	6.11	6.92
4. Jackets and coats	2.69	2.71	3.33	3.66	3.77	4.05	4.28	4.44	5.02	5.61	6.09	5.30	5.87	7.54
3. Sweaters and mid-layers	1.69	1.83	2.15	2.35	2.53	2.75	2.88	3.11	3.64	4.03	4.55	4.25	4.78	5.01
2. Shirts and blouses	1.56	1.70	2.04	2.29	2.44	2.63	2.86	2.92	3.10	3.09	3.15	2.41	2.35	2.95
1.T-shirts	1.93	2.07	2.42	2.53	2.65	2.88	3.13	3.32	3.74	3.97	4.26	3.77	3.86	4.49

(A) Total mass; (B) Total value

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

Table 64. Change of export after the removal of EU import quota in 2005

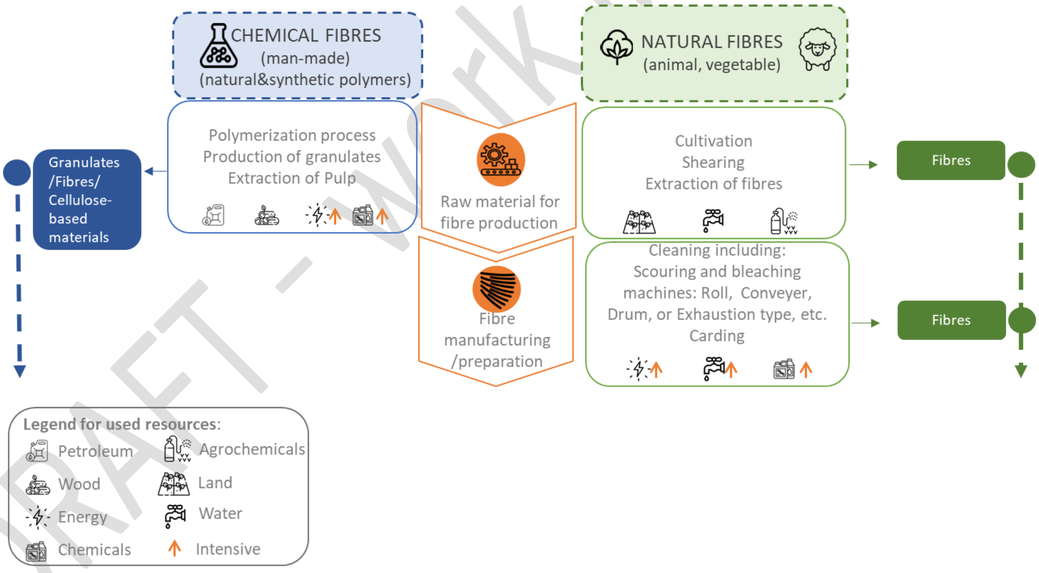
Textile apparel category	Mass (bn kg) Average value in 1995-2004	Mass (bn kg) Average value in 2005-2019	Change in mass (%)	Value (bn EUR) Average value in 1995-2004	Value (bn EUR) Average value in 2005-2019	Change in value (%)
1.T-shirts	0.02	0.07	186	1.01	2.71	168
2. Shirts and blouses	0.05	0.04	-12	1.51	2.28	51
3. Sweaters and mid-layers	0.02	0.07	246	0.61	2.56	318
4. Jackets and coats	0.04	0.07	91	0.99	3.89	291
5. Pants and shorts	0.03	0.11	226	0.88	4.19	375
6. Dresses, Skirts and jumpsuits	0.03	0.04	4	2.33	3.90	67
7. Leggings, Stockings, Tights and socks	0.12	0.03	-76	1.56	0.67	-57
8. Underwear	0.07	0.02	-74	2.24	0.92	-59
9. Swimwear	0.00	0.00	26	0.12	0.21	70
10. Accessories	0.05	0.01	-68	2.19	1.56	-28

Source: own production based on PRODCOM database (Sold production, exports and imports – DS-056120)

10.2 Life-cycle stages of textile apparel

10.2.1 Raw material and fibre manufacturing

Figure 44. Raw material for fibre production and fibre preparation



Source: production adapted from (McKinsey & Company, 2022), icons from www.flaticon.com

Raw material for fibre production

Natural fibres

The primary raw material for vegetable-based fibres is cellulose, which is the most prevalent natural polymer in nature. Cellulose is sourced from agricultural crops, which often require significant land and water use. The production process typically involves a high use of chemicals, like pesticides (Jana et al., 2023) (Roth et al., 2023). After the production process, the result is staple fibres. Following a pre-treatment or preparation phase, these fibres then serve as the input for the yarn production stage.

Animal-based fibres, also known as protein fibres, are sourced from animals through methods such as shearing or collecting silkworm cocoons. This requires farming animals like sheep or silkworms, either on pastures or through sericulture (Roth et al., 2023) (Jana et al., 2023). The production yields staple fibres, which, after a pre-treatment phase, are used in yarn production.

Chemical fibres

Man-made chemical fibres derived from natural polymers use cellulose, often from sources like wood pulp, as their primary raw material. This cellulose is then dissolved to produce a solution suitable for the next stage of fibre production. The key components in this process are the wood feedstock, which come from various sources, and the chemicals used in the dissolution process (Jana et al., 2023).

Man-made chemical fibres made from synthetic polymers use petroleum as raw material. This is processed using energy-intensive chemical reactions, which vary depending on the specific synthetic fibre, to produce synthetic polymers. These polymers are then turned into granules (Roth et al., 2023). These granules are then prepared for the subsequent fibre production process (Jaffe and Menczel, 2020).

Fibre manufacturing/preparation

Manufacturing of natural and chemical fibres

Staple fibres of natural origin, man-made chemical staple fibres derived from natural polymers, and synthetic granules produced in the raw material stage all undergo the manufacturing process. The specific production steps they undergo vary based on the source of the raw material.

Preparation of natural fibres

Natural staple fibres go through similar preparation stages before yarn manufacturing. This typically involves a scouring or cleaning process before carding. The exact procedures vary based on the fibre type, whether cellulosic (like cotton) or protein-based (like wool). The primary distinction arises from the type and amount of impurities present in the natural fibres.

Wool, a protein fibre, undergoes scouring, which is typically a wet cleaning process using detergents to remove dirt, oils, and other contaminants. After scouring, the wool is usually bleached with hydrogen peroxide, to remove its natural colour and any remaining impurities, preparing it for subsequent treatments or dyeing. This is then followed by drying. Overall, this process is intensive in terms of water, energy, and chemicals.

The cotton cleaning process involves dry procedures carried out in a blowing room. This room houses technologies that move the raw materials through various airflow cleaning systems, integrated within a mechanical cleaning process.

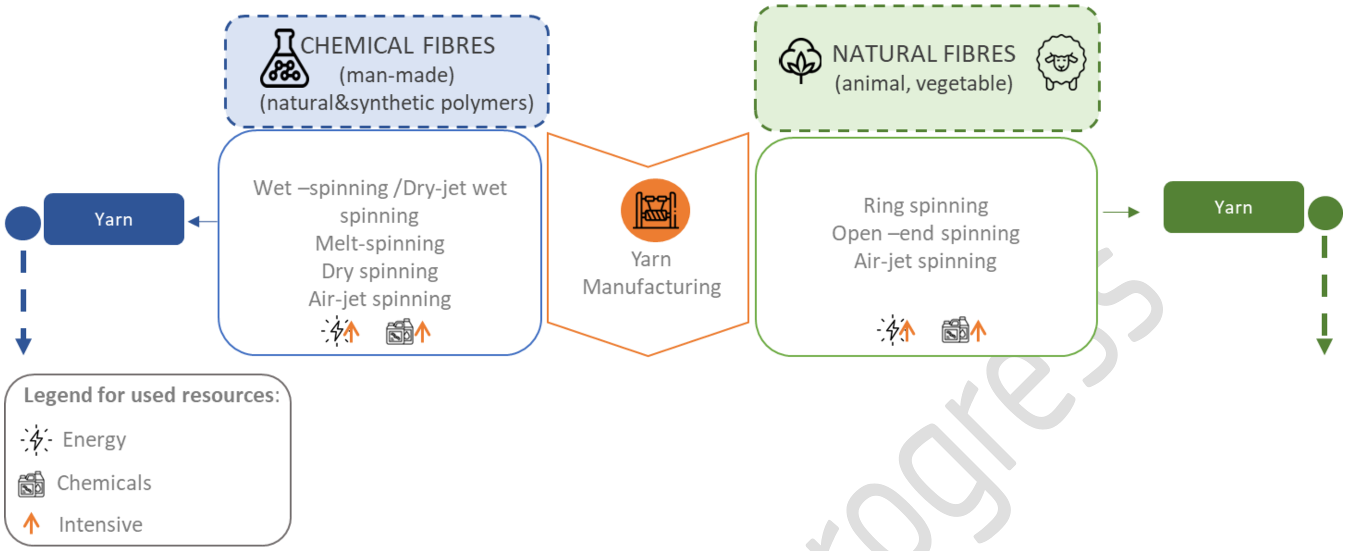
Furthermore, because natural fibres have inconsistent properties, they may undergo wet chemical processes, such as bleaching, and other treatments to enhance and modify them.

Preparation of chemical fibres

Chemical fibres skip the preparation stage, as the staple fibres and granules are used directly for the yarn production (spinning).

10.2.2 Yarn manufacturing

Figure 45. Yarn manufacturing (spinning process)



Source: own production and adapted from (McKinsey & Company, 2022), icons from www.flaticon.com

Carded natural fibres, cellulose – based material, and polymer granulates serve as inputs for the spinning process, which produces yarns.

In the textile industry, the definition of spinning varies based on the type of fibre being processed:

— Natural origin fibres: Spinning for these fibres involves passing the staple fibres through a series of rollers to straighten and align them, then twisting them to create a continuous yarn (Britannica, 2019). Each type of natural fibre goes through a unique set of steps for yarn production. For all, the initial step is carding, a mechanical process that further cleans and disentangles the fibres, aligning them. This is followed by other processes such as combing, drawing, and more. Typical spinning machines for natural fibres include ring spinning and open-end spinning (Roth et al., 2023).

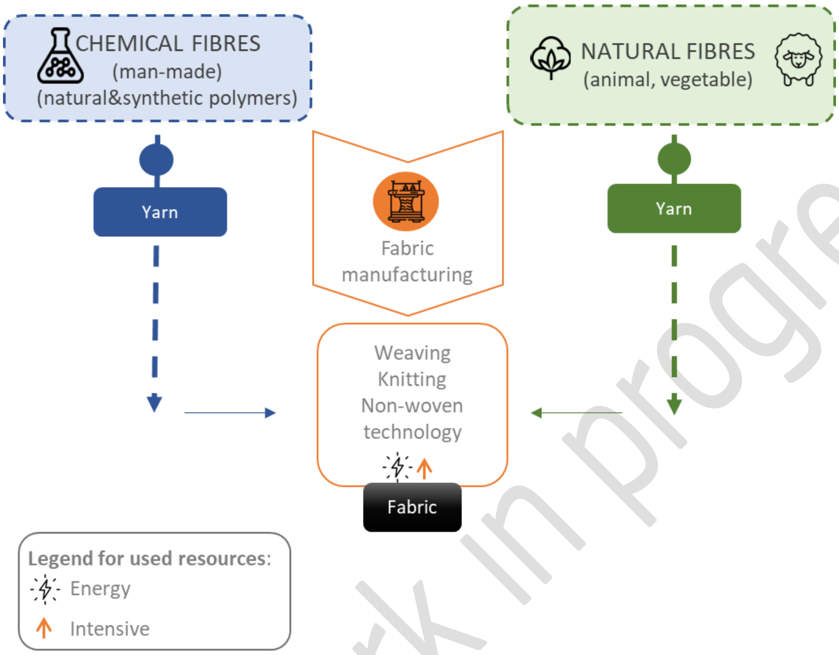
— Chemical (man-made) fibres: Spinning refers to the extrusion of a solution, like viscose/cellulose-based materials or dissolved granules, to produce a fibre or yarn. Standard industrial spinning machines for these fibres are:

- melt spinning: polymer melted in a melt extruder, and is suitable for thermoplastic fibres such as polyester, polyamide, polyolefins, glass fibre and many more;
- wet spinning: polymer dissolved in a solvent, being suitable for viscose and acrylic fibres dry spinning: polymer dissolved in a solution, applicable for acetate, triacetate and polyacrylonitrile.
  - Man-made cellulosic fibres: Spinning filaments into yarns involves processes where cellulose from wood pulp is dissolved using specific chemical solvents (e.g., sodium hydroxide for viscose, ammonia-copper solution for cupro, NMMO for lyocell, or acetic acid for acetate), and the resulting solution is typically extruded and coagulated using wet spinning techniques. Nevertheless, for staple fibres, ring or open-end spinning is used.

Drawing or air texturizing is performed to give to the chemical yarns a texture similar to natural yarns. Such treatments are carried out with energy demanding equipment (Roth et al., 2023).

10.2.3 Fabric manufacturing

Figure 46. Fabric manufacturing process



Source: own production adopted from (McKinsey & Company, 2022), icons from www.flaticon.com

The central phase of textile production is fabric manufacturing. This involves creating a two-dimensional structure by interlacing yarns. Common methods include weaving, knitting, and producing non-woven fabrics, suitable for all yarn types.

Weaving is the predominant fabric manufacturing technique. It involves interlacing two sets of yarns at right angles on a loom. Most looms are power-driven, termed 'power looms', and are energy intensive. There are also manual looms, which are labour-intensive. Key resources in weaving include chemicals for sizing and desizing textiles and oils for lubricating the loom. Sizing protects the yarn from the loom's abrasive action, while desizing removes these chemicals from the woven fabric after weaving (Roth et al., 2023).

Knitting is the second most used fabric manufacturing method. In this case, yarns are interlooped using needles to form fabric on knitting machines. These machines are broadly categorised as weft[181] (either flat or circular) and warp[182], based on the fabric's formation direction (horizontal or vertical). They're further classified by machine shape and knitting technology. This method is energy intensive. To prevent yarn damage, substances like sizing chemicals and lubricants are used for yarn strengthening and reducing friction (Roth et al., 2023).

Non-woven technology produces textile structures by bonding fibres or filaments together, either mechanically, thermally, or chemically. According to the Association of the Non-woven Fabrics Industry (INDA), they are "flat, porous sheets made directly from separate fibres or molten plastic. They are neither woven nor knitted and don't convert fibres to yarn" (INDA, 2023). Various non-woven processes exist, categorised by web-forming technologies and product consolidation. Common technologies include drylaid ([183]), wetlaid ([184]), spunmelt ([185]),

[181] The fabric is formed based on loops made on horizontal way from a single yarn, which is fed and looped in rows by one or more needles at a time (Roth et al., 2023).

[182] The yarn is fed into the knitting forming vertical loops, and moves diagonally to knit the next course (yarns generate a zigzag from side to side along the length of the fabric) (Ray, 2012).

[183] The process of fabric web forming with a stream of air, applied on dry fibres by using carding equipment (INDA, 2023).

[184] The process of fabric web forming filtering an aqueous suspension of fibre onto a screen conveyor belt or perforated drum. The fibres are retained on the screen, while the water passes through (INDA, 2023).

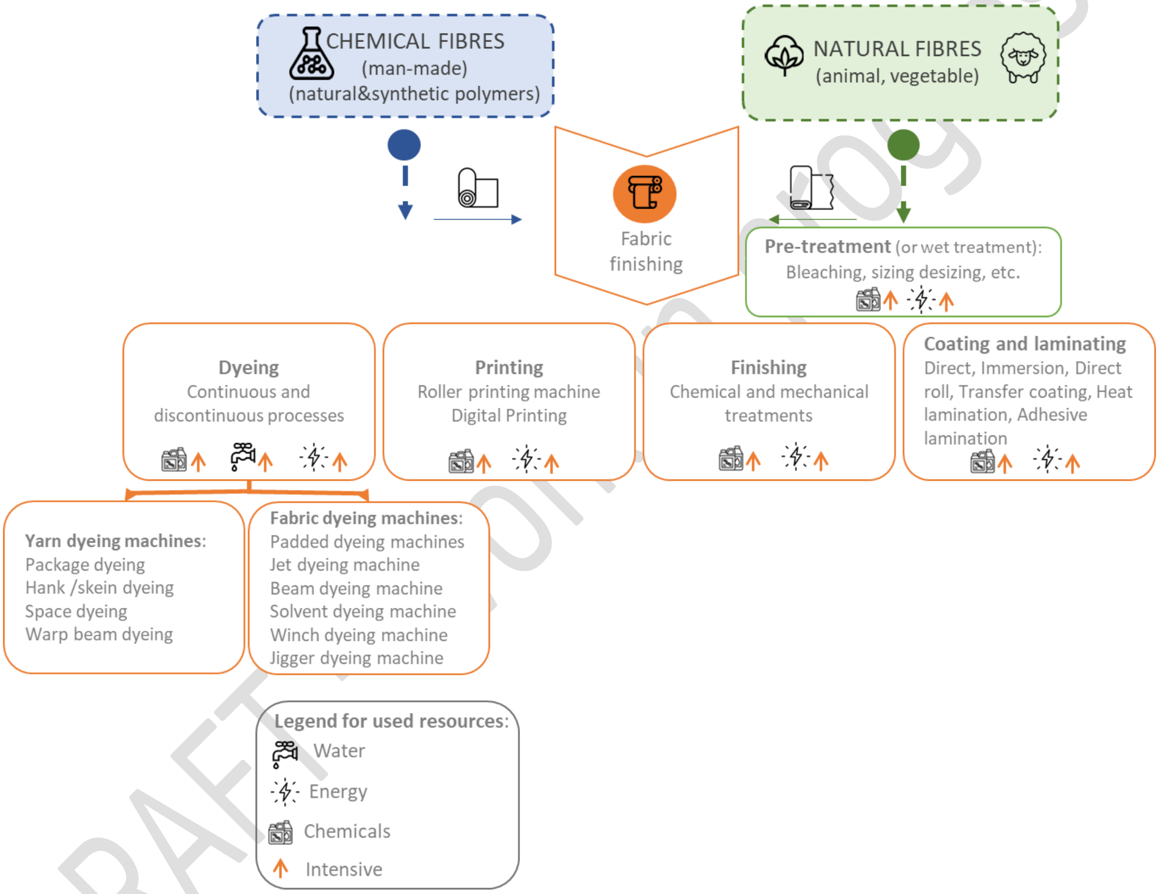
[185] The process of non-woven manufacturing through the extrusion of molten polymer spinneret to form fibres, drawing the fibres, and then laying them on a moving screen to form a web. Thee term "spunlaid" is often used interchangeably with "spunbond¨(INDA, 2023).

and needle-punched ([186]). However, many other processes are available ([187]) (Batra and Pourdeyhimi, 2012) (Mao, 2016). Overall, non-woven technology is energy intensive.

In the knitting or weaving process, the type of yarn used, and its count (indicating fabric thickness) influence the durability and strength of the final product, such as its seam or tear resistance (Yassen, 2017) (Jankoska and Demboski, 2017). Non-woven fabrics present recycling challenges due to the fibre composition and the consolidation components used in their production.

10.2.4 Finishing processes

Figure 47. Fabric/yarn finishing processes



Source: own production adapted from (McKinsey & Company, 2022), icons from www.flaticon.com

Finishing processes are an intermediate stage in treating yarn and/or fabrics with colorants and chemicals. This includes various wet treatments aimed at different objectives, such as sizing, desizing, pre-treatment, dyeing, printing, finishing, and more. These treatments are applied based on the specific requirements of the final products, rather than in a sequential manner. Each treatment utilises distinct technologies and chemicals, making this one of the most water and chemically intensive stages

Pre-treatment

Pre-treatment is typically applied to natural fibre fabrics. It encompasses processes like bleaching, scouring, mercerising[188], and others, preparing the fabrics for final treatments before dyeing, printing, and finishing. These

[186] The mechanical process that uses barbed needles to pull tufts of fibres from the web and insert them vertically into the web, which bonds the fibres together (INDA, 2023).
[187] Definitions of the technologies can be found in the Glossary of the Association of the Non-woven Fabrics Industry. Available here.
[188] Mercerising is the process of treatment of cotton fabrics to increase dyeability (generally involving the use of sodium hydroxide) (Roth et al., 2023).

processes heavily rely on chemicals, using inputs like oxidising agents (e.g., chlorine, sodium hypochlorite, calcium hypochlorite, hydrogen peroxide), scouring alkali (e.g., caustic soda), sodium hydroxide, and also consume significant amounts of energy and water.

Dyeing

Dyeing is the process where dye particles diffuse into the textile material. This involves forming chemical bonds between the dye molecules and the textile. This is achieved based on the dye-fibre chemical affinity and the specific dyeing process. Dyes can be natural or man-made (synthetic) and are molecules containing chromophores that interact with light to produce colour (Singh and Bharati, 2014). Textile dyeing uses specific dyes that have an affinity or 'chemical attraction' to particular fibres. **Table 65** reports the fibres and their corresponding dyes, ensuring shades meet performance and fastness standards (Roth et al., 2023).

Table 65. Affinity relationship between dyes and fibres

Fibre type	Fibre name	Dye type
Cellulosic	Cotton Linen Hemp Jute Modal Lyocell Viscose	Direct dyes Reactive dyes Vat dyes Sulphur dyes
Proteic	Wool Silk Other fibres of animal hair	Acid dyes Premetallised dyes Reactive dyes
Man-made	Polyamide	Acid dyes Premetallised dyes Reactive dyes Disperse dyes
	Acrylic	Cationic dyes Disperse dyes
	Polyester	Disperse dyes

Source: own elaboration based on (Clark, 2011)

The affinity between the dye and fibre affects the final performance indicators for durability, such as washing and colour fastness. Moreover, various chemicals and auxiliary products are needed to enhance the efficiency and quality of the colouration process.

Dyeing can be conducted in batch, continuous, or semi-continuous modes and is suitable for both yarns and fabrics. The process requires specific temperatures and pressures for set durations. Discontinuous dyeing machines include autoclaves, hank dyeing machines, winches, becks, overflows, jets, jigs, paddles, and drum dyeing machines. Examples of continuous dyeing machines are pad-batch, pad-roll, pad-jig, pad-dry, and thermosol machines.

Overall, the dyeing process consumes significant amounts of water, chemicals, and energy.

Printing

Printing is the colouration process that involves applying dye or pigment to the substrate surface with the aid of specific auxiliaries. This allows for colouring different areas and creating patterns.

Pigments, whether natural or man-made, are insoluble molecules containing chromophores and typically lack affinity to fibres (Singh and Bharati, 2014). The colouring process involves applying a colour paste to the textile using various techniques, followed by fixation. An after-treatment may also be applied, though it can be optional.

- Pigment printing is the most commonly used technique. It does not rely on fibre affinity, allowing for the colouring of all fabric types. The colour's fixing to the fabric surface is determined by the auxiliaries used, such as binders, thickening agents, and others.

- Dye printing requires a more intricate composition for the printing paste. This complexity is influenced by the printing technique, substrate type, application method, and fixation procedures.

For both types of printing, the technology determines how the printing paste is applied. The most common methods include flat-screen printing, rotary-screen printing, roller printing, jet printing, and transfer printing (Roth et al., 2023).

The performance indicators for durability, such as washing and colour fastness, are affected by the composition of the printing pastes and the fixation methods. Since pigments do not bond with fibres, their colour fastness is less efficient as when dyes are used in the colouration process.

Overall, the process requires significant amounts of chemicals and energy.

Finishing

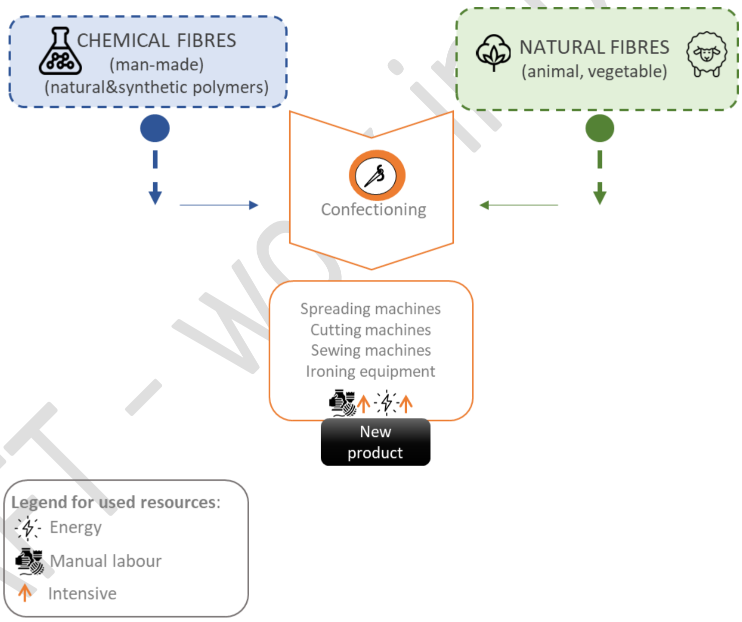
Finishing includes treatments designed to give textile substrates specific end-use properties, like unique visual effects, feel, or functional features such as waterproofing or flame resistance. A variety of chemical and mechanical/physical treatments are associated with this manufacturing stage, and they are typically applied after the colouration process. This stage consumes significant amounts of chemicals and energy (Roth et al., 2023).

Coating and laminating

Coating and laminating involve applying a thin, flexible polymeric film directly to the fabric's surface. The primary technologies employed are roller, spray, and slot die coating. Adding a polymer coating introduces new features to the fabric, such as resistance to dust, liquids, and gases. It can also enhance inherent physical properties, like the fabric's ability to resist abrasion. This stage, too, is chemically and energy-intensive (Roth et al., 2023).

10.2.5 Confectioning

Figure 48. Confectioning process



Source: own production and adapted from (McKinsey & Company, 2022), icons from www.flaticon.com

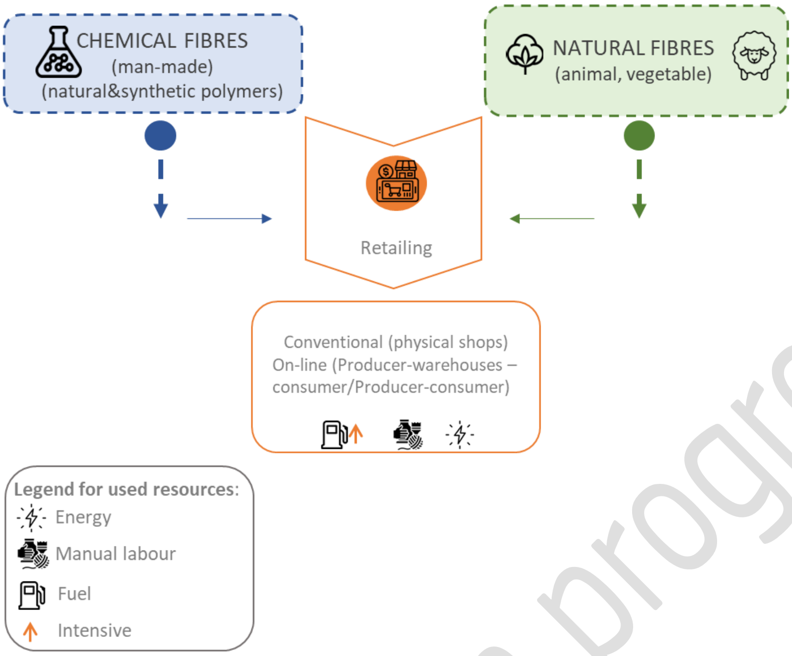
Confectioning is the production stage encompassing product design, fabric cutting, and final product assembly. It i's the most manual phase in the production process (Nayak and Padhye, 2018). The fabric spreading and cutting stage is particularly energy-intensive and can be carried out using either mechanised (operator-assisted) or digitalised (automated) machines. The assembly phase is predominantly manual and labour-intensive, involving processes like sewing and culminating in ironing, which is also energy intensive.

In the final product manufacturing phase, the quality of the sewing process, combined with the sewing stitch and yarn count, significantly affects a product's seam strength, a key durability parameter. The type and count of the yarn play a crucial role in determining a textile product's longevity (Yassen, 2017) (Jankoska and Demboski, 2017).

This is the stage that produces post-industrial waste. By automating and digitalising the design and cutting stages, waste quantities can be reduced (de Mattos et al., 2022).

10.2.6 Retailing

Figure 49. Textile products retailing



Source: own production adapted from (McKinsey & Company, 2022), icons from www.flaticon.com

Retail, defined by the Oxford dictionary as ‘the activity of selling goods to the public in shops, on the internet, etc.’ (Oxford dictionary, 2023), encompasses the transportation of final products and their sale through various channels (European Commission, 2023). The journey typically involves:

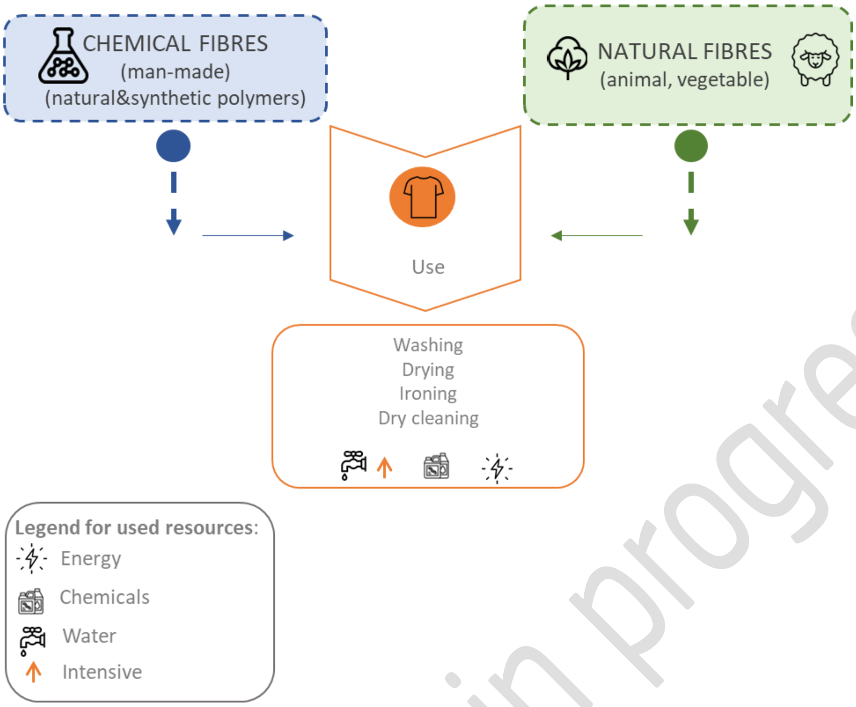
— Moving goods from the production network (manufacturers) to the export network (trade firms), and finally to the marketing networks (retailers) (de Mattos et al., 2022).

— Using various means of transport, including road, sea, rail, air, or a combination of these (multimodal transportation).

The primary resources used in this stage include fuel for transport, which leads to emissions, as well as labour and energy for sales operations. This stage produces pre-consumer waste. To reduce such waste, strategies like production on demand and integrated management systems for efficient inventory management can be employed (Aslan et al., 2015) (de Mattos et al., 2022) (Alyssa Hardy, 2020).

10.2.7 Use

Figure 50. Use phase of a textile product



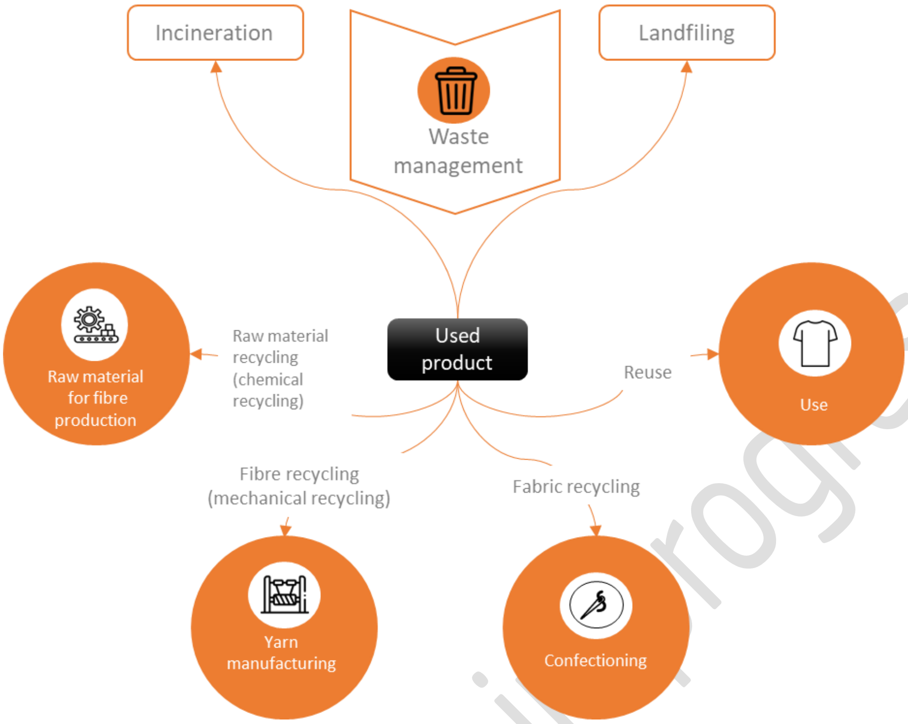
Source: own production and adapted from (McKinsey & Company, 2022), icons from www.flaticon.com

The 'use' phase of a textile product encompasses activities such as washing, cleaning, drying, ironing, and steaming (Quantis, 2022). The specific requirements for these activities depend on the product and are detailed in its care label.

This stage primarily consumes water and chemicals, with energy-intensive processes like ironing and steaming following closely. The physical durability of a textile product hinges on both the user's adherence to the care label instructions and the product's inherent characteristics.

10.2.8 Waste management

Figure 51. Textile products waste management



Source: own production and adapted from (McKinsey & Company, 2022), icons from [*www.flaticon.com*](http://www.flaticon.com)

Most disposed textile apparel, at the end of their life, are either incinerated or sent to landfills. This process not only generates waste and emissions into the environment, but it is also energy intensive. Such discarded textiles, primarily consisting of clothing and home textiles, account for about 85% of total textile waste (McKinsey & Company, 2022). Currently, this follows a linear model. However, the energy recovered from incineration can be repurposed for other applications. The calorific value of textile waste is estimated to be between 3 599 and 5 200 MJ/Kg (Vargas and Yuleimy Ramírez, 2014) (Mustia et al., 2021).

Transitioning from this linear model to a circular one involves collecting, sorting, and pre-processing discarded textiles for fibre-to-fibre recycling. Textile waste management avenues include preparation for reuse, fabric recycling, fibre recycling (mechanical recycling), and raw material recycling (chemical recycling). Currently, only 30-35% of textiles are collected, with a significant portion of unsorted waste exported outside Europe (McKinsey & Company, 2022).

Textile recycling technologies fall into three main categories (Jørgensen et al., 2022):

Fibre or Mechanical Recycling: This method uses physical processes and can be applied to all textile waste types. It can also precede other recycling methods like thermo-mechanical, chemical, or biochemical (DG GROW, 2021b).

Raw Material or Chemical Recycling: This involves chemical processes to recycle monomers or polymers, suitable for materials like cotton, PA6, or PET (DG GROW, 2021b).

Thermal Recycling: This method uses heat. Thermo-mechanical recycling melts polymers, mainly for thermoplastic textiles like polyester, while thermo-chemical recycling breaks down polymers into base components, which can then be repurposed (DG GROW, 2021b; McKinsey & Company, 2022).

Additionally, **fabric recycling** involves refurbishing or remanufacturing discarded textiles, resulting in recycled products.

The primary solution to the current textile waste issue is recycling, coupled with waste reduction efforts (DG GROW, 2021b; McKinsey & Company, 2022).

10.3 Supporting information about tests and standards in the textile industry

Table 66. Working Groups with the involvement of several scientific committees in CEN/ TC 248.

Working Group	Topic
CEN/TC248/SC1	Burning behaviour of textiles, textile products and textile containing products
CEN/TC248/SC2	Physical properties
CEN/TC248/SC3	Chemical properties
CEN/TC248/WG 10	Size system of clothing
CEN/TC248/WG 11	Monofilaments
CEN/TC248/WG 12	Physical testing of knitted fabrics and garments
CEN/TC248/WG 13	Determination of resistance of textiles to microbiological attack
CEN/TC248/WG 14	UV protective properties
CEN/TC248/WG 15	Multifilament yarns
CEN/TC248/WG 16	Textiles in the healthcare system
CEN/TC248/WG 17	Hygienic quality of textiles proposed in industrial laundries and used in sectors it is necessary to control biocontamination
CEN/TC248/WG 18	AZO dyestuffs- Detection of certain aromatic amines
CEN/TC248/WG 19	Characterization of fibres
CEN/TC248/WG 20	Safety of children's clothing
CEN/TC248/WG 21	Terry towels
CEN/TC248/WG 22	Elasticity of fabrics
CEN/TC248/WG 23	Burning behaviour of nightwear
CEN/TC248/WG 24	Test methods for the flammability of textiles
CEN/TC248/WG 25	Cosmeto-textiles
CEN/TC248/WG 26	Methods of test for phthalates
CEN/TC248/WG 27	Determination of fibre proof properties of fabrics
CEN/TC248/WG 28	Thermoregulation
CEN/TC248/WG 29	Specifications and test methods for silk articles
CEN/TC248/WG 3	Ropes and agricultural twines and fishing nets
CEN/TC248/WG 30	Quantitative analysis of fibre mixtures
CEN/TC248/WG 31	Smart Textiles
CEN/TC248/WG 32	Organic, green and ecotextiles
CEN/TC248/WG 33	Labelling of superfine wool
CEN/TC248/WG 34	Joint Working Group between CEN/TC248 and CEN/TC 252 Risks in the sleeping environment
CEN/TC248/WG 35	Slide (zip) Fasteners
CEN/TC248/WG 36	Classification of textiles and textile products based on burning behaviour
CEN/TC248/WG 37	Microplastics from textile sources
CEN/TC248/WG 38	Circular Textiles Chain- Requirements and categories
CEN/TC248 WG 39	Circular Economy for textile products and textile chain. This group is under development
CEN/TC248/WG 4	Coated fabrics
CEN/TC248/WG 5	Touch and close fasteners
CEN/TC248/WG 6	Sewing threads
CEN/TC248/WG 7	Cabinet roller towels
CEN/TC248/WG 8	Upholstery fabrics
CEN/TC248/WG 9	Prioritization of research topics
CEN/TC38/WG 35	Environmental aspects
ISO/TC173/SC/WG2	Urinary absorbing aids

Source: CEN official website ([189])

Table 67. Working Groups and subcommittees involved in ISO/TC 38.

Working Group	Topic
ISO ISO/TC 38/SC 1	Tests for coloured textiles and colorants
ISO/TC 38/SC 2	Cleansing, finishing and water resistance tests
ISO/TC 38/SC 20	Fabric descriptions
ISO/TC 38/SC 23	Fibres and yarns
ISO/TC 38/SC 24	Conditioning atmospheres and physical tests for textile fabrics
ISO/TC 38/CAG	Chair's Advisory Group
ISO/TC 38/WG 9	Nonwovens

[189] CEN Technical Committee Working Groups available at this link

Working Group	Topic
ISO/TC 38/WG 17	Physiological properties of textiles
ISO/TC 38/WG 21	Ropes, cordage, slings and netting
ISO/TC 38/WG 22	Composition and chemical testing
ISO/TC 38/WG 23	Biological properties of textiles
ISO/TC 38/WG 27	Fabric properties relating to moisture
ISO/TC 38/WG 30	Tests for Biodegradability
ISO/TC 38/WG 31	Non-fibrous bio-based material for textiles
ISO/TC 38/WG 32	Smart textiles
ISO/TC 38/WG 33	Animal welfare in the textile supply chain
ISO/TC 38/WG 34	Microplastics from textile sources
ISO/TC 38/WG 35	Environmental aspects
ISO/TC 38/WG 36	Activated carbon fibre

All standards reported in this section include tests on a specific sample of the final product.

Table 68. Standards directly related to intrinsic durability

Specific topic	ID code	Title	Type	Status
Abrasion	ISO 12945-1:2020	Determination of fabric propensity to surface pilling, fuzzing or matting — Part 1: Pilling box method	Standard	Published
Abrasion	ISO 12945-2:2020	Determination of fabric propensity to surface pilling, fuzzing or matting — Part 2: Modified Martindale method	Standard	Published
Pilling and abrasion	ISO 12945-3:2020	Determination of fabric propensity to surface pilling, fuzzing or matting — Part 3: Random tumble pilling method	Standard	Published
Pilling and abrasion	ISO 12945-4:2020	Determination of fabric propensity to surface pilling, fuzzing or matting — Part 4: Assessment of pilling, fuzzing and matting by visual analysis	Standard	Published
Colour fastness	EN ISO 105-A06:1995	Textiles — Tests for colour fastness — Part A06: Instrumental determination of 1/1 standard depth of colour	Standard	Published
Colour fastness	EN ISO 105-B01:2014	Textiles — Tests for colour fastness — Part B01: Colour fastness to light: Daylight	Standard	Published
Colour fastness	EN ISO 105-B02:2014	Textiles — Tests for colour fastness — Part B02: Colour fastness to artificial light: Xenon arc fading lamp test	Standard	Published
Colour fastness	EN ISO 105-B03:2014	Textiles — Tests for colour fastness — Part B03: Colour fastness to weathering: Outdoor exposure	Standard	Published
Colour fastness	ISO 105-C06:2010	Tests for colour fastness — Part C06: Colour fastness to domestic and commercial laundering	Standard	Published
Colour fastness	EN ISO 105-C12:2010	Textiles — Tests for colour fastness — Part C12: Colour fastness to industrial laundering	Standard	Published
Colour fastness	EN ISO 105-D01:2010	Textiles — Tests for colour fastness — Part D01: Colour fastness to drycleaning using perchloroethylene solvent	Standard	Published
Colour fastness	EN ISO 105-E01:2013	Textiles – tests for colour fastness – part E01: colour fastness to water	Standard	Published
Colour fastness	EN ISO 105-E02:2013	Textiles – tests for colour fastness – part E02: colour fastness to sea water	Standard	Published
Colour fastness	EN ISO 105-E03:2010	Textiles – tests for colour fastness – part E03: colour fastness to chlorinated water (swimming-pool water)	Standard	Published
Colour fastness	EN ISO 105-E04:2013	Textiles – tests for colour fastness – part E04: colour fastness to perspiration	Standard	Published
Colour fastness	EN ISO 105-E07:2010	Textiles – tests for colour fastness – part E07: colour fastness to spotting: water	Standard	Published
Colour fastness	EN ISO 105-N01:1993	Textiles – tests for colour fastness – part N01: colour fastness to bleaching: hypochlorite	Standard	Published
Colour fastness	EN ISO 105-N02:1995	Textiles – tests for colour fastness – part N02: colour fastness to bleaching: peroxide	Standard	Published
Colour fastness	EN ISO 105-N03:1995	Texti4484les – tests for colour fastness – part N03: colour fastness to bleaching: sodium chlorite (mild)	Standard	Published
Colour fastness	EN ISO 105-N04:1995	Textiles – tests for colour fastness – part N04: colour fastness to bleaching: sodium chlorite (severe)	Standard	Published
Colour fastness	EN ISO 105-X11:1994	Textiles — Tests for colour fastness — Part X11: Colour fastness to hot pressing	Standard	Published

Specific topic	ID code	Title	Type	Status
Colour fastness	EN ISO 105-X12:2016	Textiles — Tests for colour fastness — Part X12: Colour fastness to rubbing	Standard	Published
Abrasion resistance on coated fabric	ISO 5470-1:2016	Rubber- or plastics-coated fabrics — Determination of abrasion resistance — Part 1: Taber abrader	Standard	Published
Abrasion resistance on coated fabric	ISO 5470-2:2016	Rubber- or plastics-coated fabrics — Determination of abrasion resistance — Part 2: Martindale abrader	Standard	Published
Abrasion resistance on fabric	ISO 12947-2:2016	Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 2: Determination of specimen breakdown	Standard	Published
Abrasion resistance on fabric	ISO 12947-3:2016	Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 3: Determination of mass loss	Standard	Published
Abrasion resistance on fabric	ISO 12947-4:2016	Textiles — Determination of the abrasion resistance of fabrics by the Martindale method — Part 4: Assessment of appearance change	Standard	Published
Abrasion resistance on fabric	ASTM D3884-22	Standard Guide for Abrasion Resistance of Textile Fabrics (Rotary Platform Abrader Method)	Standard	Published
Abrasion resistance on fabric	ASTM D3885 -07A-19	Standard Test Method for Abrasion Resistance of Textile Fabrics (Flexing and Abrasion Method) (woven or nonwoven fabric)	Standard	Published
Abrasion resistance on fabric	ASTM D3886-22	Standard Test Method for Abrasion Resistance of Textile Fabrics (Inflated Diaphragm Apparatus) (both wet and dry/conditioned samples)	Standard	Published
Abrasion resistance on fabric	ASTM D4966-22	Standard Test Method for Abrasion Resistance of Textile Fabrics (Martindale Abrasion Tester Method	Standard	Published
Abrasion resistance on fabric	ASTM D4158-08-20	Standard Guide for Abrasion Resistance of Textile Fabrics (Uniform Abrasion)	Standard	Published
Antifungal activity (Functional durability)	ISO 13629-1:2012	Textiles — Determination of antifungal activity of textile products — Part 1: Luminescence method	Standard	Published
Antifungal activity (Functional durability)	ISO 13629-2:2014	Textiles — Determination of antifungal activity of textile products — Part 2: Plate count method	Standard	Published
Antiviral activity (Functional durability)	ISO 18184:2019	Textiles — Determination of antiviral activity of textile products	Standard	Published
Appearance	ISO/TR 16323:2003	Textiles — Three-dimensional measuring apparatus for fabric appearance	Standard	Published
Bursting strength	EN ISO 13938-1:2019	Textiles: Bursting properties of fabrics. Part 1: Hydraulic method for determination of bursting strength and bursting distension	Standard	Published
Bursting strength	ISO 13938-2:2019	Textiles: Bursting properties of fabrics. Part 2: Pneumatic method for determination of bursting strength and bursting distension	Standard	Published
Bursting strength	ISO 9073-3:2023	Nonwovens — Test methods Part 3: Determination of tensile strength and elongation at break using the strip method	Standard	Published
Bursting strength	ISO 9073-4:2021	Nonwovens — Test methods Part 4: Determination of tear resistance by the trapezoid procedure	Standard	Published
Bursting strength	ISO 9073-5:2008	Textiles — Test methods for nonwovens — Part 5: Determination of resistance to mechanical penetration (ball burst procedure)	Standard	
Bursting strength	ASTM D3786/D3786M-18	Standard test method for bursting strength of textile fabrics. Diaphragm bursting strength tester method. Hydraulic or pneumatic diaphragm bursting tester	Standard	Published
Bursting strength	ASTM D3787-16	Standard test method for bursting strength of textile fabrics. The constant rate of traverse (CRT) Ball burst test	Standard	Published

Specific topic	ID code	Title	Type	Status
Bursting strength	ASTM D6797-15	Standard test method for bursting strength of textiles. The constant rate of extension (CRT) Ball burst test	Standard	Published
Colour fastness	BVL B 82.10-1:2011-12	Analysis of commodity goods - Testing of coloured children's toys with respect to their resistance to saliva and perspiration	Standard	Published
Colour fastness	DIN 53160-1:2010-10	Determination of the colourfastness of articles for common use. Part 1 Test with artificial saliva	Standard	Published
Colour fastness	DIN 53160-2:2010-10	Determination of the colourfastness of articles for common use. Part 2 Test with artificial sweat	Standard	Published
Colour fastness	ISO/TR 12116:2008	Textiles — Methods of simulating colour change during actual wear by means of laboratory colour-fastness tests	Standard	Published
Colour fastness	Oeko-Tex Standard 100. Class 1	Colour fastness to saliva and perspiration for children 3 years to younger	Ecolabel	Published
Colour fastness	AATCC8 – 2016e	Test method for colour fastness to crocking	Test method	Published
Colour fastness	AATCC15 -2021e	Test method for colour fastness to perspiration	Standard	Published
Colour fastness	AATCC16 – 2004e	Test method for colour fastness to light	Standard	Published
Crease retention	ISO 7769:2009	Textiles — Test method for assessing the appearance of creases in fabrics after cleansing	Standard	Published
Crease retention	ISO 2313-1:2021	Textiles — Determination of the recovery from creasing of a folded specimen of fabric by measuring the angle of recovery — Part 1: Method of the horizontally folded specimen	Standard	Published
Crease retention	ISO 2313-2:2021	Textiles — Determination of the recovery from creasing of a folded specimen of fabric by measuring the angle of recovery — Part 2: Method of the vertically folded specimen	Standard	Published
Crease retention	AATCC test method 128-2017e	Test Method for wrinkle recovery of fabrics: appearance	Standard	Published. Not approved by ANSI
Crease retention	AATCC test method 66 – 2017e	Test Method for wrinkle recovery of woven fabrics: recovery angle	Standard	Published. Not approved by ANSI
Dimensional stability	ISO 5077:2007	Textiles — Determination of dimensional change in washing and drying	Standard	Published
Dimensional stability	ISO 3005:1978	Textiles — Determination of dimensional change of fabrics induced by free-steam	Standard	Published
Dimensional stability	ISO 7771:1985	Textiles — Determination of dimensional changes of fabrics induced by cold-water immersion	Standard	Published
Dimensional stability	ISO 16322-2:2021	Determination of spirality after laundering- Part 2 Woven and knitted fabrics	Standard	Published
Dimensional stability	ISO 675:2014	Textiles — Woven fabrics — Determination of dimensional change on commercial laundering near the boiling point	Standard	Published
Dimensional stability	ISO 9866-1:1991	Textiles — Effect of dry heat on fabrics under low pressure — Part 1: Procedure for dry-heat treatment of fabrics	Standard	Published
Dimensional stability	ISO 9866-2:1991	Textiles — Effect of dry heat on fabrics under low pressure — Part 2: Determination of dimensional change in fabrics exposed to dry heat	Standard	Published
Dimensional stability	ISO 21765:2020	Textiles — Determination of fabric deformability by forced mechanical distension	Standard	Published

Specific topic	ID code	Title	Type	Status
Dimensional stability	ISO 23231:2008	Textiles — Determination of dimensional change of fabrics — Accelerated machine method	Standard	Published
Dimensional stability (connected standard)	EN ISO 3759:2011	Textiles - Preparation, marking and measuring of fabric specimens and garments in tests for determination of dimensional change	Standard	Published
Dimensional stability (connected standard)	EN ISO 6330:2012	Domestic washing and drying procedures for textile testing	Standard	Published
Dimensional stability (connected standard)	EN ISO 15797:2018	Industrial washing and finishing procedures for testing of workwear	Standard	Published
Dimensional stability (connected standard)	ISO 3175-2:2017	Professional care, drycleaning and wet cleaning of fabrics and garments - Part 2: Procedure for testing performance when cleaning and finishing using tetrachloroethene	Standard	Published
Dimensional stability (connected standard)	ISO 3175-3:2017	Professional care, drycleaning and wet cleaning of fabrics and garments - Part 3: Procedure for testing performance when cleaning and finishing using hydrocarbon solvents	Standard	Published
Dimensional stability (connected standard)	ISO 3175-4:2017	Professional care, drycleaning and wet cleaning of fabrics and garments - Part 4: Procedure for testing performance when cleaning and finishing using simulated wet cleaning	Standard	Published
Easy-Care treatments (functional durability)	ISO 7768:2009	Textiles — Test method for assessing the smoothness appearance of fabrics after cleansing	Standard	Published
Flame retardancy (Functional durability)	ISO 12138:2017	Textiles — Domestic laundering procedures for textile fabrics prior to flammability testing	Standard	Published
Flame retardancy (Functional durability)	BS5651:1978	Method for cleansing procedure for use in the assessment of the effect of cleansing and wetting on the flammability of textile fabrics and fabric assemblies	Standard	Published
Loss of fibre fragments from textiles	AATCC TM212 – 2021e	Fibre fragment release during home laundering	Standard	Published
Loss of fibre fragments from textiles	ISO 4484	Textile and textile products- Microplastics from textile sources. Part1: Determination of material loss from fabrics during washing	Standard	Published
Loss of fibre fragments from textiles	ISO 4484-1:2023	Textile and textile products- Microplastics from textile sources. Part1: Determination of material loss from fabrics during washing	Standard	Published
Loss of fibre fragments from textiles	ISO 4484-2:2023	Textile and textile products- Microplastics from textile sources. Part 2: Qualitative and quantitative analysis of microplastics	Standard	Published
Loss of fibre fragments from textiles	ISO 4484-3	Textile and textile products- Microplastics from textile sources. Part 3: Measurement of collected material mass released from textile end products by domestic washing method	Standard	Published
Matting appearance after cleansing	ISO 16847:2016	Textiles — Test method for assessing the matting appearance of napped fabrics after cleansing	Standard	Published
Antibacterial activity	ISO 20743:2021	Textiles — Determination of antibacterial activity of textile products.	Standard	Published
Oil stain repellency (Functional durability)	ISO 14419:2010	Textiles - Oil repellency - Hydrocarbon resistance test	Standard	Published
Performance requirements	ASTM D5432-12- 19	Standard Performance specification for blanket products for institutional and household use	Standard	Published
Performance requirements	ASTM D411-12 – 19	Standard Performance specification for woven napery and tablecloth fabrics: household and institutional	Standard	Published
Performance requirements	ASTM D5433-12 – 19	Standard Performance specification for towel products for institutional and household use	Standard	Published

Specific topic	ID code	Title	Type	Status
Performance requirements	EN 13569:2001	Cabinet roller towels- Performance requirements and processing	Standard	Published
Performance requirements	EN 14697:2005	Textiles. Terry towels and terry towel fabrics. Specifications and methods for tests sets out requirements based on general applicated test methods	Standard	Published
Physiological comfort (Thermal resistance and Breathability (post-laundering) in PEFCR)	JIS L 1099 – 2021e	Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)	Standard	Published
Physiological comfort (Thermal resistance and Breathability (post-laundering) in PEFCR) (Functional property claims)	ISO 11092:2015	Textiles — Physiological effects — Measurement of thermal and water-vapour resistance under steady-state conditions (sweating guarded-hotplate test)	Standard	Published
Quality of buttons and press fasteners	CEN/TS 17394	Textiles and textile products.	Standard	Published
Quality of buttons and press fasteners	CEN/TS 17394-1:2021	Textiles and textile products – Part 1: Safety of children's clothing – Security of attachment of attached components to infants' clothing – Specification.	Standard	Published
Quality of buttons and press fasteners	CEN/TS 17394-2:2021	Textiles and textile products. Part 2: Safety of Children's clothing security of attachment of buttons. Test method	Standard	Published
Quality of buttons and press fasteners	CEN/TS 17394-3:2021	Textiles and textile products. Part 3: Safety of Children's clothing security of attachment of metal mechanically applied press fasteners. Test method	Standard	Published
Quality of zippers	ASTM D2061-07 (2021)	Standard test methods for strength test for zippers	Standard	Published
Quality of zippers	JIS S3015 – 2019e	Methods for measuring zipper dimensions standard test methods for strength	Standard	Published
Quality of zippers	EN 16732:2016	Slide fasteners (zips) Specifications	Standard	Published
Resistance to chlorinated water	ISO 17608:2015	Textiles — Bare elastane yarns — Determination of resistance to chlorinated water (swimming-pool water)	Standard	Published
Resistance to insect	ISO 3998:1977	Textiles — Determination of resistance to certain insect pests	Standard	Published
Resistance to surface wetting (Functional Durability)	ISO 9865:1991	Textiles - Determination of water repellency of fabrics by the Bundesmann rain-shower test	Standard	Published
Resistance to surface wetting (Thermal resistance and breathability (post-laundering) in PEFCR) (Functional property claims)	ISO 15496:2018	Textiles — Measurement of water vapour permeability of textiles for the purpose of quality control	Standard	Published
Seam slippage (wovens only)	ISO 13936-1:2004	Textiles — Determination of the slippage resistance of yarns at a seam in woven fabrics — Part 1: Fixed seam opening method	Standard	Published
Seam slippage (wovens only)	ISO 13936-2:2004	Textiles — Determination of the slippage resistance of yarns at a seam in woven fabrics — Part 2: Fixed load method	Standard	Published
Seam slippage (wovens only)	ISO 13936-3:2004	Textiles — Determination of the slippage resistance of yarns at a seam in woven fabrics — Part 3: Needle clamp method	Standard	Published
Seam slippage (wovens-only)	ASTM D4035/4034M-19	Standard test method for resistance to yarn slippage at the sewn seam in woven upholstery fabrics	Standard	Published
Seam smoothness	ISO 7770:2009	Textiles — Test method for assessing the smoothness appearance of seams in fabrics after cleansing	Standard	Published
Seam strength	EN-ISO 13935	Textiles — Seam tensile properties of fabrics and made-up textile articles	Standard	Published

Specific topic	ID code	Title	Type	Status
Seam strength	EN-ISO 13935-1:2014	Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 1: Determination of maximum force to seam rupture using the strip method	Standard	Published
Seam strength	EN-ISO 13935-2:2014	Textiles — Seam tensile properties of fabrics and made-up textile articles — Part 2: Determination of maximum force to seam rupture using the grab method	Standard	Published
Seam strength	ASTM D1683-22	Standard test method for failure in sewn seams of woven fabrics	Standard	Published
Seam strength	ASTM D751-19	Standard test method for coated fabrics	Standard	Published
Spirality	ISO 16322-1:2005	Textiles — Determination of spirality after laundering — Part 1: Percentage of wale spirality change in knitted garments	Standard	Published
Spirality	ISO 16322-3:2021	Textiles — Determination of spirality after laundering — Part 3: Woven and knitted garments	Standard	Published
Stain Repellency (Functional durability)	ISO 22958:2021	Textiles — Water resistance — Rain tests: exposure to a horizontal water spray	Standard	Published
Stretch and recovery	ISO 20932-1:2018	Textiles — Determination of the elasticity of fabrics — Part 1: Strip tests	Standard	Published
Stretch and recovery	ISO 20932-2:2018	Textiles — Determination of the elasticity of fabrics — Part 2: Multiaxial tests	Standard	Published
Stretch and recovery	ISO 20932-3:2018	Textiles — Determination of the elasticity of fabrics — Part 3: Narrow fabrics	Standard	Published
Tear Strength	EN ISO 4674-1:2017	Rubber or plastic-coated fabrics- Determination of tear resistance- Part 1: constant rate of tear methods	Standard	Published
Tear Strength	EN-ISO 13937-1:2000	Textiles — Tear properties of fabrics — Part 1: Determination of tear force using ballistic pendulum method (Elmendorf)	Standard	Published
Tear Strength	EN-ISO 13937-2:2000	Textiles — Tear properties of fabrics — Part 2: Determination of tear force of trouser-shaped test specimens (Single tear method)	Standard	Published
Tear Strength	EN-ISO 13937-3:2000	Textiles — Tear properties of fabrics — Part 3: Determination of tear force of wing-shaped test specimens (Single tear method)	Standard	Published
Tear Strength	EN-ISO 13937-4:2000	Textiles — Tear properties of fabrics — Part 4: Determination of tear force of tongue-shaped test specimens (Double tear test)	Standard	Published
Tear Strength	ASTM D1424-21	Standard Test Method for Tearing Strength of Fabrics by falling-pendulum (Elmendorf-Type) apparatus	Standard	Published
Tensile strength and elongation (durability parameter according to OVAM report [3])	ISO 9073-3:1989	Textiles — Test methods for nonwovens — Part 3: Determination of tensile strength and elongation	Standard	Published
Tear Strength	ISO 9073-4:2021	Nonwovens — Test methods — Part 4: Determination of tear resistance by the trapezoid procedure	Standard	Published
Tear Strength	ISO 9073-18:2007	Textiles — Test methods for nonwovens — Part 18: Determination of breaking strength and elongation of nonwoven materials using the grab tensile test	Standard	Published
Tensile strength and elongation (durability parameter according to OVAM report [3])	ISO/FDIS 9073-3	Nonwovens — Test methods — Part 3: Determination of tensile strength and elongation at break using the strip method	DIS	Under development
Tear Strength	ASTM D5587 -15-19	Standard Test Method for Tearing Strength of Fabrics by trapezoid procedure apparatus	Standard	Published

Specific topic	ID code	Title	Type	Status
Tear Strength	ASTM D2261 -13-17	Standard Test method for Tearing Strength of fabric by the tongue (single rip) procedure (constant rate of extension tensile testing machine)	Standard	Published
Tear Resistance	ASTM D2582-21	Standard Test Method for Puncture-Propagation Tear Resistance of Plastic Film and Thin Sheeting	Standard	Published
Tensile strength (durability parameter according to OVAM report [3])	EN-ISO 13934-1:2013	Textiles: Tensile properties of Fabrics Part 1 Determination of maximum force and elongation at maximum force using the strip method	Standard	Published
Tensile strength (durability parameter according to OVAM report [3])	EN-ISO 13934-2:2014	Textiles: Tensile properties of Fabrics. Part 2 Determination of maximum force using the grab method	Standard	Published
Tensile strength and elongation	ASTM D5035-11	Standard test method for breaking force and elongation of textile fabrics (strip method)	Standard	Published
Tensile strength and elongation	ASTM D5034-21	Standard test method for breaking force and elongation of textile fabrics (grab method)	Standard	Published
Tensile strength and elongation	EN ISO 1421 (2016)	Rubber or plastic-coated fabrics - Determination of tensile strength and elongation at break	Standard	Published
Unevenness of textile	ISO 16549:2021	Unevenness of textile strands. Capacitance method	Standard	Published
Visible change after washing	ISO 15487:2018	Textiles — Method for assessing appearance of apparel and other textile end products after domestic washing and drying	standard	Published
Water repellency (Functional Durability)	ISO 4920:2012	Textile fabrics — Determination of resistance to surface wetting (spray test)	Standard	Published
Water resistance after aging	EN 343:2019	Rain Protection	Standard	Published
Wicking (Functional durability)	AATCC 197-2022e	Test method for vertical wicking rate of textiles to specified distances	Standard	NA
Wrinkle resistance	ISO 9867:2022	Textiles — Evaluation of the wrinkle recovery of fabrics — Appearance method	Standard	Published

Standards made of several parts and only the most used are reported in this Table: [1]Made of 4 parts. [2]Made of 107 parts. [3]Made of 2 parts.[4] Made of 7 parts. [5]Made of 2 parts. [6]Made of 2 parts. [7] Made of 20 parts. [8] Made of 3 parts. [9] Made of 2 parts. [10] Made of 3 parts. [11]Made of 2 parts. [12] Made of 6 parts. [13]Made of 3 parts. [14] Made of 2 parts. [15] Made of 3 parts. [16] Made of 2 parts. [17] Made of 3 parts.[18] Made of 4 parts. [19] Made of 2 parts.[20] Made of 5 parts. [21] Made of 20 parts. [22] It is made of 2 parts.

Every ID Code indicates the year depending on the Standard reference, as follows:

- ISO/CEN/BVL/BS -> XXX:YEAR (4-DIGIT)
- ASTM ->XXX-YEAR (2-DIGIT)
- AATC/JIS -> XXX-YEARe (4-DIGIT)

Table 69. Standards used by several frameworks to test parameters related to durability of textile products

<table>
<tr><th>Parameter</th><th>PEFCR A&F</th><th>EU Ecolabel</th><th>Nordic Ecolabel</th><th>Blue Angel</th></tr>
<tr><td rowspan="2">Resistance to pilling and abrasion</td><td>ISO 12945-1
(Pilling box method)</td><td>ISO 12945-1
Pill box method (Knitted and non-woven products)</td><td rowspan="2">ISO 12947-2
Martindale abrasion (Woven fabrics)</td><td>ISO 12945-1
Pill box method (Knitted and non-woven products)</td></tr>
<tr><td>ISO 12947-2 Martindale abrasion (Woven and knitted products) and EN 13770 for knitted footwear garments, ASTM D3939 for snagging resistance and BS 8479 for propensity to snagging</td><td>ISO 12945-2 Martindale method (Woven fabrics)</td><td>ISO 12945-2 Martindale method (Woven fabrics)</td></tr>
</table>

Parameter	PEFCR A&F	EU Ecolabel	Nordic Ecolabel	Blue Angel
Colour fastness to dry rubbing	NA	ISO 105 X12		
Colour fastness to wet rub (Crocking)	NA	ISO 105 X12		
Colour fastness to perspiration	NA	ISO 105 E04 (Acid alkaline)	ISO 105 E04 (Acid alkaline) ISO 105 A06 (saliva)	ISO 105 E04 (acid and alkaline, comparison with multi-fibre fabric)
Colour fastness to light exposure	ISO 105-B02Xenon arc fading lamp test	ISO 105-B02		
Colour fastness to washing	NA	ISO 105 C06 (Domestic washing) ISO 15797 combined with ISO 105 C06 (Commercial washing)	ISO 105 C06 ISO 105 D01 if dry cleaning	ISO 105 C06 (single wash, at temperature marked on the product, with perborate powder)
Colour fastness to water	ISO 105-E02 for sea water ISO 105-E03 for chlorinated water	NA		
Water repellency	Bundesmann ISO 9865 or ISO 4920	NA		ISO 6330 combined with ISO 4920 (Domestic) ISO 15797 combined with ISO 4920 (Industrial washing)
Garment Integrity Test after washing	ISO 6330	ISO 6330 in combination with EN ISO 5077 (Domestic washing) ISO 15797 in combination with EN ISO 5077 (Industrial washing)		ISO 6330 and ISO 5077
Garment Integrity Test after dryclean	ISO 3175-2 to 3175-4	NA		
Oil repellency	NA	ISO 6330 (Domestic) ISO 15797 (Industrial) both in combination with ISO 14419	NA	
Soil or stain Release	NA	ISO 6330 (Domestic) ISO 15797 (Industrial) both in combination with ISO 22958	NA	
Flame retardant functions	NA	ISO 6330 in combination with ISO 12138 (Domestic) ISO 10528 in combination with ISO 12138 (Industrial)	NA	ISO 6330 in combination with ISO 12138 (Domestic) ISO 10528 in combination with ISO 12138 (Industrial)
Easy care function	NA	ISO 7768	NA	ISO 7768
Garment Dimensional Stability Shrinkage & Skew/Twist/Torque	ISO 6330 indications of 5 cycles for machine wash and dry indications. ISO 3175-2 to 3175-4 if dry-clean indications of 3 cycles and ironing after final cycle. ISO 5077 and ISO 16322-3 spirality	ISO 6330 combined with ISO 4920 (Domestic) ISO 15797 combined with ISO 4920 (Industrial washing)	NA	
Appearance	ISO 15487 with specific conditions for domestic and professional cleaning	NA		
Bursting	ISO 139381 (or-2)	NA		

Parameter	PEFCR A&F	EU Ecolabel	Nordic Ecolabel	Blue Angel
Seam slippage	ISO 13936-2 (Woven fabrics)	NA	ISO 13936-1 o ISO 13936-2 (Woven fabrics)	NA
Fabric Tear Strength	ISO 13937-1	NA	ISO 13937-1 applied on outer fabric not include any inner lining in the product	NA
Fabric Tensile Strength	ISO 13934-2	NA	ISO 13934-2	NA
Seam strength	NA		ISO 13935-2 (Woven fabrics)	NA
Product waterproofness	ISO 811	NA		
Insulation	ISO11092 RCT	NA		
Elasticity of fabrics	ISO 20932-1 and ISO 20932-3	NA		

(a) PEFCR A&F: Product Environmental Footprint Category Rules (PEFCR): apparel and footwear;
(b) EU Ecolabel criteria for textile products. Commission Decision (2014/350/EU).
(c) Blue Angel – The German Ecolabel: DE-UZ 154 Basic Award Criteria. Edition January 2023, version 2.
(d) Nordic Swan Ecolabel: Textiles, hides/skins, and leather. Version 5.4.

Source: own elaboration

Table 70. Standards related to the functionality of the textile product

Specific topic	ID code	Title	Type	Status
Soil or stain release (Functional durability)	AATCC 130-18T, 2018	Washing Procedure selection to match care label	Standard	Published
Waterproofness	ISO 811:2018	Textiles — Determination of resistance to water penetration — Hydrostatic pressure test	standard	Published
Water penetration	ISO 18695:2007	Textiles — Determination of resistance to water penetration — Impact penetration test	Standard	Published
Water adsorption	ISO 18696:2006	Textiles — Determination of resistance to water absorption — Tumble-jar absorption test	Standard	Published
Moisturising effect	ISO 21232:2018	Textiles — Determination of moisturizing effect of textile materials by measurement of microclimate between textiles and simulated human skin using sweating guarded hotplate	Standard	Published
Hygroscopic heat generation	ISO 18782:2015	Textiles — Determination of dynamic hygroscopic heat generation	Standard	Published
Aqueous stain resistance	ISO 23232:2009	Textiles — Aqueous liquid repellency — Water/alcohol solution resistance test	Standard	Published
Thermal resistance	ISO 5085-1:1989	Textiles — Determination of thermal resistance — Part 1: Low thermal resistance	Standard	Published
Thermal resistance	ISO 5085-2:1990	Textiles — Determination of thermal resistance — Part 2: High thermal resistance	Standard	Published
Fire hazard reduction	ISO/TR 9240:1992	Textiles — Design of apparel for reduced fire hazard	Standard	Published
Superhydrophobic characteristics and durability assessment	ISO/CD TS 10818	Nanotechnologies — Textiles containing nanomaterials and nanostructures — Superhydrophobic characteristics and durability assessment	Technical Specifications	Under development
Resistance of cellulose-containing textiles to micro-organisms	ISO 11721-1:2001	Textiles — Determination of resistance of cellulose-containing textiles to micro-organisms — Soil burial test — Part 1: Assessment of rot-retardant finishing	Standard	Published

Specific topic	ID code	Title	Type	Status
Resistance of cellulose-containing textiles to micro-organisms	ISO 11721-2:2003	Textiles — Determination of the resistance of cellulose-containing textiles to micro-organisms — Soil burial test — Part 2: Identification of long-term resistance of a rot retardant finish	Standard	Published
Resistance of cellulose-containing textiles to micro-organisms	ISO 11737-3:2023	Sterilization of health care products — Microbiological methods — Part 3: Bacterial endotoxin testing	Standard	Published
Antifungal activity	ISO 13629-1:2012	Textiles — Determination of antifungal activity of textile products — Part 1: Luminescence method	Standard	Published
Antifungal activity	ISO 13629-2:2014	Textiles — Determination of antifungal activity of textile products — Part 2: Plate count method	Standard	Published
Exothermic and endothermic properties	ISO 16533:2014	Textiles — Measurement of exothermic and endothermic properties of textiles under humidity change	Standard	Published
Deodorant properties	ISO 17299-1:2014	Textiles — Determination of deodorant property — Part 1: General principle	Standard	Published
Deodorant properties	ISO 17299-2:2014	Textiles — Determination of deodorant property — Part 2: Detector tube method	Standard	Published
Deodorant properties	ISO 17299-3:2014	Textiles — Determination of deodorant property — Part 3: Gas chromatography method	Standard	Published
Deodorant properties	ISO 17299-4:2015	Textiles — Determination of deodorant property — Part 4: Condensation sampling analysis	Standard	Published
Deodorant properties	ISO 17299-5:2015	Textiles — Determination of deodorant property — Part 5: Metal-oxide semiconductor sensor method	Standard	Published
Moisture drying rate	ISO 17617:2014	Textiles — Determination of moisture drying rate	Standard	Published
Odour management	ISO 20645:2004	Textile fabrics — Determination of antibacterial activity — Agar diffusion plate test	Standard	Published
Total heat transfer	ISO 20852:2020	Textiles — Determination of the total heat transfer through textiles in simulated environments	Standard	Published
Dust mite resistance	ISO 21326:2019	Textiles — Test methods for determining the efficiency of products against house dust mite	Standard	Published
Burning behaviour	ISO 6940:2004	Textile fabrics — Burning behaviour — Determination of ease of ignition of vertically oriented specimens	Standard	Published
Burning behaviour	ISO 6941:2003	Textile fabrics — Burning behaviour — Measurement of flame spread properties of vertically oriented specimens	Standard	Published
Burning behaviour	ISO 10047:1993	Textiles — Determination of surface burning time of fabrics	Standard	Published
Adsorption	ISO 9073-6:2000	Textiles — Test methods for nonwovens — Part 6: Absorption	Standard	Published
Flexural rigidity	ISO 9073-7:1995	Textiles — Test methods for nonwovens — Part 7: Determination of bending length	Standard	Published
Liquid strike-through time	ISO 9073-8:1995	Textiles — Test methods for nonwovens — Part 8: Determination of liquid strike-through time (simulated urine)	Standard	Published
Drapability	ISO 9073-9:2008	Textiles — Test methods for nonwovens — Part 9: Determination of drapability including drape coefficient	Standard	Published
Lint and particle generation	ISO 9073-10:2003	Textiles — Test methods for nonwovens — Part 10: Lint and other particles generation in the dry state	Standard	Published
Run-off of liquids	ISO 9073-11:2002	Textiles — Test methods for nonwovens — Part 11: Run-off	Standard	Published

Specific topic	ID code	Title	Type	Status
Absorbency of fabric (wettability)	ISO 9073-12:2002	Textiles — Test methods for nonwovens — Part 12: Demand absorbency	Standard	Published
Liquid strike-through time	ISO 9073-13:2006	Textiles — Test methods for nonwovens — Part 13: Repeated liquid strike-through time	Standard	Published
Air permeability	ISO 9073-15:2007	Textiles — Test methods for nonwovens — Part 15: Determination of air permeability	Standard	Published
Resistance to penetration by water	ISO 9073-16:2007	Textiles — Test methods for nonwovens — Part 16: Determination of resistance to penetration by water (hydrostatic pressure)	Standard	Published
Water penetration	ISO 9073-17:2008	Textiles — Test methods for nonwovens — Part 17: Determination of water penetration (spray impact)	Standard	Published
Biodegradability	ISO 21701:2019	Textiles —Test method for accelerated hydrolysis of textile materials and biodegradation under controlled composting conditions of the resulting hydrolysate	Standard	Published
Air permeability	ISO 9237:1995	Textiles — Determination of the permeability of fabrics to air	Standard	Published
Electrostatic property	ISO 18080-1:2015	Textiles — Test methods for evaluating the electrostatic propensity of fabrics — Part 1: Test method using corona charging	Standard	Published
Electrostatic property	ISO 18080-2:2015	Textiles — Test methods for evaluating the electrostatic propensity of fabrics — Part 2: Test method using rotary mechanical friction	Standard	Published
Electrostatic property	ISO 18080-3:2015	Textiles — Test methods for evaluating the electrostatic propensity of fabrics — Part 3: Test method using manual friction	Standard	Published
Electrostatic property	ISO 18080-4:2015	Textiles — Test methods for evaluating the electrostatic propensity of fabrics — Part 4: Test method using horizontal mechanical friction	Standard	Published
Distortion of woven fabric	ISO 13015:2013	Woven fabrics — Distortion — Determination of skew and bow	Standard	Published
Max force and elongation at max force	ISO 24281:2021	Textiles — Biaxial tensile properties of woven fabric — Determination of maximum force and elongation at maximum force using the grab method	Standard	Published
Fire hazard reduction	ISO 12952-1:2010	Textiles — Assessment of the ignitability of bedding items — Part 1: Ignition source: smouldering cigarette	Standard	Published
Fire hazard reduction	ISO 12952-2:2010	Textiles — Assessment of the ignitability of bedding items — Part 2: Ignition source: match-flame equivalent	Standard	Published
Drying rate	ISO 13029:2012	Textiles — Determination of drying rate in dynamic state by the modified sweating-guarded hotplate	Standard	Published
Reduction activity of specific proteins	ISO 4333:2022	Textiles — Determination of reduction activity of specific proteins derived from pollen, mite and other sources on textile products	Standard	Published

Standards made of several parts and only the most used are reported in this Table: [1] Made of 2 parts. [2] Made of 2 parts. [3] Made of 2 parts. [4] Made of 5 parts. [5] Made of 20 parts. [6] Made of 4 parts. [7] Made of 2 parts.
Every ID Code indicates the year depending on the Standard reference, as follows:

- ISO -> XXX:YEAR (4-DIGIT)
- AATC -> XXX-YEARe (4-DIGIT)

Table 71. Standards used for textile characterization

Specific topic	ID code	Title	Type	Status
Mass per unit length and mass per unit area	ISO 3801:1977	Textiles — Woven fabrics — Determination of mass per unit length and mass per unit area	Standard	Published
Mass per unit length and mass per unit area	EN 12127:1998	Textiles. Fabrics. Determination of mass per unit area using small samples.	Standard	Published
Width and length	ISO 22198:2006	Textiles — Fabrics — Determination of width and length	Standard	Published
Colorimetric communication	ISO 10617:2010	Textiles — Standard data format for colorimetric communication — Textiles and related measurements	Standard	Published
Dyestuff identification	ISO 16373-1:2015	Textiles — Dyestuffs — Part 1: General principles of testing coloured textiles for dyestuff identification	Standard	Published
Fibre identification	ISO 18074:2015	Textiles — Identification of some animal fibres by DNA analysis method — Cashmere, wool, yak and their blends	Standard	Published
Fibre identification	ISO 20706-1	Textiles — Qualitative and quantitative analysis of some bast fibres (flax, hemp, ramie) and their blends — Part 1: Fibre identification using microscopy methods	Standard	Published
Thickness	ISO 5084:1996	Textiles — Determination of thickness of textiles and textile products	Standard	Published
Mass per unit area	ISO 9073-1:1989	Textiles — Test methods for nonwovens — Part 1: Determination of mass per unit area	Standard	Published
Thickness	ISO 9073-2:1995	Textiles — Test methods for nonwovens — Part 2: Determination of thickness	Standard	Published
Composition	ISO/TR 11827:2012	Textiles — Composition testing — Identification of fibres	Technical Report	Published

Standards made of several parts and only the most used are reported in this Table: [1] Made of 3 parts. [2] Made of 20 parts.
Every ID Code indicates the year depending on the Standard reference, as follows:

- ISO/EN -> XXX:YEAR (4-DIGIT)

Table 72. Standards for the determination of specific substances

Specific topic	ID code	Title	Type	Status
Alkylphenol ethoxylates (APEO)	ISO 18254-1:2016	Textiles — Method for the detection and determination of alkylphenol ethoxylates (APEO) — Part 1: Method using HPLC-MS	Standard	Published
Alkylphenol ethoxylates (APEO)	ISO 18254-2:2016	Textiles — Method for the detection and determination of alkylphenol ethoxylates (APEO) — Part 2: Method using NPLC	Standard	Published
Formaldehyde	ISO 141842	Textiles — Determination of formaldehyde	Standard	Published
Formaldehyde	ISO 14184-1:2011	Textiles — Determination of formaldehyde — Part 1: Free and hydrolysed formaldehyde (water extraction method)	Standard	Published
Formaldehyde	ISO 14184-2:2011	Textiles — Determination of formaldehyde — Part 2: Released formaldehyde (vapour absorption method)	Standard	Published
Formaldehyde	ISO/CD 14184	Textiles — Determination of formaldehyde	CD	Under development
Formaldehyde	ISO/CD 14184-3	Textiles — Determination of formaldehyde — Part 3: Free and hydrolysed formaldehyde (extraction method) —Determination by high pressure liquid chromatography	CD	Under development

Specific topic	ID code	Title	Type	Status
Phthalate	ISO 14389:2022	Textiles — Determination of the phthalate content — Tetrahydrofuran method	Standard	Published
Phthalate	EN ISO 18856:2004	Water quality- Determination of selected phthalates using gas chromatography/mass spectrometry	Standard	Published
Phthalate	EN 14602:2012	Footwear- Test methods for the assessment of ecological criteria	Standard	Published
Organotin compounds	EN ISO 17353:2007	Water quality- Determination of selected organotin compounds- Gas chromatographic method	Standard	Published
Aromatic amines derived from azo colorants	ISO 14362-1:2017	Textiles — Methods for determination of certain aromatic amines derived from azo colorants — Part 1: Detection of the use of certain azo colorants accessible with and without extracting the fibres	Standard	Published
Organotin compounds	ISO 22744-1:2020	Textiles and textile products — Determination of organotin compounds — Part 1: Derivatisation method using gas chromatography	Standard	Published
Organotin compounds	ISO 22744-2:2020	Textiles and textile products — Determination of organotin compounds — Part 2: Direct method using liquid chromatography	Standard	Published
Aromatic amines derived from azo colorants	ISO 143625	Textiles — Methods for determination of certain aromatic amines derived from azo colorants	Standard	Published
Aromatic amines derived from azo colorants	ISO 14362-3:2017	Textiles — Methods for determination of certain aromatic amines derived from azo colorants — Part 3: Detection of the use of certain azo colorants, which may release 4-aminoazobenzene	Standard	Published
Detection of disperse dyestuff	DIN 54231:2022	Textiles- Determination of dyes after methanol extraction	Standard	Published
Chlorinated benzenes and toluenes	UNE-EN 17137:2019	Textiles - Determination of the content of compounds based on chlorobenzenes and chlorotoluenes	Standard	Published
Determination of extractable metals	EN ISO 105-E04:2013	Textiles – tests for colour fastness – part E04: colour fastness to perspiration	Standard	Published
Determination of extractable metals	DIN 542337	Testing of Textiles- Determination of metals.	Standard	Published
Determination of extractable metals	UNE-EN 16711-2:2016	Textiles - Determination of metal content - Part 2: Determination of metals extracted by acidic artificial perspiration solution	Standard	Published
Determination of extractable metals	DIN EN 16711-2:2016	Textiles- Determination of metal content- Part 2: Determination of metals extracted by acidic artificial perspiration solution	Standard	Published
Determination of extractable metals	DIN 38405-24:1987-05	German standard methods for the examination of water, wastewater and sludge: anions (group D; photometric determination of chromium (VI) using 1,5-diphenylcarbonohydrazide (D24)	Standard	Published
Determination of the metallic composition	EN12472-2020	Method for the simulation of the accelerated wear and corrosion for the detection of nickel release from coated items	Standard	Published
Determination of the metallic composition	ISO 1811-1:1998	Copper and copper alloys- Selection and preparation of samples for chemical analysis. Part1: sampling of cast unwrought products	Standard	Published
Determination of chlorophenols	EN ISO 17070:2015	Leather- Chemical test- Determination of tetra chlorophenol, trichlorophenol content	Standard	Published
Determination of chlorophenols	EN 17134-2:2023	Textiles and textile products - Determination of biocide additives - Part 2: Chlorophenol-based preservatives, method using gas chromatography	Standard	Published
Dyestuff identification	ISO 16373-2:2014	Textiles — Dyestuffs — Part 2: General method for the determination of extractable dyestuffs including allergenic and carcinogenic dyestuffs (method using pyridine-water)	Standard	Published

Specific topic	ID code	Title	Type	Status
Dyestuff identification	ISO 16373-3:2014	Textiles — Dyestuffs — Part 3: Method for determination of certain carcinogenic dyestuffs (method using triethylamine/methanol)	Standard	Published
Flame retardance	ISO 17881-1:2016	Textiles — Determination of certain flame retardants — Part 1: Brominated flame retardants	Standard	Published
Flame retardance	ISO 17881-2:2016	Textiles — Determination of certain flame retardants — Part 2: Phosphorus flame retardants	Standard	Published
Flame retardance	ISO/TR 17881-3:2018	Textiles — Determination of certain flame retardants — Part 3: Chlorinated paraffin flame retardants	Standard	Published
Index ingredients	ISO 2219511	Textiles — Determination of index ingredient from coloured textiles	Standard	Published
Index ingredients	ISO 22195-1:2020	Textiles — Determination of index ingredient from coloured textiles — Part 1: Madder	Standard	Published
Index ingredients	ISO 22195-2:2020	Textiles — Determination of index ingredient from coloured textiles — Part 2: Turmeric	Standard	Published
Index ingredients	ISO 22195-3:2023	Textiles — Determination of index ingredient from coloured textile — Part 3: Myrobalan	Standard	Published
Index ingredients	ISO 22195-4:2021	Textiles — Determination of index ingredient from coloured textile — Part 4: Catechu	Standard	Published
Index ingredients	ISO 22195-5:2021	Textiles — Determination of index ingredient from coloured textile — Part 5: Lac	Standard	Published
Index ingredients	ISO 22195-6:2021	Textiles — Determination of index ingredient from coloured textile — Part 6: Punica granatum	Standard	Published
Many substances	CEN/TR 16741:2015	Textiles and textile products - Guidance on health and environmental issues related to chemical content of textile products intended for clothing, interior textiles and upholstery	Technical Report	Published

Standards made of several parts and only the most used are reported in this Table: [1] Made of 2 parts. [2] made of 2 parts. [3] Made of 2 parts. [4] Made of 2 parts.[5] made of 2 parts. [6] Made of 107 parts. [7]Made of 2 parts. [8] Made of 3 parts. [9]Made of 3 parts. [10] Made of 3 parts. [11]Made of 6 parts.

Every ID Code indicates the year depending on the Standard reference, as follows:

- ISO/DIN/CEN -> XXX:YEAR (4-DIGIT)

Table 73. Standards related to loss of fibre fragments from textiles

Specific topic	ID code	Title	Type	Status
Loss of fibre fragments from textiles	ISO 4484-1	Textile and textile products- Microplastics from textile sources. Part1: Determination of material loss from fabrics during washing	Standard	Published
Loss of fibre fragments from textiles	ISO 4484-2	Textile and textile products- Microplastics from textile sources. Part 2: Qualitative and quantitative analysis of microplastics	Standard	Published
Loss of fibre fragments from textiles	ISO 4484-3	Textile and textile products- Microplastics from textile sources. Part 3: Measurement of collected material mass released from textile end products by domestic washing method	Standard	Published

Standards made of several parts and only the most used are reported in this Table: [1]Made of 3 parts.

Every ID Code indicates the year depending on the Standard reference, as follows:

- ISO -> XXX:YEAR (4-DIGIT)

Table 74 Standards and Technical Specifications potentially related to circularity and environmental aspects

Broader topic	Specific topic	ID code	Title	Type	Status
Definitions	Environmental aspects	ISO 5157:2023 ISO TC 38	Textiles — Environmental aspects — Vocabulary	Standard	Published
Circularity	Principles of circularity	Unknown developed by CEN TC 248 WG 39	Textiles - Circular economy for textile products - General principles and guidance	Technical Specifications	Under development
Circularity	Material use	Unknown developed by CEN TC 248 WG 39	Textiles - Circular economy for textile products – Categorisation of and requirements on non-virgin input materials	Technical Specifications	Under development
Circularity	Design for circularity	Unknown developed by CEN TC 248 WG 39	Textiles - Circular economy for textile products - design for circularity	Technical Specifications	Under development
Environmental claims	Terminology of Environmental claims	CEN/TS 16822:2015	Textiles and textile products - Self-declared environmental claims - Use of the terms	Technical Specifications	Published

Table 75. Standards related to topics not covered by **Table 68** to **Table 74**

Broader topic	Specific topic	ID code	Title	Type	Status
Definitions	Definitions of natural fibres	EN ISO 6938:2014	Textiles — Natural fibres — Generic names and definitions	Standard	Published
Definitions	Environmental aspects	ISO 5157:2023 ISO TC 38	Textiles — Environmental aspects — Vocabulary	Standard	Published
Definitions	Stitch types	ISO 4915:1991	Textiles — Stitch types — Classification and terminology	Standard	Published
Definitions	Seam types	ISO 4916:1992	Textiles — Seam types — Classification and terminology	Standard	Published
Definitions	Determination of mass	ISO 6348:1980	Textiles — Determination of mass — Vocabulary	Standard	Published
Definitions	Woven fabric	ISO 2959:2011	Textiles — Woven fabric descriptions	Standard	Published
Definitions	Weaves	ISO 3572:1976	Textiles — Weaves — Definitions of general terms and basic weaves	Standard	Published
Definitions	Knitted fabrics	ISO 8388:1998	Knitted fabrics — Types — Vocabulary	Standard	Published
Definitions	Description of defects	ISO 8498:1990	Woven fabrics — Description of defects — Vocabulary	Standard	Published
Definitions	Description of defects	ISO 8499:2003	Knitted fabrics — Description of defects — Vocabulary	Standard	Published
Definitions	Nonwoven	ISO 9092:2019	Nonwovens — Vocabulary	Standard	Published
Definitions	Nonwoven	ISO 11224:2003	Textiles — Web formation and bonding in nonwovens — Vocabulary	Standard	Published
Definitions	Superfine woven wool	ISO 18103:2015	Superfine woven wool fabric labelling — Requirements for Super S code definition	Standard	Published
Definitions	Man-made fibres	ISO 2076:2021	Textiles — Man-made fibres — Generic names	Standard	Published
Labelling	Labelling	ISO 3758:2012	Textiles — Care labelling code using symbols	Standard	Published
Labelling	Symbols on workwear	ISO 30023:2021	Textiles — Qualification symbols for labelling workwear to be industrially laundered	Standard	Published

Broader topic	Specific topic	ID code	Title	Type	Status
Circularity	Principles of circularity	Unknown developed by CEN TC 248 WG 39	Textiles - Circular economy for textile products - General principles and guidance	Standard	Under development
Circularity	Material use	Unknown developed by CEN TC 248 WG 40	Textiles - Circular economy for textile products – Categorisation of and requirements on non-virgin input materials	Standard	Under development
Circularity	Design for circularity	Unknown developed by CEN TC 248 WG 41	Textiles - Circular economy for textile products - design for circularity	Standard	Under development
Environmental claims	Terminology of Environmental claims	CEN/TS 16822:2015	Textiles and textile products - Self-declared environmental claims - Use of the terms	Technical Specifications	Published

Every ID Code indicates the year depending on the Standard reference, as follows:

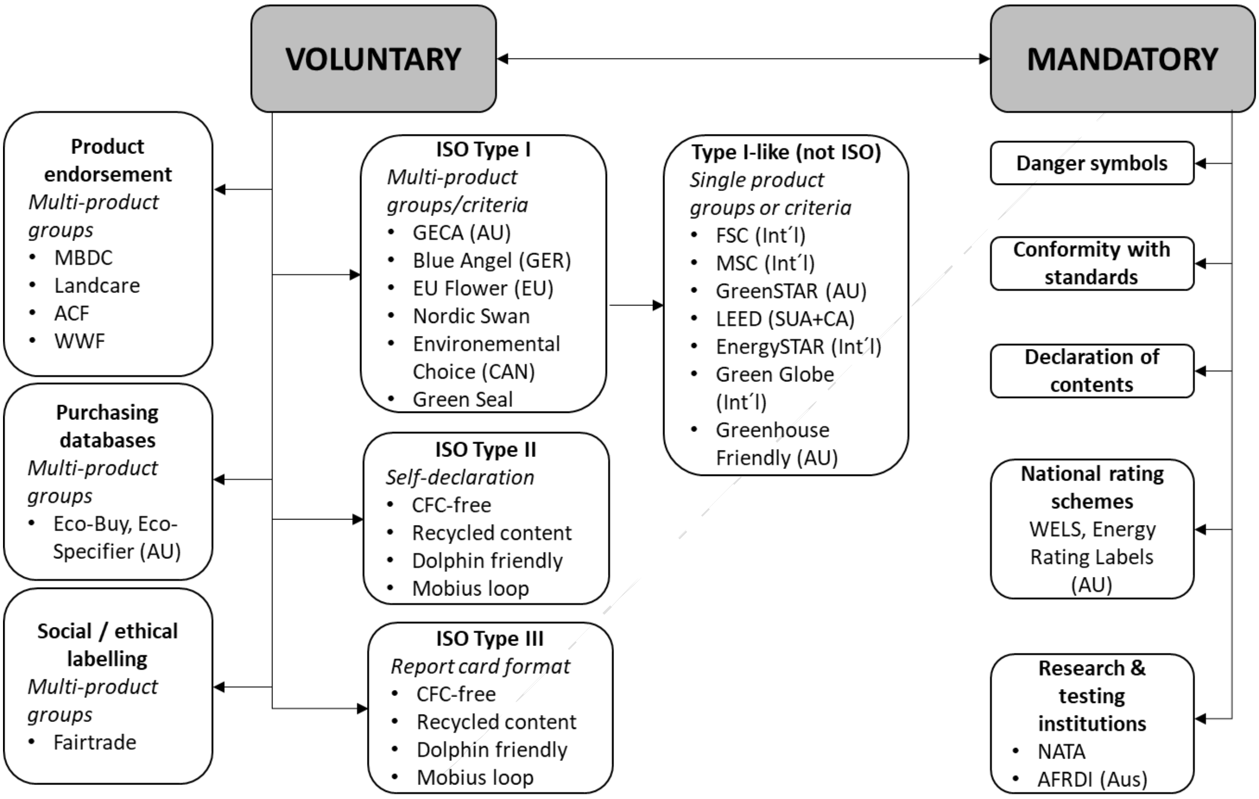
ISO/CEN -> XXX:YEAR (4-DIGIT)

10.4 Supporting information about environmental labels

10.4.1 Types of labels in general

There are many types of labels, addressing single or multiple environmental issues and covering different sectors and regions. **Figure 52** shows the taxonomy of labels, which includes mandatory and voluntary frameworks (Frydendal et al., 2018).

Figure 52. Taxonomy of labels for communication of specific product information



Source: (Frydendal et al., 2018)

The Ecolabel Index ([190]) is known to be the largest global directory of labels related to environmental and social aspects. On 12 January 2024, it counted 456 labels in 199 countries, and 25 industry sectors. Due to the high number and types of voluntary environmental labels, the International Organization for Standardization (ISO) established specific guidelines.

ISO Type I environmental labels (ISO 14024:2018) ([191]),known as **Ecolabels**, are defined as *'voluntary, multi-criteria-based and third party-verified labels that indicate an overall environmental preference in a life cycle perspective of a product or service within a specific product category'*. Ecolabels are a subset of the environmental labels that recognise a better environmental performance of a given product or service related to other products in the same product group. An Ecolabel must fulfil the following nine requirements (Frydendal et al., 2018):

1. It is built on the life cycle thinking;

[190] Ecolabel Index. Website available at this link. Last accessed on 12 January 2024.
[191] ISO 14024:2018. Environmental labels and declarations. Type I environmental labelling. Principles and procedures. Available at this link. Last accessed on 12 January 2024.

2. It is based on multiple criteria, therefore it addresses many environmental impact categories, such as global warming, eutrophication, etc.;
3. Criteria are justified by sound scientific and engineering reasons. Their objectivity is ensured by the involvement of a broad range of stakeholders (industries, consumers, governments, etc…) during the process of criteria development;
4. It comprises requirements related to functional aspects of the product (fitness for use). This characteristic guarantees a sufficient quality of labelled products and services;
5. Criteria are continuously updated according to changes affecting the labelled products. These changes could be related to technologies, the regulatory context and other aspects;
6. All stages of criteria development are transparent;
7. It is accessible to all potential applicants;
8. It involves third-party certification;
9. There is compliance monitoring after the licence is awarded.

ISO Type II environmental labels (ISO 14021:2016) ([192]),known as **Self-declared Environmental Claims**, are neither third-party verified, nor based on Life Cycle Thinking approach. Many self-declared environmental claims on the EU market do not necessarily follow the ISO 14021:2016.

ISO Type III environmental labels (ISO 14025:2016) ([193]),known as **Environmental Declarations**, are labels presenting *quantified environmental information on the life cycle of a product to enable comparisons between products fulfilling the same function*. The Environmental Declarations were mainly envisioned for business-to-business communication, but their use in business-to-consumer communication is not precluded. The establishment of Product Category Rules ensures that the life cycle assessment is performed with specific rules aiming to foster transparency and facilitate comparisons between different Environmental Declarations. The EC promotes the establishment of commonly recognised Product Environmental Footprint Category Rules (PEFCRs) ([194]). As any life cycle assessment, the Environmental Declarations are third-party verified.

10.4.2 Voluntary environmental labels used in EU

Table 76

Table 76. Environmental labels used in 2021 in Europe: ISO type and addressed topics

Ecolabel	Criteria	ISO TYPE
AnbefaltToxic	other	NA
Better Cotton Initiative	Biodiversity, chemicals, natural resources, pesticides/herbicides/fungicides, soil, wastewater/sewage, water quality, water use, other	NA
Blue Angel	Carbon/GHG emission, Energy use/efficiency, forests, natural resources, recycling, toxics, waste water/sewage, water quality, water use, other	Type I[195]
bluesign® standard	Carbon/GHG emission, Carbon/GHG offsets, chemicals, energy production/source, energy use/efficiency, material use, natural resources, pesticides/herbicides/fungicides, recycling, toxics, waste, wastewater/sewage, water quality, water use	NA
Carbon Reduction Label	Carbon/GHG emission	NA
Climatop	Animal welfare, biodiversity, Carbon/GHG emission, chemicals, energy production/sources, energy use/efficiency, forests, GMOs, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	NA
Compostability Mark of European Bioplastics	Chemicals, Material use, Natural resources, pesticides/herbicides/fungicides, recycling, toxics, waste, water quality	NA

[192] ISO 14021:2016. Environmental labels and declarations. Self-declared environmental claims (Type II environmental labelling). Available at this link. Last accessed on 12 January 2024.
[193] ISO 14025:2006. Environmental labels and declarations. Type III environmental declarations. Principles and procedures. Available at this link. Last accessed on 12 January 2024.
[194] European platform on LCA | EPLCA. Environmental footprint. Available at this link. Last accessed on 12 January 2024.
[195] Blue Angel – The German Ecolabel: DE-UZ 154 Basic Award Criteria. Edition January 2023, version 2. Available at this link. Last accessed on 12 January 2024.

Ecolabel	Criteria	ISO TYPE
Coop Naturaline:Switzerland	Biodiversity, chemicals, GMOs, natural resources, pesticides/herbicides/fungicides, soil, toxics, wastewater/sewage	NA
Cradle to Cradle Certified (CM) Products Program	Chemicals, energy production/source, energy use/efficiency, forests, material use, natural resources, recycling, toxics, waste, wastewater/sewage, water quality, water use	NA
Danish Indoor Climate Label	Other (emission to indoor air)	NA
ECOLOGO	Animal welfare, biodiversity, Carbon/GHG emissions, Carbon/GHG offsets, Chemicals, energy production/sources, energy use/efficiency, forests, GMOs, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	Type I[196]
Ekologicky setrny vyrobek/Environmentally Friendly Product	Carbon/GHG emission, Carbon/GHG offsets, chemicals, energy production/sources, energy use/efficiency, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	Type I **
Environmental product declaration (EPD)	Carbon/GHG emission, Carbon/GHG offsets, chemicals, energy production/source, energy use/efficiency, material use, natural resources, recycling, toxics, waste, water quality, water use	Type III[197]
EU Ecolabel	Chemicals, energy use/efficiency, forests, material use, natural resources, recycling, toxics, waste, wastewater/sewage, water quality, water use	Type I[198]
Fair for life	Animal welfare, biodiversity, Carbon/GHG emissions, energy use/efficiency, GMOs, natural resources, pesticides/herbicides/fungicides, soil, water use	NA
Fairtrade	Biodiversity, energy use/efficiency, forests, GMOs, natural resources, pesticides/herbicides/fungicides, soil, toxics, waste, water use	Type II***
Global Organic Textile Standard	Chemicals, GMOs, Material use, natural resources, pesticides/herbicides/fungicides, soil, toxics, wastewater/sewage, water quality	NA
Good Environmental choice "Bra Miljoval"	Chemicals, energy production/sources, energy use/efficiency, forests, material use, natural resources, toxics	Type I[199]
Good Shopping Guide Ethical Award	Animal welfare, Carbon/GHG emissions, Carbon/GHG offsets, chemicals, energy production/sources, energy use/efficiency, GMOs, material use, natural resources, pesticides/herbicides/fungicides, recycling, toxics, waste water quality	NA
Good Weave	Other (workplace environmental conditions)	NA
Green Crane: Ukraine	Biodiversity, Carbon/GHG emissions, chemicals, energy production/sources, energy use/efficiency, forests, material use, natural resources, recycling, toxics, waste, wastewater/sewage, water quality, water use	Type I****
Greenguard	Chemicals, toxics	Type II*
Green Shape	Animal welfare, biodiversity, chemicals, energy use/efficiency, GMOs, material use, natural resources, pesticides/herbicides/fungicides, recycling, toxics, waste, wastewater/sewage, water use	NA
GUT	For floor coverings. Chemicals, toxics, other (indoor air quality)	NA
IMO Certified	Fire testing certification. Chemicals, forests, pesticides/herbicides/fungicides, soil, toxics	NA
Label Step	For carpets. Chemicals, wastewater/sewage, water quality	NA
Milieukeur: the Dutch environmental quality label	Animal welfare, biodiversity, Carbon/GHG emissions, chemicals, energy production/sources, energy use/ efficiency, forests, GMOs, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	Type I**
National Programme of Environmental Assessment and Ecolabelling in the Slovak Republik (NPEHOV)	Carbon/GHG emissions, chemicals, energy production/sources, energy use/efficiency, forests, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	Type I**
Naturland e.V.	Animal welfare, biodiversity, chemicals, forests, GMOs, natural resources, pesticides/herbicides/fungicides, soil, toxics	NA
Nordic Swan Ecolabel	Carbon/GHG emission, chemicals, energy production/sources, energy use/efficiency, material use, natural resources, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	Type I[200]

[196] Ecogloballabel website available here
[197] EPD website available here
[198] Ecolabel website available here
[199] Idem

[200] Nordic Swan website available here

Ecolabel	Criteria	ISO TYPE
Oeko-Tex Standard 100	Toxics prohibited by law, chemicals harmful to health	Other Type I-like voluntary sustainable scheme[201]
OK biobased	Carbon/GHG emission, material use, natural resources, waste	NA
ÖkoControl	Forests, natural resources, pesticides/herbicides/fungicides, toxics	NA
Ølabel: Norway	Chemicals, forests, GMOs, pesticides/herbicides/fungicides, soil	NA
Processed Chlorine Free	Biodiversity, Carbon/GHG emissions, Carbon/GHG offsets, chemicals, energy production/sources, energy use/efficiency, forests, material use, natural resources, pesticides/herbicides/fungicides, recycling, toxics, waste, wastewater/sewage, water quality, water use	NA
SEE What You Are Buying Into	Animal welfare, biodiversity, Carbon/GHG emissions, Carbon/GHG offsets, energy production/sources, energy use/efficiency, GMOs, material use, natural resources, recycling, waste, other	NA
Singapore Green Label Scheme (SGLS)	Animal welfare, biodiversity, Carbon/GHG emission, Carbon/GHG offsets, chemicals, energy production/sources, energy use/efficiency, forests, GMOs, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	Type I[202]
Skal Eko Symbol	Pesticides/herbicides/fungicides	NA
SMaRT Consensus Sustainable Product Standards	Animal welfare, biodiversity, Carbon/GHG emissions, Carbon/GHG offsets, Chemicals, energy production/sources, energy use/efficiency, forests, GMOs, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	NA
Soil Association Organic Standard	Animal welfare, biodiversity, chemicals, forests, GMOs, natural resources, pesticides/herbicides/fungicides, soil, toxics	NA
SustentaX	Animal welfare, Carbon/GHG emissions, Carbon/GHG offsets, chemicals, energy production/sources, energy uses/efficiency, forests, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	NA
Terra Cycle	Carbon/GHG offsets, material use, recycling, waste	NA
Totally Chlorine Free	Biodiversity, Carbon/GHG emissions, Carbon/GHG offsets, chemicals, energy production/sources, energy use/efficiency, forests, GMOS, material use, natural resources, pesticides/herbicides/fungicides, recycling, soil, toxics, waste, wastewater/sewage, water quality, water use	NA
WindMade	Carbon/GHG emission, energy production/sources	NA

The topic of 'Toxics' addresses harmful substances that are already prohibited or regulated; whereas the topic of 'Harmful chemicals' address substances that are known to be harmful to health, but are not officially banned. N.B. The authors of the referenced study use the term 'Chemicals' when referring to 'Harmful chemicals'.
The authors of the referenced study do not specify if the topic of 'Waste' addresses any kind of waste generated along the value chain, or waste generated at a specific stage. No further explanation/specification is provided for other topics.
NA: Not available.

*Source: own elaboration based on (Ranasinghe and Jayasooriya, 2021) and the Ecolabel Index ([203]). *(Ranasinghe and Jayasooriya, 2021), **(LEITAT, 2017), *** (Ziyeh and Cinelli, 2023), ****(UNEP, 2023b)*

[201] Ecogloballabel website available here
[202] Idem
[203] Ecolabel Index. Website available at this link. Last accessed on 12 January 2024.

10.5 Supporting information on market analysis

10.5.1 Recycling plants

Table 77. Number of textile recycling plants classified per location

Region	Country	Mechanical				Chemical				Total
		All	Pilot scale	Full scale	Unknown scale	All	Pilot scale	Full scale	Unknown scale	
EU	Austria	0	NA	NA	NA	1	NA	1	NA	1
	Belgium	3	NA	2	1	0	NA	NA	NA	3
	Denmark	3	NA	2	1	1	1	NA	NA	4
	Finland	3	1	2	NA	2	2	NA	NA	5
	France	4	NA	3	1	1	1	NA	NA	5
	Germany	5	NA	5	NA	0	NA	NA	NA	5
	Italy	13	1	9	3	4	1	3	NA	17
	Netherlands	6	2	3	1	1	1	NA	NA	7
	Spain	11	2	9	NA	0	NA	NA	NA	11
	Sweden	0	NA	NA	NA	1	NA	1	NA	1
Europe (Non-EU)	Norway	0	NA	NA	NA	1	NA	1	NA	1
	Switzerland	0	NA	NA	NA	3	1	1	1	3
	UK	1	NA	1	NA	0	NA	NA	NA	1
Middle East	Israel	0	NA	NA	NA	1	NA	1	NA	1
	Türkiye	3	NA	3	NA	0	NA	NA	NA	3
Africa	Mauritius	1	NA	1	NA	0	NA	NA	NA	1
	Morocco	1	NA	1	NA	0	NA	NA	NA	1
Asia	Bangladesh	1	NA	1	NA	0	NA	NA	NA	1
	China	4	1	2	1	5	NA	4	1	9
	India	11	1	7	3	1	NA	NA	1	12
	Indonesia	1	NA	NA	1	1	NA	1	NA	2
	Japan	3	NA	2	1	1	NA	NA	1	4
	Malaysia	1	NA	1	NA	0	NA	NA	NA	1
	Pakistan	3	NA	2	1	0	NA	NA	NA	3
	Singapore	1	NA	NA	1	0	NA	Na	NA	1
	Taiwan	1	NA	1	NA	8	1	6	1	9
	Thailand	1	NA	1	NA	0	NA	NA	NA	1
America	Canada	1	NA	1	NA	1	1	NA	NA	2
	Guatemala	1	NA	1	NA	0	NA	NA	NA	1
	Mexico	1	NA	1	NA	0	NA	NA	NA	1
	USA	5	NA	5	NA	7	4	1	2	12
Oceania	Australia	0	NA	NA	NA	1	NA	1	NA	1

The recycling plants identified were equal to 130. NA: Not available

Source: own elaboration based on Airtable - Sorting for Circularity - Recyclers Database ([204]), (Jørgensen et al., 2022; Textile Exchange, 2022a)

Table 78. Number of textile recycling plants classified per input fibres

Input fibre	Mechanical				Chemical				Total
	Tot	Pilot scale	Full scale	Unknown scale	Tot	Pilot scale	Full scale	Unknown scale	
Cotton	53	4	41	8	17	7	8	2	70
Polyester (PES)	51	2	36	13	26	13	8	5	77
Blends of cotton and PES	14	1	12	1	9	3	5	1	23
Man-Made Cellulosic (MMC)	5	NA	5	NA	5	1	3	1	10
Polyamide (PA)	13	1	10	2	6	NA	5	1	19
Wool	40	5	33	2	0	NA	NA	NA	40
Blends of wool and synthetic fibres	21	NA	17	4	0	NA	NA	NA	21
Acrylic (PAC)	13	1	11	1	0	NA	NA	NA	13
Other plant-based	10	NA	10	NA	1	NA	1	NA	11
Other synthetic	8	NA	7	1	0	NA	NA	NA	8
Other blends	6	NA	5	1	1	NA	1	NA	7

[204] Airtable - Sorting for Circularity - Recyclers Database. Available at [this link](). Last accessed on 31 January 2024.

Input fibre	Mechanical				Chemical				Total
	Tot	Pilot scale	Full scale	Unknown scale	Tot	Pilot scale	Full scale	Unknown scale	
Silk	4	1	3	NA	0	NA	NA	NA	4

Numerous plants could process more than one type of textile fibre.
NA: Not available

Source: own elaboration based on Airtable - Sorting for Circularity - Recyclers Database ([205]), (Jørgensen et al., 2022; Textile Exchange, 2022a)

10.5.2 Comparison among BREFs

Table 79. Environmental performance levels for emission to water by BREFs in the World

Country/organisation / Environmental parameter	European Union (EU-BREF)	India (MINAS)	South Korea	United States (US EPA)	World Bank (EHS Guideline)	China
AOX (mg/L)	0.1-0.4	NA	NA	NA	1	30-40 (only for a specific wool treatment)
BOD (mg/L)	No BAT-AEL applies for BOD (**)	30	NA	1.4-35.2 kg/kkg(*) Daily max 0.7-17.6 kg/kkg (*) 30-day avg New 1.4–16.9 kg/kkg (*) Daily max 0.7-8.7 kg/kkg (*) 30-day avg	30	NA
COD (mg/L)	40-100	100	18-30	21.3-256.8 kg/kkg (*)	160	7-30000
Chromium (mg/L)	0.01-0.1	2	0.5	Daily: 0.023-0.22 kg/kkg (*) 30-day average: 0.011-0.11 kg/kkg (*)	0.5	NA
Copper (mg/L)	0.03-0.4	NA	1	NA	0.5	NA
Nickel (mg/L)	0.01-0.1	NA	0.25	NA	0.5	NA
Zinc (mg/L)	0.04-0.5	NA	-	NA	2	NA

(*) Kilograms per 1000 Kilograms. The conversion to milligrams per litre (mg/L) is not straightforward. For enhanced accuracy, it is deemed more prudent to retain the unit in its original form in accordance with the United States Best Available Technology (BAT) standards.
(**) As an indication, the yearly average BOD5 level in the effluent from a biological wastewater treatment plant will generally be ≤ 10 mg/L.

Source: (OECD, 2022)

[205] Airtable - Sorting for Circularity - Recyclers Database. Available at this link. Last accessed on 31 January 2024.

Table 80. Environmental performance levels for emission to water by the Chinese BREF

Process	Fibres	Origin of wastewater	AOX (mg/L)	COD cr Concentration (mg/L)
Processing of raw materials	Hemp	Biological removal	NA	7-3000
		Chemical removal of glue	NA	2000-4000
		Joint removal of glue	NA	1000-3000
	Silk	Boiling cocoon and filament processes	NA	80-400
		Refining: oil removal	NA	20-12000
		Refining: water washing	NA	800-4000
	Wool	Washing	NA	40-9000
		Carbonization (**)	NA	200-400
		Silk-Resistant (***)	30-40	400-600
	Chemical fibres	NA	NA	200-600
Finishing fabrics	Cotton, Hemp & mixed machine fabrics	Slurry removal	NA	30-10000
		Cooking (****)	NA	1000-2000
		Bleaching	NA	200-400
		Mercerization	NA	500-2000
		Dyeing	NA	500-2500
		Printing	NA	1200-2000
		Organizing (*)	NA	2000-10000
	Wool	Dyeing	NA	800-2000
		Organizing (*)	NA	300-1000
	Silk	Pre-Treatment	NA	1500-2500
		Dyeing	NA	500-1500
		Printing	NA	1200-2000
	Chemical Fibres	Refining	NA	10-8000
		Polyester fabric alkali reduction	NA	10000-30000
		Dyeing	NA	500-800
		Printing	NA	1000-2000
		Organizing (*)	NA	2000-5000
	Knitwear	Finishing	NA	500-800
	Yarn	Finishing	NA	1000-2000

(*) Organizing wastewater includes waste finishing fluids and equipment cleaning wastewater.
(**) Carbonization is the process of removing plant impurities before the comb process by chemical means.
(***) The silk photorestriction process is the process of using chlorine as a chemical auxiliary to remove surface scales of wool and apply softeners.
(****) Cooking is the process of further removing impurities such as grease, wax, pectin and other impurities of fibre using thermoaline and surfactants

10.5.3 Service lifespan

Table 81. Studies addressing the lifespan of textile apparel

Study	Type of study	Source of data	Comments
(WRAP, 2017a)	Technical report	Online survey	Country: UK Sample: 3 244 people
(Laitala and Klepp, 2020a)	Scientific article	Wardrobe survey and data collected by previous research studies	Wardrobe survey: Countries: China, Germany, Japan, the UK, and the USA Sample: 213–230 respondents per country. Respondents' statistics: 100% 18-64 years old 51.6% Women 48.4% Men

Study	Type of study	Source of data	Comments
			Researched studies from: Australia, Norway, UK (2 studies) Netherlands (2 studies), Denmark, Finland and Norway
(Quantis, 2022)	Technical report	Producer judgement and literature studies	Values proposed by part of the industry within the development of the Product Environmental Footprint Category Rules for apparel and footwear
(Roos et al., 2015)	Technical report	Surveys and expert assumptions supported by national statistics on related topics	The study uses this data to perform an environmental assessment of the Swedish fashion consumption
(Laitala, IG Klepp, et al., 2018a)	Scientific article	Elaboration based on surveys	Average values from surveys carried out in: Norway, Netherlands, Greece, Spain, USA, Sweden, Germany, Poland, Australia, Canada and Finland
(Gray et al., 2022)	Key Findings Report	Surveys	Country: UK Sample: 6 000 interviewed users who purchase clothing at least once a year. Analysis on 44 807 items
(Drycleaning Institute, 2015)	Technical report	Expert judgement	Data are provided by the association of Australian dry cleaners.

Source: Own elaboration

Table 82. Parameters related to lifespan of specific types of apparel

Parameter	T-shirts	Shirts	Knitwear	Jeans	Socks
Average wear days per year	25	16	30	75	50
Implied wear days per month	2.1	1.3	2.5	6.2	4.2
Total days of wear for the garment's whole lifetime	112.5	80	150	300	125
Hours of wear during lifetime	1 350	960	1 800	3 600	1 500
Assumed days of wear per wash	2	2	5	10	2
Hours of wear per wash	24	24	60	120	24
Average number of washes for the target lifetime	56	40	30	30	62

Source: (WRAP, 2017a)

Table 83. Possession span expressed as years by studies reported in Laitala et al. (2018)

Apparel type	Wardrobe Audit Survey in Seven Countries	Wardrobe Audit Interviews Norway (Textile Waste)	Survey. Norway	Online Survey. UK	Survey. UK	16 Households' Purchases. Netherlands	Survey. Netherlands	Survey (Germany. Poland. Sweden and USA)	Online Survey. Finland
T-shirts	4.6	4.2	NA	4	3.3	6.8	NA	3-4	4.5
Shirts and blouses	4.6	NA	5.6	3.3 (Blouses) 4.3 (shirts)	3.6	7.2	NA	NA	5.7
Sweaters and midlayers	5.8	NA	10.8 (woollen sweaters)	4.5	3.7	7.1	6.17 (Woollen sweaters)	NA	NA
Jackets and coats	5.3 (Jackets) 6.3 (Coats)	4 (Jackets)	6.4 (Coats)	6.5 (Jackets) 6.2 (Coats)	NA	11.5 (Jackets) / 11.6 (Coats)	NA	NA	7.6 (Coats)
Pants and shorts	4.9 (Pants) 3.9 (Jeans)	4.3 (Jeans)	4.4	5.4 (Pants) 3.8 (Jeans)	3.1 (Jeans)	6.2	2.45 (Cotton jeans)	3-4 (Jeans)	5.3
Dresses. skirts and jumpsuits	4.5 (Dresses) 4.8 (Skirts)	4.1 (Skirts)	NA	4.7 (Dresses) 5.2 (Skirts)	NA	15.2 (Skirts)	NA	NA	NA
Leggings, stockings. tights and socks	3.6 (Socks and stockings)	2.9 (Socks)	NA	2.4 (Socks)	1.8 (Socks)	NA	NA	NA	2.3 (Socks)
Underwear	2.5	4.4	NA	2.4	NA	NA	NA	NA	3
Swimwear	NA	NA	NA	NA	NA	NA	NA	NA	NA
Textile apparel accessories	NA	NA	NA	NA	NA	NA	NA	NA	NA

Source: (Laitala, IG Klepp, et al., 2018a)

Table 84. Possession span, expressed as years, of types of apparel with specific fibre content

Garment Category	Cotton and blends	Synthetic/Man made	Wool and Blends	Silk
Pants/trousers	4.2	5.1	4.8	NA
Jackets	4.3	4.9	5.7	NA
Coats	5.8	8.4	5.3	NA
Sweaters	5.6	6.5	6.0	NA
Shirts and blouses	3.8	6.2	6.0	8.5
Ties	9.5	12.8	9.3	14.5
Socks and stockings	3.3	4.2	5.5	4.3
Underwear	2.2	3.2	3.9	3.5

Source: (Laitala, IG Klepp, et al., 2018a)

10.6 Supporting information about user behaviour

10.6.1 Pre-purchase aspects

Approximately, Europeans purchase 14.8 kg of textile products annually (EEA, 2022b; Vladimirova et al., 2024), which includes 6.0 kg of clothing, or roughly 24 new garments each year. However, these numbers conceal significant inequalities as purchasing frequency rises with income (WRAP, 2022; Vladimirova et al., 2024).

10.6.1.1 Reasons for purchasing

McNeill and Moore (2015) distinguished two specific approaches consumers have towards apparel: 1) consumers who see apparel as purely functional and 2) those who view apparel as self-representational. This influences what aspects are the most important for consumers at the point of sale.

A survey among Dutch consumers show that before shopping, almost half of 1 046 users claim to know what they are going to buy (D&B, 2020a) and they indicate that the main reasons for buying apparel are the following (listed in order from most to less common):

1. Look good or fun;
2. Replacing old, worn or broken apparel;
3. Buy “essential” apparel, meaning apparel that is basic and for everyday wear, i.e. one-colour t-shirt;
4. Want to join the trend;
5. Want new apparel;
6. Need apparel for a special occasion.

Another survey targeting 200 Dutch consumers showcased that consumers may be more likely to buy new apparel when is outdated, in terms of appearance or when they are afraid the item will break again quickly after being repaired (milieu centraal, 2021).

A survey representative of the German population showed that a third of respondents associate fun with buying apparel. In the 40-70 age group the proportion of those who enjoy buying apparel is significantly higher than the population average. In the female surveys from this social group, it is more than 60%. Fun shopping for apparel is also widespread among female respondents from the young group (Kleinhückelkotten et al., 2018a).

It shall be noted that there are a number of factors that may influence consumers buying behaviour: brand perception and exclusivity, personal factors such as age, gender, culture, etc., marketing campaigns, economic conditions, etc. (Anisha and Kalaivani, 2016; Khanna, 2021). In particular, malicious interface design strategies have been investigated to trick users into decisions against their best interests, such as spending money (Schäfer et al., 2023). These patterns are prevalent in digital services, including online shopping sites (Yada et al., 2022). An example of dark patterns that may be more prevalent in apparel purchases is the ‘low-stock message’ which entail a false claim that a product is nearly sold out to create a sense of urgency and encourage quicker purchases (Schäfer et al., 2023). Moreover, the results of an analysis of webshops ran by the Swiss consumer organisation (FRC) and the association Public Eye, showcased that dark patterns frequently tempt consumers to purchase additional items. For instance, 13 shops displayed supposedly matching items as soon as something was added to the online shopping cart, while 10 shops calculated shipping costs to encourage higher spending if the purchase amount is too low (FRC and Public Eye, 2022).Apparel is often bought spontaneously without thinking long beforehand. Only 16% of the respondents clearly disagree with the corresponding statement. In turn, the proportions of spontaneous buyers and those who regularly 'declutter' their wardrobe to make room for new things are above average in the 40-70 age group. More than 60% of female respondents in this population segment are frequent spontaneous buyers. The relatively high proportion of spontaneous buyers as a whole, leads to the conclusion that only a minority inform themselves correctly before buying apparel. The differences between the social groups are not particularly large in this regard (Kleinhückelkotten et al., 2018a).

The aspects affecting the purchase decision of apparel among consumers could be influenced by discount offers that stimulate impulsive purchases both in on-line sites and in physical shops (Djafarova and Bowes, 2021). In fact, a phenomenon that affects both type of stores around the globe is the New Year sales which incentivise the purchase motivation (Amasawa and Kimita, 2023). It seems clear that the more impulsive purchases consumers make, the more often they buy apparel per year while also spending more money on apparel each month (D&B, 2020a).

Even though visual aids are used in social media channels to produce a similar purchasing experience to the one in physical stores (Djafarova and Bowes, 2021), the impulse purchases seem to be more associated to the physical stores and affect especially the younger population (Cook and Yurchisin, 2017). However, online retailers have also reported that a significant portion of their customer base comprised individuals who engaged in casual shopping for fashion items without a specific utilitarian purpose often characterized as impulse buyers (Vinted, 2021). When users have events coming up (parties, travelling plans, etc.) then, purchases of apparel become a priority and this may lead to impulsive purchases (Hultén and Vanyushyn, 2014). Impulse purchase tendency may be also triggered more often among consumers who are wealthier and also have more time available for purchasing apparel (Hultén and Vanyushyn, 2014).

Moreover, according to a survey among 2 500 consumers in the United Kingdom, Sweden, Italy, France and Germany, offering discounts can prompt excessive consumption, leading to feelings of regret among buyers. Although the initial thrill of finding a bargain can be exhilarating, it often results in impulsive purchases and a focus on obtaining deals rather than considering actual needs. Zalando survey indicates that 65% of consumers prioritize low prices or discounts when shopping apparel. The allure of a discounted purchase is particularly strong, with 52% of females and 46% of males emphasizing the importance of the excitement associated with buying. This tendency suggests that many consumers may prioritize the thrill of the purchase over making thoughtful, sustainable choices, potentially leading to overconsumption. Interestingly, despite recognizing that impulsive bargain hunting contradicts their sustainability values, consumers frequently experience post-purchase regret. A substantial 82% of respondents admit to feeling some form of regret after shopping, with 28% expressing concerns about environmental impacts and labour conditions during production (Heiny and Schneide, 2021).

10.6.1.2 Criteria used when buying apparel

Studies revealed four main attributes concerning apparel purchase decision: brand, style, place of purchase, and price (Iwanow et al., 2005, as cited in Harris et al., 2016). Price being one of the main drivers in apparel purchase decision (Adıgüzel et al., 2020).

Fashion trends are significantly more important for younger consumers than for older ones (AK Wienn and Greenpeace, 2023a; Spaepen et al., 2021) and they are even seen as a sign of success (AK Wienn and Greenpeace, 2023a). Preference for brand new items and aspects such as comfort when wearing an item of apparel, its country of origin, type of textile material and even knowledge about the brand are important drivers for older generations of consumers (Generation X and Baby Boomers) (Spaepen et al., 2021).

According to Mishra et al., 2023, perceived value refers to "the subjective evaluation of the worth or benefits that a customer believes they will receive from a product or service". In this sense, a survey of over 3 000 American adults of over 18 years old indicates that 'value' was the first driver influencing purchasing behaviour across apparel followed by quality (Thredup, 2023). Similarly, 1 506 Austrians were surveyed about their apparel consumption and most of them reported functionality (92%) and quality (85%) to be among the most important criteria when purchasing apparel (AK Wienn and Greenpeace, 2023a). The monetary value of the apparel follows the ranking closely with 78% of respondents who claim that a low price is a very important factor when acquiring apparel (AK Wienn and Greenpeace, 2023a).Similarly, among the primary factors influencing Spanish consumers' apparel purchases are quality and price, with environmental impacts also playing a significant role, being quite or very influential for 44.2% of over 2 000 surveyed consumers (CECU, 2023).

Currently, the EU lacks harmonized labelling regulations that require the disclosure of working conditions where textile products are made. This lack of information on social responsibility is seen as an issue by 65% of respondents to the Textile Labelling Regulation Public Consultation, as it makes it difficult to make informed purchasing decisions (Evaluation report of the Textile Labelling Regulation, under development).

Sustainability and social standards with around 40% of respondents considering them as less important drivers in the purchasing decision (AK Wienn and Greenpeace, 2023a). This is in line with the responses from German consumers who indicate that ecological and social criteria play only a minor role in the purchase of apparel (Kleinhückelkotten et al., 2018a) and the average of respondents who claim that environmental aspects were unimportant in their last purchase of a coat (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018). Moreover, 35% of 2 500 survey respondents indicate that they often opt for a deal instead of a sustainable item (Heiny and Schneide, 2021). In the young and low-income population segments such criteria are given far less importance (Kleinhückelkotten et al., 2018a). Nonetheless, the responses of three-quarters of respondents to the survey suggest that a possible pollutant exposure could prevent them from buying certain apparel (Kleinhückelkotten et al., 2018a). In any case, social criteria considerations are relevant for the revision of the EU Ecolabel criteria on textiles.

A survey in Germany explored the social importance given to apparel by gender and by groups with similar socioeconomic positions and cultural values (Kleinhückelkotten et al., 2018a). In this survey, more than half of the respondents indicated a certain reluctance to buy apparel, with 26% who actually try to get by with few apparel. The proportion of men in the precarious group, who claim to be reluctant to buy apparel is significantly higher at 46.6%. In the focus groups it had already become clear that many of them have inhibitions to throw away apparel. This is in line with the fact that 78% of respondents strongly agree with the statement that apparel should be used for as long as possible and should only be disposed if it is no longer wearable. The intention to use the apparel for as long as possible is significantly lower in the higher age groups (40 to 70 years with higher level of education). Also the statement “I like apparel that I can wear in many occasions” has been repeated in all groups of survey participants. Although in the youth segment, comparatively there is less interest in versatile apparel (Kleinhückelkotten et al., 2018a).

Additionally, more than half of users below 25 years old (Generation Z) are more likely to shop with a brand that offers second hand alongside new (Thredup, 2023). Moreover, Generation Z values unique apparel and the possibility of ordering and returning items online (Spaepen et al., 2021). Moreover, the Thredup survey (2023) indicates that resale is increasingly driving the purchasing decisions of Generation Z users, in concrete 82% of them have considered the resale value of apparel before buying it compared to only 58% of the overall consumers.

According to Kleinhückelkotten et al. (2018) purchasing decisions of the German population are not very much influenced by whether the apparel was made nationally or is easy to repair. However, a very large proportion of respondents claim to pay attention to the easy to maintain aspect when buying apparel (Kleinhückelkotten et al., 2018a). In contrast, a survey from Fashion Revolution (2020) revealed that 75% of surveyed German consumers consider important that brands provide repair and care information about an apparel item, the average being 79% of 5 000 consumers across five countries (Fashion Revolution, 2020). The survey participants were between 16 and 75 years old (Fashion Revolution, 2020).

It shall be noted that the surveys analysed so far do not specifically address sportswear. On the contrary, a Cotton Incorporated’s survey investigated consumer’s attitudes and behaviours on sportswear purchases. The survey targeted 1 500 gendered balanced consumers, ages 13 to 70, representative of the United States population found that found that top purchase drivers for sportswear among consumers were: comfort (77%), fit (69%), washes clean (65%), quality (64%) and durability (62%) (Cotton Incorporated, 2014)

10.6.1.3 Quality assessment of apparel

Consumer satisfaction with the quality of an apparel product can be measured in three phases: at the point of purchase, while using the item, and ultimately, when it is disposed. Quality is generally first evaluated “pre-use” and then experienced “during use” (Piippo et al., 2022a).

Fashion is a highly tactile experience in which purchasing decisions are often made based on how the apparel or accessory ‘feels’ and how the quality is perceived (De Klerk and Lubbe, 2008; Williams and Ackerman, 2011;

McLaren et al., 2016; Vladimirova et al., 2022). Yet, for consumers it is very difficult to assess the quality and durability of apparel at the point of purchase (Harris et al., 2016; McLaren et al., 2016). Gowerek et al. (2012) reported that consumers usually judge apparel quality by its feel (personal considerations) and the brand. In any case, it shall be noted that the topic of longevity in relation to visual or aesthetic degradation has been minimally explored in existing literature. The lack of information on how expected longevity evolves over time is a significant barrier (Kumar et al., 2023). This gap not only may prevent consumers from making informed purchasing decisions but also complicates their ability to use the apparel item effectively according to Kumar et al., (2023).

Several researchers have tried to gather the aspects that influence the perception of quality in apparel (**Table 85**).

Table 85. Aspects that influence the perception of quality in apparel

Intrinsic product attributes	Extrinsic producer factors	Experienced features	Values, convictions
Material Manufacturing quality Fit	Price Brand Manufacturing location	Tactile feeling Functionality Durability Emotional value Fit Availability Context Price	Low environmental impact Local production Ethical production

Source: Adapted from Niinimäki, (2011); Koszewska, (2016); Henninger et al., (2017)

The aspects reported in **Table 85** are mentioned in different consumer surveys. Overall, it is documented that price is usually associated by consumers as a quality indicator (Keiser et al., 2012 as cited in Wakes et al., 2020). In an American survey, it was documented that 58% of users thought that the apparel with lower price had worse quality compared to higher-priced items, and 78% (ages 13–24 years and 35–70 years) indicated that "you get what you pay for" implying that apparent better quality apparel may be the ones that have higher price (Monitor, Cotton Incorporated Lifestyle, 2018).

Durability and ease of care characteristics seem not to be considered per se, by users when they are buying apparel (De Klerk and Lubbe, 2008; Wakes et al., 2020a). However, this may be because quality and durability are associated by consumers and industry specialists (Yuille, 2015; Wakes et al., 2020a). In other words, apparel with perceived high quality is expected to be durable.

As it happens when assessing the quality of apparel, consumers' expectations of apparel longevity are mostly related to the price (Forbrugerrådet Tænk, 2022). This is a particular believe for younger generations (Monitor, Cotton Incorporated Lifestyle 2018 as cited in Wakes et al., 2020). Nonetheless, price may not correctly reflect the quality and hence, the durability to laundering, for instance (Ghaani Farashahi et al., 2018b; Wakes et al., 2020a; Badgett, 2017). In fact, some studies have proved that cheaper apparel are not always a synonym of worse quality (Wakes et al., 2020a; Badgett, 2017). Nonetheless, according to Harris et al., (2016) the price is the deal breaker when it comes to decide whether to buy a piece of apparel or not, even among environmentally aware consumers.

Lifetimes expectations for consumers are also linked to where the apparel are purchased, care requirements, material and purpose/context (Forbrugerrådet Tænk, 2022). It is interesting to note that 43% of Austrian survey participants declared their willingness to buy long-lasting apparel despite of the price while 30% of them already buy them (AK Wienn and Greenpeace, 2023a). In addition, 55% out of 1 000 German consumers would be willing to pay more for their apparel if being certain about increased durability (VZBV, 2022). In a Zalando survey, 58% of 2 500 consumers consider long-lasting quality to be significant in apparel, with 52% stating that they frequently consider this aspect while shopping. Similarly, 45% of respondents prioritize value for money (Heiny and Schneide, 2021).

10.6.1.4 Information reported on apparel labels

Apparel labels and tags can have the same meaning. Generally speaking, the word label is used to refer to an attachment that is not meant to be removed from the apparel and provides details about it. The term tag may be referred to any type of attachment, whether made out of paper or cardboard including tags attached at the point of sale intended for removal.

Textile products sold in the EU must have a label and comply with the EU labelling requirements set in the EU Textile Labelling Regulation (TLR) 1007/2011 ([14]). According to the mentioned Regulation, the label must be firmly attached to the apparel and must contain information on fibre composition. Moreover, the information on textile composition must be separated from other type of information such as product care.

Information about care of the apparel is voluntary, according to EU law[206] and in general practice, but can also be legally required, notably by Member States and third countries (GINETEX, 2017a). In fact, currently, nine Member States mandate care labelling through their national laws, while others only offer it as a recommended option (Evaluation report of the Textile Labelling Regulation, under development). In most instances, the legislation does not specify how this requirement should be implemented. However, some countries, like Estonia, directly reference ISO standards in their national laws. In Austria, care symbols are provided in an annex to the national legislation (Evaluation report of the Textile Labelling Regulation, under development). When it comes to care labelling, manufacturers and even retailers can provide the product care instructions using symbols or offering a written explanation (GINETEX, 2017a).

It is interesting to note that when it comes to making informed consumer decisions, around 75% of respondents to the TLR Public Consultation consider it a problem the lack of harmonised labelling rules regarding care information of textile products and textile related products (Evaluation report of the Textile Labelling Regulation, under development).

Information about user attention to apparel care labels is available in Section 10.6.2.8. However, when it comes to labels in general, little is known about the extent to which consumers pay attention to them. For instance, 1 056 Portuguese consumers were surveyed about their habit of reading labels before purchasing apparel. The results were somewhat mixed, with the majority (53%) indicating that they do have this habit, while 39% reported that they do not typically read labels before making a purchase (Ribeiro et al., 2023).

An attitude-behaviour gap survey from Zalando showed that 58% of 2 500 respondents indicate that they should understand certain aspects of the apparel item, i.e. the materials used. However, just 38% regularly check the label for information (Heiny and Schneide, 2021). Similarly, while 60% of the survey participants express the significance of transparency about apparel aspects, only 20% actively pursue information during their buying journey (Heiny and Schneide, 2021). In like manner, a significant 74% of a sample of 1 000 Italian consumers expressed a strong need for clearer and more transparent information regarding the true sustainability of apparel and the production processes behind them (Altroconsumo and IPSOS, 2024).

Furthermore, a 2010 Eurobarometer survey found that 50% of 26 635 European citizens check the country of origin when buying textiles and clothing, and over half of those individuals reported that this influences their decision (28% of all respondents). This indicates that country of origin labelling plays a significant role in consumers' purchasing choices (European Commission, 2010). Related to this, a survey from the Spanish Consumer Organization (OCU) targeting 340 Spanish consumers indicated that 42% of respondents admit looking at the origin of the apparel in order to buy locally or not to buy from countries contributing to labour exploitation (OCU, 2018). Some of the Spanish consumers who responded to the same survey check the labels to get information about the material composition as 38% of them have personal preferences towards natural origin fibres while 25% avoid synthetic fibres due to the microplastic release occurring after washing the apparel (OCU, 2018).

Overall, textile labels and the information they provide are considered valuable only if they are trusted by consumers (Circle Economy, 2020 as cited in the Evaluation report of the Textile Labelling Regulation, under development). This is especially important for voluntary labels that highlight the sustainability features of textile products (Circle Economy, 2020 as cited in the Evaluation report of the Textile Labelling Regulation, under development). In this light, users seem to have a growing interest in EU ecolabelled products in the category of 'textiles, clothing/footwear'. In particular, 71% out of 26 635 survey respondents in the EU27 Member States express a desire to find more of the abovementioned products carrying the EU Ecolabel. This sentiment is prevalent in all countries, with varying percentages (from 54% in Czechia to 83% in Portugal and Romania) (European Commission. Directorate General for Environment, 2023).

10.6.1.5 Attitudes towards second-hand apparel purchase

In recent years, there has been a notable shift in consumer behaviour towards the adoption of second-hand apparel, reflecting evolving preferences and attitudes. In fact, more than three out of ten (34% of 26 595

206 The ongoing review of the Textile Labelling Regulation is exploring whether to harmonise and even render care labelling mandatory

respondents) would purchase second-hand textiles (apparel and home textiles included in this category) (European Commission. Directorate General for Environment, 2014). Another survey indicates that 17% out of 11 483 European consumers purchase their apparel in second-hand shops while 12% buy them on resale apps (YouGov, 2021). Additionally, more than 70% of 27 498 respondents across the European Union agree that second-hand apparel should be promoted more (European Commission, 2019). In fact, 65% of 2 500 Spanish consumers expressed their desire to give a second life to their apparel items as 87% of them believe that is important (Asociación para la Gestión del Residuo Textil y el Calzado, 2024). Despite of this, surveys have found that the attitudes and the consumer behaviours are not always aligned. This is the case for 61% of users who think that second-hand purchase is important but only 25% of them buy second-hand apparel (Heiny and Schneide, 2021).

There seems to be gender disparities as women exhibit a higher inclination towards buying second-hand apparel compared to men (European Commission. Directorate General for Environment, 2014; YouGov, 2021). The age dynamics indicate that younger demographics, particularly 18-25 year-olds, lead in second-hand apparel adoption, contrasting with relatively lower participation among those aged 26-40 (D&B, 2020a). This is supported by the findings in AK Wienn and Greenpeace (2023), young consumers (aged 16-29) buy far more second-hand apparel (both online and offline). The primary drivers behind the adoption of second-hand apparel include financial savings, sustainability/environmental consciousness, and a preference for unique, vintage pieces (D&B, 2020a).

It shall be noted that the second-hand cycle relies on the primary market and consumer behaviour, with consumers acting as both partners and suppliers by disposing of items in good, reusable condition, thereby making used apparel available for second-hand use (Machado et al., 2019 as cited in Turunen and Gossen 2024). Consequently, there is a dual role for consumers: those disposing of apparel items with the intention to receive money from them (sellers) and those interested in purchasing used clothing (buyers) (Turunen and Gossen, 2024).

Moreover, preliminary observations from the Turunen and Gossen (2024) study indicates that current second-hand business models also incorporate consumption-promoting marketing strategies. The study also noted an increase in unworn or slightly used items on second-hand platforms. The use of subscription models to encourage ongoing buying and selling, may result in shorter garment lifespans. Turunen and Gossen (2024) also highlight that self-service flea markets, with their lower prices, may attract treasure hunters more for the shopping experience than the actual purchases, sometimes leading to less responsible buying behaviour of apparel (Turunen and Gossen, 2024).

The ‘replacement rate’ for apparel items is understood as “the degree to which the purchase of second-hand articles replaces the purchase of similar new items” (Nørup et al., 2019; Trzepacz et al., 2023). On one hand, there are studies which highlight that second-hand purchases, generally speaking, tend to have a reduction effect on the purchase of new apparel (Klepp et al., 2020b; Vinted, 2021) thus extending the life of existing apparel (Klepp et al., 2020a). In particular, some studies operate under the assumption of a one-to-one replacement ratio, meaning that buying a used apparel item completely offsets the purchase of a new one (Trzepacz et al., 2023). However, various studies indicate that actual replacement rates differ significantly (Sandin and Peters, 2018; Trzepacz et al., 2023). For instance, results of a survey based on over 350 000 responses across eight European markets showed that 39 out of 100 people buying a second-hand product on the retailer’s website would have avoided purchasing a new product (Vinted, 2021). Depending on the product category, significant variation in the avoided purchase rate was observed for instance, coats and jackets were among the products having high replacement rate (Vinted, 2021). In Farrant et al., (2010), purchasing 100 second-hand apparel items would save between 60 and 85 new ones, depending on the location where they are reused.

Consequently, more research and other variables should be taken into account when considering estimations of replacement rates (Trzepacz et al., 2023). As for example, an apparel item with low quality, sold after just one use, may avoid the purchase of other items. However, due to its low quality, the usability of the item may be limited. This means there may be cases in which buying brand-new items with higher quality could have better impact on the environment than buying second-hand apparel items with lower quality.

10.6.1.6 Attitudes towards the purchase of apparel made without harmful chemicals

Over 85% of 27 498 respondents of an EU-wide survey expressed concern about how chemicals found in everyday products may affect their health (European Commission, 2019). In particular, consumers have reported to be increasingly concerned about the use of hazardous chemicals in apparel (Evaluation report of the Textile Labelling Regulation, under development).

According to 61,2% of over 2 000 Spanish consumers, the restriction of hazardous chemicals in apparel is the second most important measure that policy makers should take after ensuring clothes are produced in fair conditions (CECU, 2023).

A survey involving 26 718 citizens across the 27 EU Member States found that the chemicals in the apparel fabrics are generally perceived as minimally risky, with 60% of Europeans viewing them as not posing a risk to people. Among different fabric types, synthetics are viewed as posing the highest risk, although only 22% of Europeans categorize them as presenting a significant health risk (European Commission, 2009).

Fabrics with chemical-specific quality labels indicating the absence of harmful chemicals to health and the environment, are thought to carry lower risks and materials like wool, cotton, or linen are perceived as entirely risk-free. Europeans hold divergent views on the relevance health and environmental risks when purchasing apparel – some consider it highly important, while an equivalent proportion does not find it significant (European Commission, 2009).

Europeans were also surveyed about the significance they attribute to potential health and environmental risks associated with fabric when purchasing apparel for themselves or their families. Of the respondents, 18% consider it fairly important, while nearly four in ten respondents find it very important (39%), and a similar proportion deems it not important (37%). A country-level analysis reveals that approximately two-thirds of respondents in Germany and Slovakia find environmental and health risks very important when buying apparel. Conversely, in Denmark and the United Kingdom, more than six in ten respondents consider this aspect not important (European Commission, 2009).

Additionally, data from the Fashion Revolution (2020) consumer survey shows that an average of 37% of 5 000 consumers in the United Kingdom, France, Germany, Italy and Spain consider important to buy apparel that is not produced using harmful chemicals. On top of that, a survey from Sveriges Konsumenter (2020) shows that 86% of 1 000 surveyed Swedes would like to access information about the content of harmful chemicals in apparel at the time of purchase. The Fashion Revolution survey does not provide information about the type of chemicals. It shall be noted that all age groups, genders and users with different income provided no important differences in the responses.

10.6.1.7 Attitudes towards the purchase of apparel made with recycled materials

The Fashion Revolution (2020) survey indicated that an average of 11% of 5 000 European consumers from the United Kingdom, France, Germany, Italy and Spain pointed out that it is important that the apparel they buy contains recycled materials. Italy, is considerably above the average with 51% of users considering important the presence of recycled materials in the apparel they purchase. Spain, France and Germany remain in the average for the five countries. However, the survey does not offer information about such materials. In this case, the group of respondents between 55 and 75 years old consider less important whether the apparel they purchase have recycled materials or not, as only 7% declare so as opposed to the youngest age group (12-24 years old) in which 14% percent of users indicate the importance of buying apparel containing recycled materials. No notable differences in survey responses exist between different income and gender groups.

Furthermore, three-quarters of 27 498 respondents of an EU-wide survey declared that apparel should only be made from materials that can be recycled (European Commission, 2019).

10.6.2 Post-purchase aspects: the user behaviour during use

The post-purchase aspects of apparel encompass the use and care phases. Studies on laundering procedures have been investigated from a variety of angles, including their impact on the environment and cleanliness. Nevertheless, the majority of these research (Gooijer and Stamminger, 2016 as cited in Laitala et al., 2017) solely consider machine washing, paying little attention to other cleaning techniques such as hand washing, dry cleaning, airing, steaming, ironing, and stain removal (Laitala et al., 2017). These maintenance procedures have a different environmental impact than machine cleaning and are widely used specially for woolen and delicate apparel according to Laitala et al., (2017).

Moreover, the underlying drivers and barriers to sustainable consumer use and care are not sufficiently well captured in the literature, especially regarding frequency of laundering apparel, number of uses and product's lifetime (Conrady et al., 2014; Yates and Evans, 2016; Luo et al., 2023b). In fact, retailers claim that the way users take care of apparel determine their physical lifespan (McLaren et al., 2016). This is important as it seems that not many consumers seem to be willing to change their laundering behaviour (Uitdenbogerd 2007 as cited in Luo et al., 2023).

The frequency of laundering, washing temperature, number of days apparel are worn between washes and chemicals used for washing the apparel are among the factors that affect the durability of apparel and also determine the extent of the environmental impacts associated to washing them. All these aspects are heavily dependent on the behaviour of users which vary depending on the culture and climate (Laitala et al., 2017; Klepp and Laitala, 2023b).

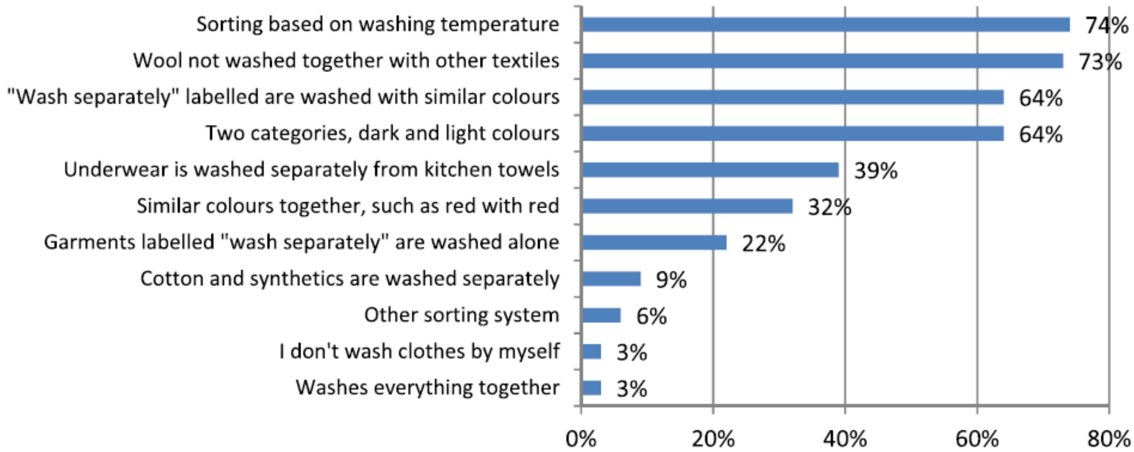
As a result, this chapter brings forward some information about different user laundering practices which encompass the sorting of the apparel before washing, the washing temperature and washing frequency, the drying method, the ironing or steaming process and the storage.

10.6.2.1 Sorting before washing

Textile materials have specific cleaning requirements, hence the importance of sorting before washing in order to preserve the apparel shape and colour (Cooper and Claxton, 2022b; Klepp and Laitala, 2023b) and hence extend the lifetime of the apparel (Cooper and Claxton, 2022b).

Figure 53 gives an overview of different sorting practices and average percentage of users that opt for each of them. The results are based on responses from 545 users in Norway. It seems that sorting based on washing temperature is the most popular sorting method while washing everything together without differentiation between the apparel is not generally chosen by consumers.

Figure 53. Laundry sorting methods



Source: Laitala and Boks, (2012)

The sorting processes in laundry exhibit considerable variation, influenced by factors such as washing temperature, colour, fibre type, usage area, and care labelling. Merely 3% of participants indicated a preference for washing all items together. Younger respondents tend to categorize colours into just two groups (light and dark). Sorting based on washing temperature is more prevalent among female participants and those in higher age brackets. Woollen products are commonly segregated from other fibre types, with 73% of survey respondents affirming that they avoid washing wool alongside other textile materials. Some consumers find it challenging to amass a sufficient amount of apparel to fill the machine when using multiple sorting categories (Laitala et al., 2012).

10.6.2.2 Washing temperature and washing frequency

The average laundry temperatures differ between different countries. The average European washing temperature was 42.4°C in 2020 (A.I.S.E, 2020), in Scandinavia is 46.2°C and in Southern Europe lower 39.7°C (A.I.S.E, 2017b). In the USA, the average temperature is 30°C, while in Japan is 20°C (Laitala et al., 2020).

Figure 54 shows that washing cycles at an average of 40°C have been found as the most commonly selected washing temperature among consumers. This is also supported by the study from Laitala et al., (2012).

Table 86. Preferred washing temperatures for consumers

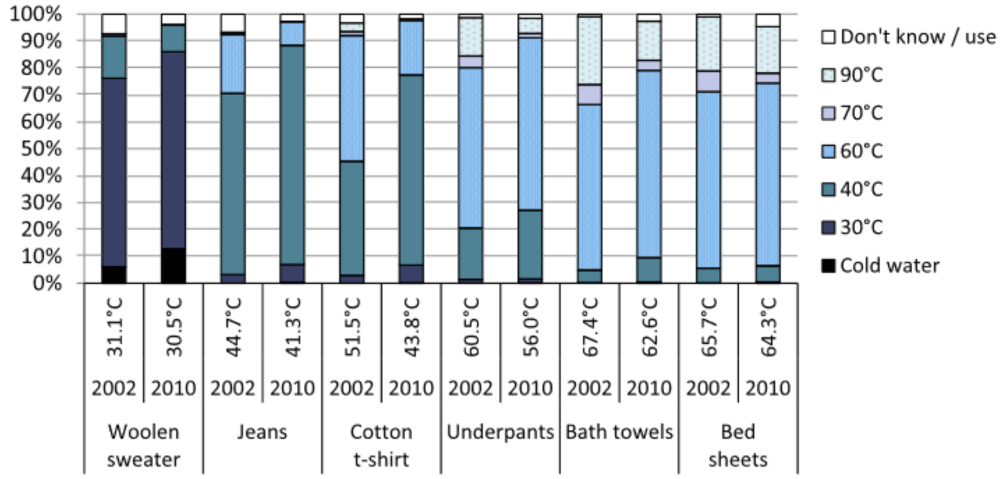
Publication	Sample details and characteristics of the study	Country	Preferred washing temperatures[(a)]			
			20 or cold setting	30	40	60
WRAP (2019)	Two waves of online surveys: Wave 1 was conducted in November 2016 and Wave 2 in June 2019. The sample size in 2016 was 1 000 per country. In 2019 the samples were as follows: Denmark 1 046; Germany 1 113; The Netherlands; 1 117 and Italy 1 226.	Denmark (DK), Germany (DE), The Netherlands (NL) and Italy (IT).	NA	Second most frequently used laundry wash temperature in all five countries.	Most frequently used laundry wash temperature in all five countries	NA

[(a)] There is no information about the correlation between the temperatures indicated and the information reported on the care labels

Source: own production based on references indicated in the first column of the table

Whether the washing temperatures in **Figure 54** are in line with care label recommendations of the apparel in question is not specified in the study from Laitala et al., (2012). A total of 1 008 users participated in the survey from Laitala et al., (2012) while the sample in 2010 was a bit more than half the size with 546 respondents.

Figure 54. Distribution of washing temperatures for different textile products



Source: Laitala and Boks, (2012)

The frequency of washing is a crucial factor in determining the longevity of apparel because it represents one of the primary factors that can cause the apparel item to wear out and either extend or shorten its lifespan.

The average washing frequency per household in Europe is estimated in 3.8 washing cycles per week (Schmitz and Stamminger, 2014; Klepp and Laitala, 2023; Laitala et al., 2018b).

The frequency of washing cycles is closely tied to the household's size. As the number of individuals in the household rises, so does the overall number of washing cycles. However, the average number of washing cycles per person decreases, suggesting a more efficient utilization of washing machine capacity (Klepp and Laitala, 2023b).

Other sources indicate that users wash their apparel items on average 10.9 times a month, excluding underwear and socks (D&B, 2020a). Women (average 11.58 times per month) wash their apparel more often than men (average 9.93 times per month). Additionally, users living in metropolitan areas tend to wash less often (8.2 times a month) than users whose home is in less urban areas (13.3 times a month in a non-urban area). The analysis of the survey results from D&B (2020) found no explanation for this behavioural pattern. Age and educational level, did not offer different results in washing frequency (D&B, 2020a).

The duration of time that apparel is worn before being washed exhibits significant variability among different types of apparel. Typically, items like underpants and socks are laundered after each use, whereas certain outer apparel are infrequently washed (Laitala et al., 2018).

Table 87 displays the difference in number of uses prior to washing depending on the purpose of the category of apparel.

Table 87. Average number of uses of apparel categories prior to washing

Study	T shirts	Shirts and blouses	Sweaters and mid layers	Jackets and coats	Pants and shorts	Dresses skirts and jumpsuits	Leggings stockings tights and socks	Underwear	Swimwear	Textile apparel accessories	Knitwear
Quantis, (2022)	1	2	5	20	3	3	2	1	1	NA	NA
Klepp et al., (2020)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	NA	NA
Laitala, IG Klepp, et al., (2018a)	1.5 (Cotton)	2 / 3 (Woollen undershirts)	10 (Wool) / 5 (Cotton)	NA	5.5 (Jeans)	NA	2	1	NA	NA	NA
WRAP, (2017a)	2	2	NA	NA	10 (Jeans)	NA	2	NA	NA	NA	5
Roos et al., (2015)	2	NA	NA	100	9 (Jeans)	3 (Dresses)	NA	NA	NA	NA	NA
Gray et al., (2022)	2.6	2.3	4.7 (Sweatshirt and hoodie)	14.5 (Non-padded) / 16.7 (Padded)	4.2 (Shorts) / 4.5 (Trousers) / 5.5 (Jeans)	3.2 (Skirt) / 2.6 (Dress)	3.3 (Leggings) / 2.4 (Socks and hosiery)	3.5 (Bras)	1.7	NA	4.3

NA: Not available
Knitwear products could belong to more than one category from those considered

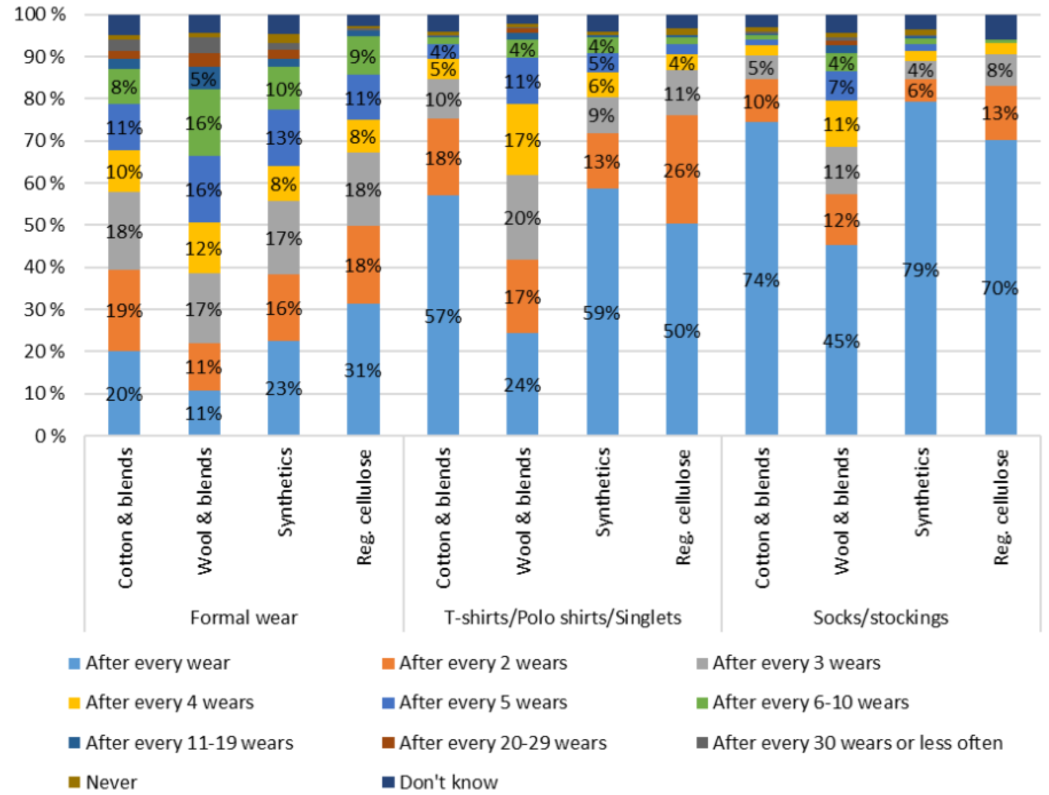
Source: own production based on references indicated in the first column of the table

The wardrobe survey conducted by Klepp et al. assessed the cleaning frequency among its respondents. However, there is a big variability among respondents as 39% of them washes the apparel item after every wear, 14% after every 2 wears, 11% after every 3 wears and 29% after every 4 wears or more (Klepp et al., 2020a).

The study conducted by Laitala et al., 2018a presents an overview of studies that provide the average count of wear instances before laundry for distinct types of apparel. It indicates that fibre types are an important factor in determining the number of uses before washing (Laitala et al., 2018a) and overall influence the washing frequency (Laitala et al., 2020)

When it comes to differences in the washing of textile categories and fibres, survey data of 23.392 apparel representing five countries show that socks are washed more frequently compared to t-shirts and formal wear **Figure 55**. In terms of fibres, apparel made out of wool are washed less often compared to other fibres (Laitala et al., 2020).

Figure 55. Frequency of wash or dry clean per fibre content



Source: Laitala et al., (2020).

The type of materials is likely to influence how often apparel is washed, as synthetic fabrics like polyester or polyamide are prone to retaining strong body odours compared to apparel made from natural materials like wool or cotton (Klepp and Laitala, 2023b).

Additionally, even identical types of apparel may undergo washing at distinct frequencies across various countries. A study comparing laundering habits in five countries revealed that, for instance, the Japanese tend to launder their formal wear less frequently (after an average of 8.8 wears) compared to Chinese and American consumers, who wash them after 3.3 and 3.6 wears, respectively (Laitala et al., 2020). In this context, laundry washes include the generic pre-programmed settings the washing machine runs to complete its work (washing, rinsing, and spinning phase). In view of this, Italy has the highest (5.9) number of laundry washes per week, while Germany has the lowest (4.0). However, the number of laundry washes per week have decreased since 2016 in Denmark (from 5.5 to 4.5 per week), Germany (4.4 to 4.0) and The Netherlands (6.0 to 4.8) (WRAP, 2019).

The stronger users feel about the fact that washing apparel less often is not a habit a clean person would follow, the more often they wash. This association of less washing with poor hygiene is also linked to our image: we want to appear to others as a “clean” person, because that is the social norm (D&B, 2020a). Additionally, the more annoying users find the washing of apparel, the less often they do this. Individual beliefs about hygiene and convenience play a role in how often users wash their apparel. Factors such as time, money and environmental convictions do not seem to play a role in the frequency of washing apparel (D&B, 2020a).

In general, users do not only throw their apparel in the laundry bin when they are actually dirty, but also ‘after wearing them several times’. The latter reason indicates customary behaviour also supported by the literature: the majority of people do not check whether the apparel are dirty before putting them in the laundry bin because they are used to washing them after a certain number of wears (D&B, 2020a).

It is important also to consider that the cleaning process itself may have environmental and lifespan implications. Frequent laundering may accelerate the wear and tear on apparel, indirectly reducing their total lifespan. If laundering fails to effectively remove stains or odours from apparel, it can lead to premature disposal of apparel (Klepp and Laitala, 2023b). As established in the study based on the survey conducted by Laitala and Klepp (2020), apparel that are laundered less frequently exhibit longer lifespans. Those washed less often than every 30 wears have lifespans up to 4.8 years longer than those washed after each wear. On top of that, apparel washed after each wear are used 94 times less compared to apparel washed less often (washed every 30 wears) (Laitala and Klepp, 2020a). Nonetheless, it shall be noted that particularities in laundry frequency behaviour may apply for instance to sportswear. Their type of use and in some cases, distinct fibre and fabrics, could differ significantly from everyday casual wear apparel (Wei et al., 2020). In particular, certain types of sportswear can quickly absorb sweat and may also lead to unpleasant odours. This odour can create social awkwardness and discomfort for both the wearer and those around them (Chang and Wang, 2023). Therefore, washing sportswear promptly after one single use is generally done by users (Brice and Thorpe, 2021).

As a result, in addition to the frequency of washing, the examination of lifespan can also involve evaluating the number of cleaning cycles that the specific apparel item can endure in technical assessments or the number of cleaning cycles they generally experience during consumer studies. This approach may provide more consistent insights into the durability and potential longevity of apparel.

10.6.2.3 Choice of softeners and detergents

According to a 2017 A.I.S.E survey, compared to 2008, fewer consumers are reading information on detergent packaging. Nonetheless, in 2017, 52% claimed to read it before purchasing a product, and 60% mentioned doing so before using the product (A.I.S.E, 2017c). However, it appears that a majority of consumers continue to dose detergent arbitrarily, as indicated by A.I.S.E in 2020 hence overdosing is a common mistake, contributing to increased environmental impact and less effective washing results due to poorer rinsing effects (Paloviita and Järvi 2008 as cited in Klepp and Laitala, 2023).

Interestingly, when consumers' attention is compelled, the average time spent on a detergent label is approximately 20 seconds, irrespective of the label size or content (A.I.S.E, 2017c). When asked if consumers deliberately check composition information, 37% of European consumers responded affirmatively. They do so primarily to compare products (59%), avoid specific substances (29%), assess the quantity of a particular substance (28%), or because they are allergic to a specific substance (24%).

Fabric softeners, also known as fabric conditioners, are chemicals originally developed to reduce static electricity in synthetic fabrics and are now more commonly used to soften cotton, ease ironing and add fragrance to laundry (Klepp and Laitala, 2023b). Studies suggest that softeners are utilized in about 55% of washing cycles in Europe (Stamminger 2016 as cited in Laitala 2023), with significant national variations. In Norway, approximately 61% of the population use them often, 19% occasionally, and 19% never (Laitala, K., M. Kjeldsberg, and I.G. Klepp 2012 as cited in Klepp and Laitala, 2023), while in Hungary and Romania, only about 5% use softeners in all wash cycles, and 60% never use (Stamminger 2016 as cited in Laitala, K., M. Kjeldsberg, and I.G. Klepp 2012 as cited in Klepp and Laitala, 2023).

Further details on the A.I.S.E, 2017a survey results on laundering habits can be found in **Table 88**.

In conclusion, economic factors, such as the price and promotions, play a substantial role in users' choices of laundry products. Sustainability is an important criterion for a significant portion of respondents, but less important than economic aspects. There is still a segment of users that may add more or less detergent than recommended as it happens with the dosing of softeners.

10.6.2.4 Consumer awareness on microplastic release during washing cycles

A structured survey among 411 Belgium citizens respondents spanning all age groups, aimed at gauging consumer awareness regarding microfiber pollution and its influence on washing habits (Herweyers et al., 2020). Overall, 68% of respondents are aware of the plastic pollution issue. Conversely, only 37% are aware of microfiber pollution and its association with the problem. Individuals under 25 exhibit the lowest awareness of synthetic fibre pollution (29%). Those aged 41 to 60 and over 60 are the most knowledgeable about the issue, yet still, less than half of respondents in these age groups are aware of synthetic fibres' potential harm (43%) (Herweyers et al., 2020).

Table 88. Summary of surveys on laundering habits related to apparel

Publication	Sample details & characteristics of the study	Country	Washing Habits										
			Choice of laundry detergents and/or softeners by users expressed in % of respondents					Laundry detergents dosage habits per user expressed in %					
			Total price of the box	Specials offers and promotions	The detergent form (i.e. liquid/powder)	The fragrance	Sustainability criteria	Aware of the dosing instructions on the package	Find it easy to dose laundry detergents	Usually measure the quantity of detergent to be used	Check the package for dosing instructions	Add more detergent than recommended	Add less detergent than recommended
A.I.S.E (2017)	4 611 participants (aged 18-65) 200 respondents per country. No details on the demographic or social factors of the subjects.	23 European countries	78	71	70	71	Ranked lower than the economic criteria[(a)]	63	74	62	50	24	23

Source: own production based on references indicated in the first column of the table

10.6.2.5 Drying

Apparel undergoes diverse drying methods, all of which involve air, causing moisture to evaporate and be carried away. The tools employed by consumers include an array of drying racks and cords utilized both indoors and outdoors, drying cabinets, dryers, and dedicated drying spaces, such as drying ceilings with or without heating. The prevalence of tumble dryers varies significantly even among Western countries, with the USA leading at approximately 80% of households owning one (Engelberg and Brassell, 2019), while the European average stands at around 32% of households (De Almeida et al., 2011).

The data from surveys conducted by Laitala et al. (2020) and GINETEX (2017) provide insights into the prevalence of specific drying methods among participants from different countries and age groups.

A summary of surveys related to drying of apparel is available in **Table 89**.

Table 89. Summary of surveys related to drying of apparel

Publication	Sample details and characteristics of the study	Country	% of users per drying method [(a)]			
			Tumble-drier	Shared tumble-drier	Line dried indoors	Line dried outdoors (natural drying)
Laitala et al. (2020)	1 111 participants Age groups: 18-29 years, 30-49 years and 50-64 years	China, Germany, Japan, United Kingdom and USA	32.5	8	33	27
GINETEX (2017)	6 000 participants (aged 18-65)	Germany, United Kingdom, France, Italy, the Czech Republic and Sweden	NA	NA	NA	62

(a) Whether the results per drying method depend on where the user lives in, is not reported by the studies

Source: own production based on references indicated in the first column of the table

10.6.2.6 Ironing

The final stages of the domestic laundry process involve employing techniques to shape, structure, and refine the appearance of freshly washed fabrics, a step commonly achieved through ironing (Klepp and Laitala, 2023b). In contemporary times, the amount of time dedicated to ironing has notably decreased, particularly over the past few decades (Klepp and Laitala, 2023b). As it seems, ironing is one of the procedures consumers dislike the most (Yun et al., 2017).

Ironing practices exhibit significant variations not only between countries and consumer demographics but also among different types of apparel. In Norway, the statistics indicate diverse ironing habits, with approximately 12% of adults ironing on a weekly basis, 40% opting for monthly ironing, 28% engaging in less frequent ironing, and 20% asserting that they never iron anything (Laitala, IG Klepp, et al., 2018b). Notably, a higher proportion of men and younger respondents tend to forgo ironing, in contrast to women and elderly respondents (Klepp and Laitala, 2023b).

On a different note, the care labels on textiles often contain symbols indicating whether the apparel can be ironed and if so, the most appropriate ironing setting. In some cases, the ironing symbol may be accompanied by dots. The number of dots indicates the temperature ranges for ironing. Ironing at a hot setting can also contribute to the shrinkage of apparel (Chartered Textile Technologist interview as cited in Cooper and Claxon 2022).

10.6.2.7 Storage after washing and drying

The folding and storage of apparel after being washed and dried may have influence on the lifespan of apparel. The way users store their apparel may affect the intrinsic quality they have. Nonetheless, no studies have been found that address the folding and storage of apparel after being washed and dried. Rather some studies on the user behaviour related to the storage of inactive or no-longer-worn-apparel have been identified and are presented in Section 10.6.2.10.

10.6.2.8 Following apparel care label instructions

Care labels may indicate the recommended washing temperature, cycles, detergent to be used, and the way apparel should be hanged while still damp, among other things (Cooper and Claxton, 2022b).

Survey evidence (**Table 90**) suggests that a significant percentage of users across various countries tend to follow care instructions on apparel labels, often with reasons including avoiding washing problems and preserving apparel. Both, GINETEX (2017) and GINETEX (2019) surveys report a similar percentage of users (70%) who always follow textile care instructions, suggesting consistency in this behaviour across the two studies. Moreover, the surveys from GINETEX (2017) and AB-REOC and BV-OECO (2019) indicate that around 58% of users follow the care instructions often. This is in line with Ribeiro et al. (2023) study where roughly 53 % of 1 056 Portuguese consumers typically adhere to label instructions for washing and drying their apparel.

Despite consumers recognizing the influence of care and laundering practices on the lifespan of their apparel, adherence to care labels diminished after the initial wash, as indicated by McLaren et al. 2015. In the present survey, 47% of participants acknowledged generally reading apparel care labels. However, when specifically asked about reading care labels for T-shirts, 59% indicated doing so either at the point of purchase (10%) or before cleaning/after use (49%). The percentage of participants who abstained from reading care labels entirely decreased with an increase in T-shirt price. Moreover, survey results from Cotton Incorporated's Lifestyle Monitor revealed a declining trend in the number of consumers who 'always' or 'usually' read care labels before laundering apparel (2003—77%; 2007—64%; 2009—57%), with younger consumers (under 35 years) displaying a reduced inclination to read care instructions.

Furthermore, evidence suggests that there appears to be an imbalance between the essential information consumers need and the volume of details provided on physical care labels in apparel (Evaluation report of the Textile Labelling Regulation, under development). This results in user practices such as cutting labels out reflected in the GINETEX (2017) survey where 62% of the respondents would do so (GINETEX, 2017a). The fact that there are consumers who tend to cut the care labels is also observed in disposed textiles which are collected with missing labels. This affects both, the reselling potential of apparel and their preparation for reuse (WRAP, 2017c; Cura et al., 2021; European Commission. Directorate General for Internal Market, Industry, Entrepreneurship and SMEs, 2021). There are variations in behaviours and opinions, with some users finding care labels uncomfortable (when wearing the apparel item) or too long. GINETEX (2017) report the behaviour of cutting out care labels, suggesting that a portion of users across different countries may engage in this practice. In parallel, 39% of 6 000 consumers in Germany, United Kingdom, France, Italy, the Czech Republic and Sweden would never or rarely buy a piece of apparel without a label, where French consumers may bring up the average with 67% of 1 000 users reporting so (COFREET, 2023).

There is also a desire for more convenient access to care instructions, such as having them directly on the sewn label or accessible through a QR code on a smartphone reported by 65% and 17%, respectively, of 1 000 French survey participants (COFREET, 2023). Similarly, when 1 056 Portuguese consumers were asked how they prefer to access product information in apparel, 49.75% indicated that they favour getting this information directly from the product label. Meanwhile, 33.7% showed a preference for using visual codes, such as QR codes or barcodes, to obtain the information (Ribeiro et al., 2023).

Regarding clarity and transparency of content, approximately half of the respondents in the TLR Public Consultation (117 out of 234) indicated that the information is somewhat clear and transparent. Meanwhile, 27% (64 out of 234) felt that the clarity and transparency are limited, and around 18% (28 out of 234) believed the information is largely clear and transparent (Evaluation report of the Textile Labelling Regulation, under development).

The inclusion of multiple European countries in GINETEX (2017) and GINETEX (2019) contributes to a broader representation. The representativeness may vary based on the scope of coverage. However, these sources offer an overview of common specific behaviours, such as attention to labels, indicate low variability in user practices. The representativeness is influenced by the extent to which these behaviours are widespread.

While the data provides percentages of users following care instructions and engaging in specific behaviours related to care labels, the reasons behind these behaviours are not extensively detailed. Understanding the motivations behind user actions could enhance the representativeness of the findings. Nonetheless, the data provide valuable insights into the way users follow care instructions and engage in specific behaviours related to care labels.

Further details on surveys about user behaviour interaction with apparel care labels can be found in **Table 90**.

Table 90. Summary of surveys on user behaviour interaction with apparel care labels

Publication	Sample details and characteristics of the study	Country	% of users who follow the textile care instructions			% of most repeated reasons to follow the care instructions according to users			Other behaviour and opinions related to apparel care labels expressed in % of users					
			Average for the EU population	Follow them 'Always'	Follow them 'Often'	To avoid washing problems such as shrinking	Follow the care label to preserve their apparel and keep them longer	Never or rarely buy a piece of apparel without a label	Find the care labels Useful	Cut the care labels out	Think that care labels itch and irritate the skin	Think that care labels are often too long and uncomfortable	Want to find the maintenance instructions directly on the sewn label on the apparel	Want to consult them on smartphone via a QR code.
GINETEX (2017)	6 000 participants (aged 18-65)	Germany, United Kingdom, France, Italy, the Czech Republic and Sweden	70	13	57	38	31	39	NA	62	74	55	NA	NA
GINETEX (2019)	7 000 participants (aged 18-65)	France, Germany, the Czech Republic, the United Kingdom, Sweden, Italy and Spain	70	NA	NA	NA	NA	NA	82	NA	NA	NA	NA	NA
AB-REOC and BV-OECO (2019)	1 756 Belgian residents (aged 16-80)	Belgium	NA	NA	58	NA	NA	NA	NA	NA	NA	NA	NA	NA
COFREET (2023)	1 000 French residents (aged 18-65)	France	NA	NA	NA	NA	NA	67	NA	NA	NA	NA	65	17

Source: own production based on references indicated in the first column of the table

On a different note, in the investigation conducted by Wakes et al. in 2020, it was observed that the price of the T-shirt had an impact on individuals' attitudes towards care labels: a lower purchase price correlated with a lower likelihood of adhering to care instructions. For T-shirts priced above the lowest tier, over 40% of participants followed care instructions before cleaning or after use. Notably, purchasers of higher-priced T-shirts exhibited a greater tendency to read care labels at the point of sale compared to those who bought lower-priced T-shirts (Wakes et al., 2020a). The Wakes et al., (2020) study was conducted in New Zealand, among females from 18–25 years.

The extent to which users associate a care label symbol to its corresponding care instruction is collected in **Table 91**. Survey evidence indicates that there seems to be a consistent understanding across symbols among participants in both, the GINETEX (2017) and AB-REOC and BV-OECO (2019) surveys. There is a demonstrated high level of understanding for the ironing symbol, with almost all respondents in both surveys correctly associating it with the care instruction. The washing symbols also show a strong association, with 91% in GINETEX (2017) and 89% in AB-REOC and BV-OECO (2019) correctly connecting the symbol with the care instruction.

Table 91. Summary of surveys indicating the extent to which users associate a care label symbol to its corresponding care instruction.

Publication	Sample details and characteristics of the study	Country	% of users who correctly associate the care label symbol with the care instruction				
			Ironing symbol	Washing symbols	Bleaching symbol	Drying symbol	Professional cleaning symbol
GINETEX (2017)	6000 participants (aged 18-65)	Germany, United Kingdom, France, Italy, the Czech Republic and Sweden	97	91	33	32	21
AB-REOC and BV-OECO (2019)	1756 Belgian residents aged between 16 and 80	Belgium	98	89	28	24	15

Source: own production based on references indicated in the first column of the table

However, there is a notable decrease in the correct interpretation and understanding of the bleaching, drying and professional cleaning symbols and their respective care instructions among the participants of the two surveys. This suggests that users may find the bleaching, drying and professional cleaning symbols less intuitive compared to other symbols.

While both surveys provide insights into user associations, the GINETEX (2017) survey encompasses a broader international scope, involving participants from Germany, the United Kingdom, France, Italy, the Czech Republic, and Sweden. In contrast, AB-REOC and BV-OECO (2019) focuses specifically on Belgian residents. Despite this difference, the overall patterns in user understanding of care label symbols are comparable between the two surveys.

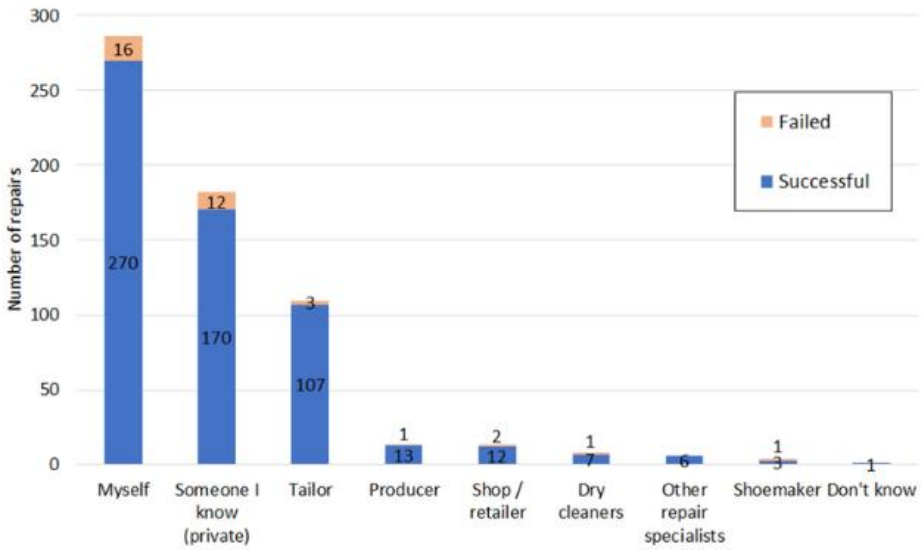
10.6.2.9 Repairing

Consumers nowadays have a quite transitory relationship with their apparel as they are often disposed before they are worn out or broken. Reasons for this may be related to overconsumption and the fact that it is easier and more convenient to replace the unwanted apparel for certain new items rather than repair or modify them (Harris et al., 2016). The degree of emotional product-person attachment also influences whether users are willing to engage in repairing certain apparel items (Terzioğlu, 2021; EEA, 2022a). The product-person attachment is described in Section 10.6.3.3.

Consumers can repair their apparel by themselves in private households or at a professional repair shop (EEA, 2022a). The apparel repair industry appears to be predominantly comprised of independent repairers operating as small businesses, often with the owner and a few employees, if any. However, there is a lack of detailed information about the characteristics of this business sector, as European statistical data (Eurostat) on the professional repair of textiles is not available separately (EEA, 2022a).

Figure 56 reflects that most of the apparel repairs are carried by the user followed closely by somebody the user knows, e.g. family member. Bringing the apparel item to repair to a tailor comes as third option. It shall be noted that most repairs are successful in the three repair options users usually opt for.

Figure 56. Number of successful and failed repairs done by different actors (total 625 repairs)



Source: Laitala et al., 2021

A survey in Ireland discovered that 45% of consumers pay to have their apparel repaired while 34% ask family or friends to help them with the repairs. The same survey revealed that around 48% of users would like to repair apparel but do not have the equipment to do it or do not know how to do it. Only 23% of people agree they are not interested in repairing. Interestingly, this behaviour tends to be more common among consumers who purchase apparel often and among young men (EPA Circular Economy Programme and B&A, 2021). Moreover, a survey among 200 Dutch consumers showed that consumers are more likely to help their loved ones with apparel repairs rather than other acquaintances and unknown people (milieu centraal, 2021).

69% of the over 1 000 respondents to a survey in Spain confirm to know where to bring their apparel and shoes for repair (CECU and Amigos de la Tierra, 2022). 67.4% of them add that, if apparel had a label indicating to what extent the product can be repaired, they would use this as a criterion to decide whether to purchase or not the apparel (CECU and Amigos de la Tierra, 2022). Additionally, 52% of 2 000 surveyed consumers declare repairing or bringing their apparel to repair (CECU, 2023).

Furthermore, according to Terzioğlu, (2021), individuals typically weigh the costs and benefits before deciding whether to repair an item. For example, how easy is to find a repair solution compared to the price of an apparel item influences the user's decision to engage in repairing activities. As a result, the consumer's trust in commercial repair shops could be promoted by improving the transparency of prices, quality and repair time for example. This would help overcoming the barriers affecting the repair of apparel (EEA, 2022a).

Repair skills for apparel are ceasing to exist. Recent research on sewing skills shows that while different sewing instructions are readily available on the Internet, the main incentive for sewing is trust in one's own skills. A study focused on textile repair in the United Kingdom found that citizen's lack the skills needed to repair compared to previous generations. According to researchers, the decrease in skills is due to the fact that they are no longer taught in schools and the lack of time and equipment in everyday life (Finnish Ministry of the Environment, 2023a).

Laitala and Boks 2012 indicate that users decide to mend their apparel depending on whether they have sewing skills. A relevant number of consumers report to be able to sew a button on (**Table 93**), and have done so in the past year (**Table 92**). On the contrary, replacing the zipper is highlighted as a demanding repair which can be seen by the low rate of users who replaced it in the past year (**Table 92**) and who are confident about doing such work (**Table 93**). If the zipper breaks, the apparel is disposed unless a strong person-product attachment exists (Laitala and Boks, 2012). Nonetheless, the users who still may be able to adequately repair apparel may not feel the need to do so anymore (Harris et al., 2016). Moreover, a survey discovered an attitude-behaviour gap among 2 500 users as 58% of them declared to find apparel repair as important while only 23% of them engaged in repair activities (Heiny and Schneide, 2021). This is largely due to the reason indicated above: for some consumers it is more convenient and easier to replace undesired apparel with new items rather than opting for repair or modification (Harris et al., 2016).

Table 92. Summary of surveys that provide the percentage of respondents who have made repairs to their apparel in the past year.

Publication	Sample details and characteristics of the study	Country	% of respondents who have made different repairs to their apparel in the past year						
			Has sewn a button	Fixed seams	Patched apparel	Repaired holes or worn areas in the apparel (darning)	Lengthen or shorten pants (take a hem up or down)	Adjusted size/fit	Changed zipper
Laitala and Boks (2012)	Survey year: 2010 268 participants (aged 15-60+) Survey selection is female dominated (83%)	Norway	73	55	31	27	26	16	10
Laitala and Boks (2012)	Survey year: 2011 1 124 participants (aged 18-60+) Gender of participants equally represented	Norway	64	52	34	NA	NA	NA	NA
Laitala and Klepp (2018)	Survey year: 2011 1 001 participants (aged 18-60+) Gender of participants equally represented	Norway	51	41	NA	25	NA	NA	NA

Source: own production based on references indicated in the first column of the table

The data collected regarding the respondents who have made repairs to their apparel in the past year (**Table 92**) refers to their own willingness to repair and is not always correlated with the user repairing capabilities.

The data collected in **Table 93** regarding how confident users are to repair their apparel is related to their own willingness to repair and is not always correlated with the user repairing capabilities or skills. Additionally, a summary of surveys that showcase how confident users are to mending their apparel depending on the type of repair needed may be found in **Table 94**.

Table 93. Summary of surveys that showcase how confident users are to mending their apparel depending on the type of repair needed.

Publication	Sample details and characteristics of the study	Country	% of respondents who are confident undertaking apparel repairs					
			Sew a button on	Repair holes or worn areas in the	Lengthen or shorten pants (take a	Adjust size/fit	Changed zipper	Stain removal

				apparel (darning)	hem up or down)			
WRAP (2019)	Two waves of online surveys: Wave 1 was conducted in November 2016 and Wave 2 in June 2019. The sample size in 2016 was 1 000 per country. In 2019 the samples were as follows: Denmark 1 046; Germany 1 113; The Netherlands; 1 117 and Italy 1 226	Denmark (DK), Germany (DE), The Netherlands (NL) and Italy (IT)	DK 75 DE 75 NL 70 IT 69	DK 52 DE 46 NL 40 IT 48	DK 46 DE 30 NL 35 IT 32	DK 27 DE 17 NL 25 IT 36	DK 25 DE 25 NL 25 IT 29	DK 72 DE 69 NL 71 IT 61

Source: own production based on references indicated in the first column of the table

Table 94. Summary of surveys that showcase overall declared frequency of apparel repairs.

Publication	Sample details and characteristics of the study	Country	Overall declared frequency of apparel repairs without specifying the type of repair				
			% of users who have repaired apparel in the past 6 months	% of users who have repaired apparel in the past year	% of users who repair apparel often	% of users who repair apparel sometimes	% of users who never mended apparel
Laitala and Boks (2012)	268 participants (aged 15-60+) Survey selection is female dominated (83%)	Norway	NA	NA	35	51	14
EPA Circular Economy Programme and B&A (2021)	Survey year: 2011 1 000 participants (aged +16) Gender of participants equally represented	Ireland	NA	43	NA	NA	NA
CECU and Amigos de la Tierra (2022)	1 011 participants (+25)	Spain	67.3* (the question included footwear too)	NA	NA	NA	NA

Source: own production based on references indicated in the first column of the table

The aptitude to repair is the same or very similar disregarding the country. Denmark and German consistently rank higher in repair confidence across various activities, while the Netherlands and Italy generally exhibit lower but still varied confidence levels. These variations may stem from cultural, educational, or societal factors influencing attitudes toward apparel repairs in each country. However, all countries seem to have high level of confidence in sewing a button and repairing holes or worn areas in the apparel.

Finally, there is also research such as Laitala et al., (2023) highlighting the importance on the need for clear guidelines defining what constitutes unacceptable wear and tear versus normal use, and distinguishing between commercial warranties and legal rights. Consumer's complaints on defective or faulty apparel items that fail to meet minimum lifespan requirements, serve as a valuable source of feedback for retailers to understand product performance especially with regards to durability.

The apparel's general quality, and consequently its value, influences the consumer's decision on whether to consider it worthwhile to invest time and money in repairing. Hence, the importance of a good design that may also contribute to strengthen the emotional product-person attachment with the apparel.

10.6.2.10 The storage of apparel

The storage of apparel can be done for active or inactive apparel. Storing active apparel would be the action of placing inside wardrobes, for instance, all those apparel items that an individual wears regularly. In other words, the apparel that users move between use and storage frequently (Cluver, 2008a). Inactive apparel items constitute the apparel kept at home without being used for an undetermined time. These are represented by the over 30% of apparel stored in Europeans closets that have not been used for a year or even more time (European Parliamentary Research Service, 2019).

Inactive apparel may comprise apparel that do not fit. In fact, this seems to be generally the case among consumers (Bye and McKinney, 2007). Therefore, why would consumers store items that are not able to use due to their body size? The wishful thinking that the apparel will eventually fit again may trigger the storing of these apparel. In certain cases, this practice may also help some consumers to monitor their weight. This temporary storage of inactive apparel, can be understood as keeping apparel that are not worn for an unknown time period before doing something different with them. Temporary storage may be done while the users are considering the best way to dispose the apparel, when waiting for the apparel to be back in fashion, to repair in the case of wear and tear or just because they want to make sure there was no longer a way to make use of the apparel (Cluver, 2008a). Interestingly enough is the fact that basic apparel that were once very necessary for the user, even though no longer in fashion and/or suffered wear and tear, were stored until new apparel were purchased to substitute them (Cluver, 2008a).

Bye and McKinney, (2007) carried out surveys in which respondents indicated that inactive apparel could be linked to the past personality of the owner who no longer wants to be attached to, hence the reason not to wear them, but still feels like a part of their lives (Guy et al., 2001; Bye and McKinney, 2007). The respondents indicated that they hold onto apparel that were no longer used because they allowed them to recall important people and past experiences they had while wearing them (sentimental value). In other cases, the consumer keeps apparel that were purchased because of a wrong choice just to justify the price paid for them. Finally, some consumers keep certain apparel because a perceived aesthetic value attached to them. On a different note, around 13% of 350 000 Vinted users who are engaged in the resale of apparel items report to store in the closet the items that they do not manage to sell in the online platform Vinted, without the intention of using them (Vinted, 2021). In any case, it is important to note that prolonged inactive storage can eventually cause consumers to discard their apparel due to extended periods of non-use (Accenture, 2022).

All in all, as indicated by Maldini et al., (2019) wardrobes can be seen as a "pull" system, where new apparel items are added only when unsatisfactory ones are replaced. Thus, delaying disposal should delay purchases, decreasing overall demand. However, in practice, wardrobes integrate new apparel items for various reasons, following unpredictable patterns. New items are frequently purchased without considering existing ones, pushing older apparel to the back as more attractive options come in. This behaviour may eventually result in disposing the apparel due to lack of space for new items (Accenture, 2022).

It can be concluded that the storage of apparel items, whether temporary or not, seem to be strongly linked to a person-product attachment. Additionally, it should not be not assumed that longer apparel lifespans and delayed disposal always yield positive environmental impacts given the unpredictability of the users 'purchase and storage behaviour, as described above.

10.6.3 User behaviour regarding the disposal of apparel

10.6.3.1 Reasons for the disposal of apparel

Disposal of apparel happens when a user transfers its ownership to another person or entity (Cluver, 2008a).

Henninger et al., (2021) investigated 154 papers of which 32 touched upon the user behaviour related to the disposal of apparel items. Moreover, most of the studies were published after 2015 which showcases that it is a topic that is recently gaining more attention than in the past (Henninger et al., 2021).

The intrinsic or physical durability can be defined as the ability of a product to withstand the tear and wear of time without its functionality and aesthetics being compromised. This is envisaged during the design phase of the product when the selection of materials, modelling, etc. focused on improving the robustness of the article (Alliance of Commerce and Deloitte, 2022).

The intrinsic durability of apparel may be lost due to abrasion, colour changes, broken zipper, soiling that cannot get cleaned, etc. (Laitala and Boks, 2012). However, Laitala and Boks (2012) reported that the examination of disposed apparel showed that there is a great difference in opinions regarding when the apparel is too worn out to be used. Some users did not mind pilling or small holes, whereas for others, these changes indicated the apparel was worn out and were important disposal reasons.

A composition analysis involving 391 composition samples from Swedish municipalities between 2012 and 2014 revealed that 59% of apparel was in a condition suitable for reuse (SMED, 2016).

However, a survey run by Cooper and Claxon in 2022 on 1 476 disposed apparel items unveiled various types of physical issues. The predominant problems were associated with colour fading, particularly in jersey and woven fabrics, and pilling in knitwear and jersey items. Fabric deterioration, characterized by fraying, especially around hems, as well as wear around the crotch of trousers and jeans, and accidental damage such as stains, tears, and rips, were also prevalent. Other forms of failure included the loss of dimensional stability, logo malfunction, discoloration, notably in the collar area of white shirts, holes in seams (including jacket linings), and trim failure. The percentages are calculated based on all apparel in the sample. Notably, 69% of all apparel exhibited either a colour-related or logo problem, while 75% experienced fabric-related issues, indicating that many apparel had multiple problems (Cooper and Claxton, 2022b). The physical failures found in disposed apparel are indicated in **Table 95**.

Table 95. Recorded problems in apparel (% of all apparel items)

Type of Failure	%
Colour fading	53
Fabric breakdown	29
Accidental damage	29
Loss of dimensional stability	20
Logo failure	16
Discolouration	15
Hole(s) in seams	14
Trim failure	8

Source: Cooper and Claxton (2022).

The individual characteristics of the consumers, their habits, demographic context, product traits and quality seem to influence the user's decision to get rid of a product (Cluver, 2008; Goworek et al., 2012, as cited in Harris et al., 2016; Sandin et al., 2019).

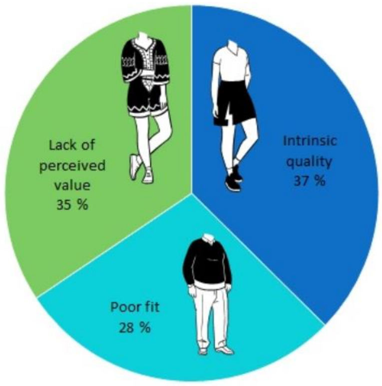
The perceived quality of a product is decisive when consumers decide to get rid of a piece of apparel, either because it seems to be worn-out or no longer functional (Aakko and Niinimäki, 2022). In fact, early disposal of apparel may be also accentuated by the loss of the symbolic perceived value of apparel for the consumer (Gwozdz et al., 2017a). Moreover, certain studies document that low quality, may trigger an early disposal of apparel (Piippo et al., 2022a). Additionally, the fact that some consumers often want to own new apparel shortens their time in use too (Klepp and Grimstad, 2001; Piippo et al., 2022a). This is the case for 45% of 982 Italian consumers who indicated that they dispose their apparel items because of they are old (YouGov, 2019). Similarly, 7% of 1 000 Polish consumers indicated to get rid of apparel items as they lacked sufficient space for new ones (Accenture, 2022).

The two most common reasons for the disposal of apparel for both, female and male German participants to a survey were material defects due to wear and tear and an inappropriate size. For German men, the third most common reason to dispose apparel is that it had fallen out of shape. This reason was also mentioned by the female respondents, but it was more often stated that the apparel simply was not liked anymore. In this regard, the female respondents from the youth group stand out. The percentage of those who disposed apparel because they no longer liked it is significantly larger in this social segment than among female respondents from other social environments and almost twice as much compared to the male respondents from the same social group. Reasons related to taste, fashion or personal style are more commonly mentioned among the young people (Kleinhückelkotten et al., 2018a).

The decision to dispose apparel, and how frequently it happens, is also influenced by the price of the apparel. There is evidence that consumers see higher value in more pricey apparel items (Morgan and Birtwistle, 2009b; Joy et al., 2012b). This means consumers tend to dispose more frequently the cheapest apparel as they understand that the value proposition in terms of durability and quality is lower (Lewis, 2015).

Across all countries reported in **Table 96**, a significant percentage of participants cite intrinsic quality as a primary reason for the disposal of apparel, indicating a shared concern for durability and material integrity. Additionally, fit problems are a consistent factor influencing apparel disposal, suggesting that comfort and suitability play a universal role in user behaviour. Participants in most countries mention perceived value, indicating that subjective judgments, such as taste-related unsuitability, impact their decision to dispose apparel. These results are in line with the ones presented in the Laitala and Klepp, (2022) review of 17 consumer studies involving around 20 000 participants in which the most common reasons for apparel disposal were identified as intrinsic quality, perceived value and fit issues (**Figure 57**).

Figure 57. Main reasons for disposal of apparel



Source: Laitala and Klepp, (2022).

Finally, changing fashion trends contribute to apparel disposal across various countries, emphasizing the influence of style preferences on user behaviour.

The overall implication of the data reported above is that the reasons for the disposal of apparel exhibit a complex interplay of individual factors. Quality and fit are universal concerns, suggesting a global emphasis on durable and well-fitting apparel. Cultural differences emerge in the importance placed on perceived value, taste-related aspects, situational reasons (e.g lack of space for new apparel), and responsiveness to fashion changes.

While each study contributes valuable insights, the combined dataset offers a more comprehensive understanding of global apparel disposal trends. Variations in sample characteristics and the scope of data collection highlight the importance of considering multiple studies for a holistic perspective.

Table 96. Summary of apparel disposal reasons in recent consumer studies with high number of participants.

Publication	Sample details and characteristics of the study	Country	Main reasons for the disposal (expressed in % of respondents)				
			Intrinsic quality (e.g worn-out items)	Fit issues	Perceived value (e.g. taste-related unsuitability)	Fashion changes	Other (e.g. Situational reasons, functional shortcomings)
Greenpeace, (2015)	1 011 participants	Germany	92	72	64	40	NA
Ungerth and Carlsson, (2011)	1 014 participants (aged 16-74)	Sweden	60	9	21	NA	4
Laitala and Boks, (2012))	546 participants (adult population, age groups not defined) 77% of the subjects were women and the 25-39 age group is overrepresented in comparison to the rest age groups	Norway	49	19	11	NA	19
Laitala and Klepp (2020)	1 111 participants (aged 18-65) Women and men are equally represented in all countries	China, Germany, Japan, United Kingdom, and USA	44	13	35	NA	9
WRAP (2017b)	2 058 participants	United Kingdom	18	42	33	NA	NA
Lang, Armstrong, and Brannon (2013)	555 participants	USA	30	31	39	NA	NA
Morell-Delgado et al., (2024)	1 439 participants	Spain	NA	44	21.5	NA	2.5
YouGov, (2019)	982 participants	Italy	60	47	16	12	2
Accenture, (2022)	1 000 participants	Poland	38	21	7	6	21

Source: own production based on references indicated in the first column of the table

10.6.3.2 Disposal channels for apparel

By 1 January 2025, mandatory separate collection of textiles will be set in the EU Member States as required by Article 11(1) of the Waste Framework Directive. Additionally, the Commission has proposed the establishment of mandatory extended producer responsibility (EPR) schemes designed to streamline and put in place collection, sorting, reuse, preparation for reuse, and recycling infrastructure required to address the material collected once the separate collection obligation takes effect[207]. Moreover, the on-going review of the Textile Labelling Regulation is exploring whether to introduce specifications for physical and digital labelling of textiles, including end-of-life disposal instructions and other circularity parameters based on requirements under the proposed Regulation on eco-design for sustainable products and on the implementation of EPR schemes across Member States.

The person-product type of attachment plays a key role in how apparel may be disposed of. If there are positive associations with a piece of apparel, this might be gifted to relatives or friends while if there is a negative association the apparel may end up being donated, swapped or just disposed in the general waste bin (Joung and Park-Poaps, 2013; Lewis, 2015). Throwing away (usable) apparel is associated with bad conscience and moral aspects hence they are given to friends, family and charities as the preferred way to dispose of the apparel (Klepp and Grimstad, 2001). Furthermore, selling apparel is among the alternative methods consumers are using nowadays when they wish to get rid of apparel they no longer wear. In fact, 21% of 11 483 European consumers sell their apparel online, and 59% of those do so more than once a year (YouGov, 2021).

The surveys in **Table 97** show the most common disposal trends in different countries. In both surveys, donating apparel to charity emerges as a popular choice among participants, indicating a shared inclination towards contributing to charitable causes through apparel. Also, both surveys highlight the significance of giving apparel to family and friends as a prevalent disposal method, suggesting a common practice of sharing apparel within one's social network.

By and large, the studies reported in **Table 97** provide valuable insights into apparel disposal practices. While there are some differences in terms of the represented countries, the similarities in identified disposal methods across the survey results suggest common trends in how individuals choose to handle apparel they no longer need or use. The prominence of charitable donations and sharing within social circles appear to be consistent behaviours, transcending geographical and cultural boundaries to some extent. The survey run by Vinted slightly differs, as participants were asked what would they do with the apparel items that they did not manage to sell in the online platform Vinted.

Table 97. Surveys responses on main types of alternative apparel disposal

Publication	Sample and characteristics of the study	Country	Main types of alternative apparel disposal (expressed in % of respondents)			
			Donate to charity	Give to family/friends[208]	Used as cleaning cloth[208]	Discarded in the general waste bin at home
Koukouvinos (2012)	201 participants (aged 18-35) 75% of the subjects were women	Greece	51	59	45	NA
Laitala and Boks (2012)	546 participants (adult population, age groups not defined)	Norway	36	12	8	27
Vinted (2021)	350 000 participants	Belgium, Germany, Spain, France, Italy,	19	19	NA	Less than 1

[207] Proposal for a Directive of the European Parliament and of the Council amending Directive 2008/98/EC on waste (COM/2023/420 final). Available here: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52023PC0420

[208] The quality of these products is unknown.

		The Netherlands, Poland and United Kingdom				
YouGov, (2021)	11 483 participants	France, Germany, Austria, Denmark, Finland, Italy, Norway, Spain, Sweden, Switzerland	69	34	NA	13
Morell-Delgado et al., (2024)	1 469 participants (aged 16 to more than 65) 68.8% of the subjects were women	Spain (survey sample focused on Catalonia Autonomous Community)	26	48.9	32.5	7.8

Source: own production based on references indicated in the first column of the table

Finally, it is also important to note that the primary finding of the European Commission's Directorate General Joint Research Centre (2021) study on the quality of clothing found in residual waste is the existence of a correlation between the proportion of separately collected clothing and the average quality and value of clothing discarded in residual waste. According to this study, this correlation is partly due to households making discerning decisions based on the perceived monetary value of apparel, determining which items are suitable for donation or resale for reuse and which have minimal potential for reuse. This idea is supported by a study conducted in Denmark in 2018 (Watson et al., 2018), which strengthens this theory. The study suggests that the 42 000 tonnes of clothing disposed of in Danish residual waste for incineration in 2017 had an estimated value of 12-15 million euros before disposal. In contrast, the 36 000 tonnes of clothing separately collected were sold on reuse markets for an estimated 65 million euros, indicating a value per tonne four to five times higher. As a result, it appears to be commonly understood that textiles with the least potential for re-use are more abundant in the textile portion of mixed municipal waste, but the limited existing research presents inconclusive results according to Huygens et al., 2023. Additionally, an analysis of 38 samples from across five Welsh local authorities emphasises the correlation between the method of textile collection and the reusability of the collected textiles. For instance, in Wales, the reusability rate of textiles collected via container stands at 75.3%, compared to 54.6% for those gathered through door-to-door collection (WRAP Cymru, 2022). Last but not least, findings from Morell-Delgado et al., (2024) indicate that apparel perceived to be in better condition are typically disposed of in street containers for textile waste (78%), with minimal disposal in mixed-fraction containers (3%). Conversely, when apparel are in worse condition, citizens exhibit uncertainty regarding disposal methods, with approximately 30% disposing of them in specialized containers and another 30% opting for mixed-fraction containers. Therefore, the population's decision regarding the disposal destination of unwanted apparel seems to be influenced by the perception of the quality the item may still possess by the consumer (Morell-Delgado et al., 2024).

10.6.3.3 Person-product attachment

The emotional attachment formed between the apparel and the consumer is generally referred to as 'person–product attachment'. This type of connection between a textile item and the user has an influence on how long consumers own a textile and how often they make use of it. The person-product attachment is usually embedded in the term 'emotional durability' which goes beyond just functionality. The Ellen MacArthur Foundation report (Ellen MacArthur Foundation, 2021) defines emotional durability as: 'the product's relevance and desirability to a user, or multiple users, over time'. A product that holds emotional durability tells a compelling narrative, creates history with its users through bonding and aligns with their values.

The ownership of apparel could be 'active' (i.e. use on a daily basis or several times a week), 'seldom' (use several times a year) or 'inactive or in storage' (very rarely or never use the apparel) (Niinimäki and Armstrong, 2013).

Niinimäki and Armstrong (2013) carried out a survey with over 400 participants from United States of America (45.1% were men). The sample ranged in age from 18 to 67: 18–24 (7.5%), 25–34 (27.4%), 35–44 (23.5%), 45– 60 (28.1%), and over 60 (13.5%), most of whom were Caucasian/white (88.0%) and had completed a college degree or higher (66.1%). **Table 98** collects the elements that generate person-product attachment listed according to the number of times each of them were mentioned by the respondents to the questionnaire.

Table 98. Elements that generate person-product attachment (Niinimäki and Armstrong, 2013).

Order of relevance	Element	Description (in order of most referenced by users)
1	Functionality	Comfortable Good fit Multi-function Functional (good for sports and hide body deformation) Easy to match Easy to put on
2	Memory	Memories (youth and childhood) Received from special person Family ties Remind of special person Represent membership to a group (e.g. team/band)
3	Emotional satisfaction	Look/feel good in it Receive compliments wearing the piece of apparel Love the brand
4	Design and style	Good design (e.g. cool looking) In style
5	Fabric and material	Nice colour Pleasant to touch (silky and soft) Fabric aesthetic (not thick, light weight, and sparky) Flexible (not stretched)
6	Personal values	Uniqueness Feel relaxed in it
7	Quality	Durable High quality in manufacturing High quality in material
8	Effort invested	Reward for self Hand made
9	Financial value	Price (good deal and very expensive)

Source: Niinimäki and Armstrong (2013).

The findings showed that apparel that were purchased brand-new turned out to have the highest emotional attachment for the respondents. This is largely explained by the fact that there is a widespread idea of 'new' apparel as something that has a value in itself. New apparel are clean canvas, both in the sense that they are physically clean, i.e. free of spots, presentable and hygienic, but it is also 'mental clean' in the sense that it is free from stories attached to the apparel in question (Forbrugerrådet Tænk, 2022).

Moreover, it is the frequently used regular T-shirts, dresses and jeans the ones respondents indicated to be more meaningful to them. Functionality, a special memory, emotional satisfaction were the most repeated attributes by the respondents that help promoting emotional attachment to apparel.

The value found in new apparel is a major barrier to reuse and is also reflected in the fact that apparel are used more when they are brand new than when they have several years. In fact, apparel purchased as second hand are used 30 per cent less than those purchased as brand new (Forbrugerrådet Tænk, 2022). On top of that, it should be noted that reuse may increase the possession span of the apparel, but does not necessarily increase the use of the apparel (Forbrugerrådet Tænk 2022; Laitala and Klepp 2021).

The durability and active use of apparel depends on the robustness and longevity of its materials but also on the changing trends, needs and wishes of consumers. Emotional durability remains a forward-looking issue, which is difficult to measure because it is intrinsically linked to consumer perceptions and brand representations. Its understanding is based on social sciences concepts and there is no evaluation methodology that has been fully tested (Alliance of Commerce and Deloitte, 2022).

However, apparel may have a certain initial physical or functional lifetime that may be extended if a strong product-user relationship is promoted by retailers. For instance, retailers can maximise the value of the apparel they sold by ensuring that the design meets real long-term needs and that incorporates a particular added value which prevents the user from an early disposal of the textile product (Niinimäki and Armstrong, 2013; Alliance of Commerce and Deloitte, 2022). The aim would be to create articles that can be adapted to the different stages of consumer life, integrating more modularity (multi-seasonality, reversibility, extensibility, etc.) and facilitating alterations, or offering timeless products whose colours and shapes are resistant to changes in trends. To enhance the perceived value of their articles, brands can rely on personalisation levers or marketing methods such as co-creation, tailor-made manufacturing or limited series, which make it possible to create an emotional attachment of the customer to their apparel, while limiting promotions and the continuous inflow of novelties (Alliance of Commerce and Deloitte, 2022).

Bottom line is the role of the quality of the apparel. Laitala et al., (2021) asked a number of consumers what aspects would incentivise them to wear their apparel longer. The most repeated answer both for men and women was if the apparel were of better quality. The same was concluded in OVAM (2021). Along the same lines, 92% of 101 visitors to a dress exchange at Greenpeace Hamburg declared that they would wear apparel for more than a year if they were of good quality. 89% of participants to the same survey indicated that if apparel maintained their shape and colour for a longer period would also incentivise them to wear apparel for longer. The third most commented reason for wearing apparel for longer was if there was a bonding with the apparel (product-person attachment) (Kleinhückelkotten et al., 2019).

All in all, the consumers deal with objects in different ways. This is the main reason why the product-user textile attachment is quite subjective and difficult to draw conclusions from. The designers may play an important role in stimulating the length of ownership and use of apparel when choosing the fabrics, the type of confectionary work and durable design. Research has referred this design as ´emotional durable design´ which emphasizes creating enduring experiences over new products. The primary challenge is to develop something that captivates customers, encouraging them to cherish it rather than succumb to the desire for novelty (Chapman 2015 as cited in Vanacker et al., 2022). Through each design decision, the long-term customer satisfaction may be increased, resulting in a higher emotional user-product attachment. Nonetheless, there is also research indicating that strategies towards the promotion on person-product attachment showed that their effect had not been empirically validated (Maldini and Balkenende, 2017).

10.6.3.4 Returns of apparel

Convenience seem to be the main reason for buying online as reflected by half of the usual online customers in the survey run by AK Wienn and Greenpeace (2023). However, if the consumer lacks the time to return a parcel to a retailer with a non-flexible returns policy, he or she may be more selective when choosing what to buy to avoid having to keep the purchased items because the time to return the items is up. This may be one of the reasons why longer periods for free returning allow for ordering more apparel as the customer has a more relaxed approach to the potential returns. At the same time, it can happen that for some consumers returning online buy-outs is deemed a barrier because it becomes cumbersome to send it back, despite the type of return policy that the retailer may offer. This means that apparel that do not fit, or apparel that are not up to the customer's preference, end up stored in the cabinet (Forbrugerrådet Tænk, 2022).

A study from the European Environment Agency retrieved that casual dresses and jackets have the highest return rate followed closely by jeans and vests (EEA, 2024). Interestingly, the same EEA study found that expensive products have more probability of being returned. An explanation for this behaviour has not been found.

When it comes to demographics, it is not widely analysed in the scientific literature whether it is females or males who are more prompt to return apparel. A study pinpointed that women return more online purchases than men (AK Wienn and Greenpeace, 2023a). This seems to be supported by the fact that womenswear is the winner category of apparel when it comes to returns (British Fashion Council's Institute of Positive and Roland Berger, 2023). Moreover, young consumers are more likely to order online and return apparel more frequently as they tend to buy more apparel and order several sizes compared to other age groups (AK Wienn and Greenpeace, 2023a).

According to the results of the Foresight Factory survey fit issues is the first reason for returns by consumers (Foresight Factory, 2021; Zimmermann et al., 2021) .The second most popular reason to return apparel is taste-related unsuitability of an item and/or its product details for the consumer. In this category, the share of total returns in Zimmermann et al. (2021) corresponds to the dislike of the shape or cut of the apparel (16%), a dislike for the material (8%) and colour or pattern (6%).

Online shopping often leads to mis-buying (Forbrugerrådet Tænk, 2022).The main reasons found in the literature for returning apparel are problems fitting the item and the dislike of the apparel by the consumer. These two reasons are followed almost equally by lack of quality of the apparel and receiving a faulty item. A survey run by Foresight Factory in 2021 with over 20 000 respondents, reports the same main reasons for returning apparel by consumers; 38% of them reported that the items did not fit well while 15% of respondents indicated that the apparel did not suit them. Quality was not enough for 14% of the survey participants and 13% of them received faulty items (Foresight Factory, 2021).

'Bracketing' occurs when consumers purchase several identical or similar items, have them shipped, keep one, and return the others (NRF and APPRISS RETAIL, 2023). It is interesting to see that in the study from Zimmermann 2021, bracketing, is not among the main reasons for returning goods (Zimmermann et al., 2021). A similar behaviour is reported by the survey from Foresight Factory, in which only 6 % of the respondents explicitly indicated that they bought multiple sizes but did not intend to keep all the ordered items. The same percentage of users reported that they purchased multiple styles without the intention to keep everything (Foresight Factory 2021). Another reported behaviour linked returns is what is known as 'wardrobing'. This happens when a consumer purchases an expensive item, wears it, and then returns it (NRF and APPRISS RETAIL, 2023). A survey focusing on retailers, highlighted that 48.8 % of them experienced wardrobing (NRF and APPRISS RETAIL, 2023).. No data was found from consumers acknowledging this practice.

The fitting issues that usually come with ordering apparel online are often linked to the inability of consumers to interpret correctly the sizing scales offered in some online sites but there may be also cases of inconsistent and not correct sizing (Vladimirova et al., 2022).

Products with perceived low quality, less durability and the remorse of the consumer due to buying apparel are also highlighted as potential reasons for returning apparel (Bernon et al., 2011).

A lot of consumers have a look at the return policies before purchasing items online (Asdecker and Sucky, 2019; Makov, 2023). In fact, 70% of consumers indicate that whether they repeat a purchase on a site or not, depends on their return experience (Asdecker and Sucky, 2019). Nonetheless, it seems that most users assume that the returned items are always put back into sale when this is not necessarily the case due to the complex reverse logistics of the supply chain (Makov, 2023).

In summary, with the data available, it is not possible to clearly distinguish between the behaviour regarding apparel returns of men and women. Nonetheless, some studies stress that younger generations return more items given their tendency to buy apparel more often. The influence different demographic aspects play when returning products have not been possible to analyse.

Reasons for returning items purchased online tend to have a common root: the difficulties users have choosing the appropriate size and the right product based on the online descriptions. Furthermore, studies exploring the reasons for returning products at physical stores have not been found. This may be because online returns are comparatively much higher than those at physical stores. The impossibility for consumers to try the apparel on the spot and have a tactile experience contributes to this difference in number of returns between the online and physical store shopping.

Table 99. Reasons for returning apparel to e-commerce

Publication	Sample details and characteristics of the study	Country	Reason for returning (expressed in % of respondents)				
			Fit issues	Taste-related unsuitability	Insufficient perceived quality	Faulty items	Change of mind
Foresight Factory (2021)	20 000 participants	United Kingdom, United States, Canada, Australia, France, Germany, Italy, Netherland, Norway, Japan, Saudi Arabia and UAE	38	15	14	13	8

Source: own production based on references indicated in the first column of the table

10.7 Supporting information about environmental labels and current EU Ecolabel criteria

10.7.1 Figures of EU Ecolabel for textile products

Figure 58. Evolution of licences and products awarded with EU Ecolabel for textile products

Source: own elaboration based on EU Ecolabel facts and figures ([209])

Table 100. Figures of EU Ecolabel for textile products in September 2023

Licences			Products		
Competent body	**Number**	**Percentage compared to the total number (%)**	**Competent body**	**Number**	**Percentage compared to the total number (%)**
Denmark	24	28	Portugal	3854	42
Italy	18	21	Italy	3359	36
Norway	11	13	Denmark	1338	14
Austria	6	7	Sweden	172	2
Germany	5	6	Netherlands	164	2
Netherlands	5	6	Norway	161	2
Sweden	5	6	Poland	89	1
Czechia	3	3	Austria	50	1
Bulgaria	2	2	Czechia	31	0
Spain	2	2	Germany	14	0
Poland	2	2	Spain	9	0
Belgium	1	1	Bulgaria	7	0
Portugal	1	1	Belgium	1	0
Romania	1	1	Romania	1	0
Cyprus	0	0	Cyprus	0	0
Estonia	0	0	Estonia	0	0
Greece	0	0	Greece	0	0
Finland	0	0	Finland	0	0
France	0	0	France	0	0
Croatia	0	0	Croatia	0	0
Hungary	0	0	Hungary	0	0
Ireland	0	0	Ireland	0	0
Iceland	0	0	Iceland	0	0
Lithuania	0	0	Lithuania	0	0
Luxemburg	0	0	Luxemburg	0	0
Latvia	0	0	Latvia	0	0
Malta	0	0	Malta	0	0

[209] EU Ecolabel facts and figures. Available at [this link](). Last accessed on 12 January 2024.

Licences			Products		
Competent body	Number	Percentage compared to the total number (%)	Competent body	Number	Percentage compared to the total number (%)
Slovenia	0	0	Slovenia	0	0
Slovakia	0	0	Slovakia	0	0

The licence is awarded to a company by a competent body. A licence can include the award of the EU Ecolabel to one or more products. The expression 'number of products' does not refer to the number of items related to a specific product.

Source: Own elaboration after consultation with EU Ecolabel Helpdesk

10.7.2 Contributions to the initial questionnaire

Table 101. Type of respondents that contributed to the section on EU Ecolabel during the initial questionnaire

Type of respondent	Number	Percentage compared to the total (%)
University or research institute	2	6
Certified laboratory	0	0
Government (local, regional, or national)	6	18
Non-governmental organisation – Environment	2	6
Non-governmental organisation – Consumers	2	6
Industry – manufacturing	10	29
Industry – manufacturing - association	1	3
Industry – waste collection, sorting and treatment	0	0
Industry – waste collection, sorting and treatment - association	1	3
Distributer/Retailer	2	6
Distributer/Retailer association	1	3
Other	7	21
TOTAL	34	100

Among the respondents of the questionnaire, 7 declared to be licence holders of the EU Ecolabel for textile products, and 4 declared to be competent bodies of the EU Ecolabel.

Source: own elaboration

Table 102. Suggestions received by respondents to the initial questionnaire on EU ecolabel criteria 1-9, which focus on fibres

Criterion	Suggestions
Criterion 1. Cotton and other cellulosic seed fibres	- Make sure that only fibre-to-fibre from post-consumer waste is accepted; - Analyse the real traceability of fibres; - Investigate regenerative farming; - Focus only on organic cotton, disregarding the Integrated Pest Management cotton; - Establish a clear distinction between organic cotton and transitional organic cotton; - Investigate the implications of different minimum percentages of organic cotton; - Extend the analysis of restricted pesticides to recycled cotton; - Consider the expansion of the restricted pesticides following Blue Angel and Oeko-Tex 100.
Criterion 2. Flax and other blast fibres	- Investigate the possible use of the European Flax standards developed by the Alliance for the European Flax-Linen and Hemp; - Revise the COD and TOC limits as absolute values.
Criterion 3. Wool and other keratin fibres	- Assess the possible inclusion of organic fibres; - Consider the inclusion of biological husbandry control; - Specify that also recycled fibres should be checked for ectoparasiticide; - Ban mulesing; - Investigate the possible inclusion of specific certified wool, e.g. recycled, responsible and regenerated wool; - Question the ambition of pH, COD and temperature limit values.
Criterion 4. Acrylic	Limit the residual acrylonitrile in raw fibres to 1.5 mg/kg.
Criterion 5. Elastane	Investigate the possibility to accept 5% of elastane if the current production of elastane does not involve a large use of organotin.
Criterion 6. Polyamide	- Extend the traceability along the entire value chain of any feedstock material: recycled or virgin; - Investigate the effectiveness of verification methods if production occurs outside EU; - Include thresholds of CO_2 emissions.
Criterion 7. Polyester	- Remove the distinction between consumers and commercial or public sector customers; - Allow only fibre-to-fibre recycling; - Analyse the traceability of fibres: virgin and recycled. - Decrease the limit of antimony and accept its verification via a test.

Criterion	Suggestions
	- Investigate the feasibility of verification of VOC emissions.
Criterion 8. Polypropylene	Investigate the relevance of VOC emissions
Criterion 9. Man-made cellulose fibres	- Increase the percentage of fibre coming from sustainable forestry management; - Include the regenerated fibres based on the FAO principles on sustainable forestry management; - Align the ambition of this criterion to the latest EU Ecolabel criteria for absorbent hygiene products; - Investigate how to better support applicants and CBs to check compliance with criterion 9(a); - Consider potential updates of the criterion 9(a) due to latest European Regulation; - Allow only use of organic cotton; - Question the ambition level of AOX emissions; - Investigate the use of the latest learnings about the Roadmap for cleaner viscose by Changing Market Foundation; - Investigate inclusion of other environmental impacts caused by the production of MMCF.

Source: own elaboration

Table 103. Suggestions received by respondents to the initial questionnaire on EU Ecolabel criteria 10-12, which focus on components and accessories

Criterion	Suggestion
Criterion 10. Filling	Include specific sub-criteria addressing: - animal welfare (e.g. prohibition of live plucking), - wastewater production, - hygiene requirements when downs and feathers are used.
Criterion 11. Coating, laminates and membrane	- Include limits about adhesives, organic solvents, and minimum recycled content; - Forbid the use of CFCs as foaming agents; - Include assessment of polyamide in criterion 11(b).
Criterion 12. Accessories	Extend the scope of accessories as done in the criteria of Blue Angel.

Source: own elaboration

Table 104. Suggestions received by respondents to the initial questionnaire on EU ecolabel criteria 13-16 and appendixes, which focus on chemicals

Topic	Suggestion
General points	- Cover the entire supply chain; - Simplify requirements revising their proportionality; - Explicitly report the chemicals that should be analysed; - Improve the comprehension of the criteria.
Criterion 13. Restricted Substances List (RSL)	- Provide directions about the random sampling; - Investigate the use of ZDHC Gateway; - Assess aspects related to Hercosett method on wool; - Transparently report intentionally added chemicals; - Forbid any ingoing SVHC regardless of their concentration; - Use other certification schemes, such as Oeko-Text Standard 100 and Bluesign, as criterion verification.
Criterion 14. Substitution of hazardous substances in dyeing, printing and finishing	- Include restriction to substances that hinder recyclability, and reassess those currently derogated; - Ban substances classified as H400; - Consider the expansion of the following hazard classes: Persistent, bioaccumulative, Toxic (PBTs), very Persistent very Bioaccumulative (vPvBs); Persistent, Mobile and Toxic (PMT), Very Persistent very Mobile (vPvM), endocrine disruption; - Investigate the possibility to completely exclude flame retardants, biocides and optical brighteners.
Criterion 15. Washing, drying and curing energy efficiency	Update the criterion considering the latest evolution of best available technologies.
Criterion 16. Treatment of emissions to air and water	- Update the criterion considering the requirements set by the latest EU-BREF; - Include emission parameters set by the latest version of the Blue Angel criteria; - Investigate verification methods which would facilitate the process when a facility is located outside EU.

Topic	Suggestion
Appendix 1. EU Ecolabel textile restricted substance list	- Analyse the possible ways to verify chemical requirements when the supply chain is outside EU. - Assess the possibility to include in the RSL: • All per and polyfluoroalkyl substances (some exemptions remain for outdoor use) • Flame retardants • SVHC regardless of concentration • Biocides (currently allowed for transportation and storage) • Nanomaterials • Phthalates • Elemental chlorine or hypochlorite • Metal complex dyes • APEOS also in end products • PFAS • Chlorinated solvents • Organotin compounds • Azo dyes - In (f), (ii) the term surfactant is redundant and the 95% is hard to interpret and calculate. - In verification column of (g), (ii) it can be more clear that non-use means no use of easy-care finish. - The term SDS could always be written as “SDS (updated REACH/GHS)” to prevent many outdated incomplete SDS.
Appendix 2. Dye restrictions	- Investigate latest updates adopted by other ISO Type I environmental labels and Oeko-Tex; - Consider inclusion of ZDHC MRSL v.3.0 or higher; - Analyse the possible ways to verify dye requirements when the supply chain is outside EU.
Appendix 3. Best available techniques in the field of washing, drying and curing energy efficiency	- Update the criterion considering the latest evolution of best available technologies; - For washing, assess formulations including surfactants (anionic and nonionic) together with polymers and enzymes with good cleaning performance at low temperatures.

Source: own elaboration

Table 105. Suggestions received by respondents to the initial questionnaire on EU Ecolabel criteria 17-25, which focus on fitness for use

Criterion/topic	Suggestion
Criterion 17. Dimensional changes during washing and drying	- Investigate latest updates adopted by other ISO Type I environmental labels; - Include examples of fabrics with interlock and chunky knit; - Include specific fibre groups that are missing; - Reassess the ambition level of the criterion.
Criterion 18. Colour fastness to washing	Investigate to include restriction to dry cleaning.
Criterion 19. Colour fastness to perspiration (acid, alkaline)	Verify if the depth method is still up to date; Investigate latest updates adopted by other ISO Type I environmental labels.
Criterion 20. Colour fastness to wet rubbing	Investigate latest updates adopted by other ISO Type I environmental labels.
Criterion 21. Colour fastness to dry rubbing	Investigate latest updates adopted by other ISO Type I environmental labels.
Criterion 22. Colour fastness to light	- Verify if the standard depth method is still up to date; - Investigate latest updates adopted by other ISO Type I environmental labels.
Criterion 23. Wash resistance of cleaning products	Investigate latest updates adopted by other ISO Type I environmental labels.
Criterion 24. Fabric resistance to pilling and abrasion	- Extend the possibility to verify the requirement using ISO 12945-3 (RTPT - random tumble); - Include more fibre groups. - Investigate latest updates adopted by other ISO Type I environmental labels.
Criterion 25. Durability of function	- Consider the possibility to include further durability aspects, as reported by latest publications; - Investigate aspects related to oil and stain repellence, which are connected to the use of PFAS; - Assess the exclusion of flame retardants.
Other	Include requirements on tear strength and zipper quality.

Source: own elaboration

Table 106. Suggestions received by respondents to the initial questionnaire on EU ecolabel criteria 26-28, which focus on Corporate Social Responsibility and supporting information

Criterion	Suggestion
Criterion 26. Fundamental principles and rights at work	- Investigate the possibility to use the OECD Guidelines for Multinational Enterprises and the application to the entire value chain; - Assess the latest legislative developments reported in the proposal for the Corporate Sustainability Due Diligence Directive; - Change the headline to better reflects social aspects; - Include the ILO convention 190 and ILO Convention 185, or even going beyond the ILO core criteria; - Investigate the possibility to use other certifications, such as BSCI/Amfori, SMETA, to verify compliancy; - Align with the latest EU Ecolabel requirements for electronic displays and absorbent hygiene products.
Criterion 27. Restriction on the sandblasting of denim	- Investigate the possibility to use the OECD Guidelines for Multinational Enterprises and the application to the entire value chain; - Restrict potassium permanganate.
Criterion 28. Information appearing on the Ecolabel	- Investigate the possibility to include: • a sentence about social aspects; • a specific recycled material content, with its traceability; • Information that sums up the requirements that the product meets; • the specific chain of custody model used for the traceability of virgin and recycled materials; - Consider the latest proposal for Green Claims Directive.

Source: own elaboration

10.7.3 Comparison among Ecolabels

Table 107. Textile fibres - comparison among Ecolabels

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
Organic cotton	**Requirement**	Minimum quantity of organic cotton used to manufacture the final product to be labelled: 95%	Minimum quantity of organic cotton used to manufacture the final product to be labelled: 100%	Must be sourced from controlled organic cultivation or fibres from the conversion phase and comply with requirements of regulations and certificates.
		N.A		At all stages of the processing chain, it must be ensured that controlled biological fibres and products are not mixed with conventional fibres and products and controlled biological fibres are not contaminated due to contact with prohibited substances.
	Verification	Common regulation to certify organic cotton: American National Organic Programme (NOP)		
		Council Regulation (EC) No 834/2007	Regulation (EU) 2018/848	
		Traceability of organic cotton	N.A	Implied in the requirement text
		Certification annually for each country or origin: Regulation (EC) No 834/2007; The US National Organic Programme (NOP), Set by other trade partners. Cotton volume or blend requirements require records, invoices, and documentation from the spinning or fabric production stages.	Fulfilling requirements, emphasising the cultivation of organic cotton in line with the standards. Transaction certificates for suppliers with Global Organic Textile Standard certification are needed.	Compliance verification of requirements. Fibres labelled with the German organic logo (Bio-Siegel), the EU organic logo ("Euro leaf"), or the American National Organic Program (NOP), IFOAM or DIN EN ISO/IEC 17065. For products in the conversion phase, certification of Fibre production is required, and in the case of RAL GmbH, a shipping or transaction certificate is necessary if relevant.
Other cotton production	**Requirement**	Minimum content of 20% of cotton grown according to IPM principles, and 60% is the minimum content of cotton grown according to IPM principles for the following products: T-shirts, woman's tops, casual shirts, jeans, pyjamas, and nightwear, underwear, and socks.	Only applicable to clothing (uniforms and workwear) and bed linen, towels, bathrobes, tablecloths, tea towels, cloths, and napkins for, e.g., hotels, hospitals, and other institutions. Cotton cultivated according to different IPM standards (BCI, CmiA, and FairTrade cotton) and not GMO (genetically modified organisms according to EU Directive 2001/18)	Applicable to: the fibres used in the products must not be sourced from genetically modified organisms (GMO). In the case of fine yarns (fineness range > NM100), where the required fibre lengths cannot currently be sourced from the controlled organic cultivation of cotton

[210] EU Ecolabel criteria for textile products. Commission Decision of 5 June 2014 establishing the ecological criteria for the award of the EU Ecolabel for textile products. Commission Decision (2014/350/EU). Available at this link.

[211] Nordic Swan Ecolabel criteria for textiles, hides/skins, and leather. Version 5.6, 01 March 2022 – 31 December 2026. Available at this link. Last accessed on 27 November 2024.

[212] Blue Angel – The German Ecolabel: DE-UZ 154 Basic Award Criteria for textiles. Edition January 2023, version 2. Available at this link. Last accessed on 12 January 2024

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
		Traceability requirements.		
		List of forbidden pesticides for conventional cotton production	N.A	N.A
		N.A	N.A	At all stages of the processing chain, it must be ensured that controlled biological fibres and products are not mixed with conventional fibres and products and controlled biological fibres are not contaminated due to contact with prohibited substances.
	Verification	•Need for proper documentation or certification to demonstrate compliance with standards concerning cotton production. •Certified Integrated Pest Management (IPM) schemes during the cotton cultivation process: BCI, CmiA, and Fair Trade cotton. •Emphasis on the absence of genetically modified cotton and the traceability of the supply chain.		The German Environment Agency can inspect to decide whether the cotton used in the product has been certified by a different certification system (e.g., Cotton Made in Africa (CmiA) and Fairtrade Cotton) can also be approved.
		Pesticide restrictions. Necessity for testing or declarations of non-use from farmers or producer groups. Comprehensive testing methodologies for pesticides such as US EPA 8081 B, 8151 A, 8141 B, and 8270 D for different types of pesticides.	N.A	N.A
Recycled cotton (fibres or materials)	**Requirement**	Same as the general recycling requirement	Pre-consumer or post-consumer raw materials, according to ISP 14021 standard Mechanically and chemically recycled fibres are included	The same requirements as the recycled Fibres
	Verification	Same as the general recycling requirement	Global Recycled Standard certificate 4.0 (or later versions), Recycled Claim Standards (RCS) or other certification approved by Nordic Swan Ecolabelling, AND/OR Documentation indicating the fibre was purchased 100% recycled and indicates the supplier	The same requirements as the recycled Fibres

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
Flax, linen and other bast fibres	**Requirement**	N.A	N.A.	Must be sourced from controlled organic cultivation or fibres from the conversion phase and comply with requirements of regulations and certificates. At all stages of the processing chain, it must be ensured that controlled biological fibres and products are not mixed with conventional fibres and products and controlled biological fibres are not contaminated due to contact with prohibited substances.
		Retted under ambient conditions and without thermal energy inputs.	Retting only allowed if the wastewater from the retting ponds is treated to reduce the COD or TOC	If the Fibres are produced using water retting, the water has to be treated to reduce the chemical oxygen demand (COD) or the total organic carbon
		Percentage by which COD or TOC in wastewater from retting should be reduced (at least 75% for hemp and at least 95% for flax and other bast Fibres)		
		N.A	Only cultivated using pesticides permitted according to Regulation (EC) No 1107/2009	N.A
		N.A	N.A	The fibres used in the products must not be sourced from genetically modified organisms (GMOs).
	Verification	For water retting: Test report showing compliance and using the test method: ISO 6060 (COD) Declaration of the retting method used by the farmers and/or other suppliers.	For water retting: Test method for measuring COD and TOC: ISO 6060. Test report from the producer or Proof of a valid EU Ecolabel licence in line with the Commission Decision of July 2014.	For water retting: Test of the COD will be carried out in accordance with ISO 6060 or DIN 38409-41 or DIN 38409-44 or DIN-ISO 15705.
		N.A	For pesticides: Valid certificate from European Flax Standard or equivalent.	Compliance verification Compliance with requirements: Fibres labelled with German organic logo (Bio-Siegel) or Euorganic logo ("Euro leaf") or American National Organic Programme (NOP),·IFOAM or DIN EN ISO/IEC 17065,· For products "in conversion" only if fibre production can be certificated. In the case of RAL GmbH --> a shipping or transaction certificate (if relevant), Regulation (EC) No 834/2007 2018/848 (EC Organic Regulation) Declaration of compliance with requirements and verification submission for using residues from the agricultural, timber and food industries.
Wool and	**Requirement**	The **same restrictions on a group of ectoparasiticides** with a maximum of 0.5 ppm or a maximum of 2 ppm. The requirement does not apply if specific documentary evidence is presented, together with an independent verification of specific details.		N.A

Topic	Requirement/ Verification	EU Ecolabel [210]	Nordic Swan [211]	Blue Angel [212]
other keratin fibres		Derogation for Wool scourers operating closed-loop water systems that break down the ectoparasiticides above must comply with at least two treatments indicated in EUEL.	N.A	N.A
		COD values restrictions for wool scouring operations. Limits (same as the Nordic Swan) •45 g/kg for fine wool •25 g/kg for coarse wool	**COD** emissions from wool scouring plants. Limits (same as the EUEL) • 45 g/kg for fine wool • 25 g/kg for coarse wool Wastewater sent to local/regional treatment works is exempted. Measurement of PCOD, TOC or BOD may also be used if a correlation to COD is evident.	Requirements for wastewater from wool scouring before mixing (indirect discharge) The **COD** limit is 45 g/kg of greasy wool before mixing with other wastewater (it does not apply to recycled fibres) Requirements for wastewater from wool scouring at the discharge point (direct discharge) The COD limit is 150 mg/l (qualified random sample) or 1.5 mg/l (2-hour mixed sample) of greasy wool.
		N.A	**pH value and temperature** of wastewater from wool scouring The pH value of the wastewater released to the surface water must be 6-9 (same as Blue Angel), and the temperature must be lower than 40°C (higher temperature than Blue Angel's requirement)	**pH value of the wastewater** discharged to surface waters must be between 6 and 9 (same as the Nordic Swan) (unless the pH value of the receiving waters is outside this range), and the **temperature** must be below 35°C (lower temperature than Nordic Swan's requirement) (unless the temperature of the receiving waters is already above this limit). The requirement does not apply to recycled fibres.
		Scouring: Measures to recover value from either oxidised grease, fibre, suint or sludge arising from the scouring site used for the ecolabelled wool products •Recovery for sale as a chemical feedstock; •Production of compost or liquid fertiliser; •Manufacturing of products such as building materials; •Treatment and energy recovery by anaerobic digestion or incineration	**Scouring** agents Must be either readily aerobically biodegradable or inherently aerobically biodegradable by test method: OECD 301 A-F (60% degradability), OECD 310 (60% degradability), OECD 302 A-C (70% degradability) or equivalent.	**Scouring:** Exclusion of washing agents containing alkylphenol ethoxylates Washing agents containing alkylphenol ethoxylates (APEO) are prohibited. Direct and indirect discharge limits may not exceed 5µg/l APEO (NPEO, OPEO, NP, and OP).
	Verification	**Ectoparasiticides:** Provide the documentation or the following test methods: IWTO draft test method 59 (same as the Nordic Swan). In case of derogation, applicants must provide evidence confirming the scouring plant configuration and laboratory test reports.	**Ectoparasiticides:** Tests must be performed in accordance with IWTO Draft Test Method 59 (same as EUEL). Verify through the wool supplier's declaration that no mulesing has been used. Test report showing that the pesticide requirement has been fulfilled.	N.A
		COD same test for all: Test method ISO 6060 and the following compliance/verification methods		

Topic	Requirement/ Verification	EU Ecolabel (210)	Nordic Swan (211)	Blue Angel (212)
		COD: Compliance with this criterion shall be based on monthly averages for the six months preceding the application.	**COD:** Test report or a valid GOTS or EU Ecolabel certificate	**COD:** Declaration of compliance with the requirements and confirmation from the operator of the wool scouring plant+ method treatment Test of the COD: DIN 38409-41 or, DIN 38409-44 or DIN-ISO 15705. If discharged to an urban wastewater treatment plant, the applicant shall also enclose a notice of approval verifying compliance with Directive (EEC) 91/271.
		Scouring: Provide a report and waste transfer notes confirming the type and proportion of waste recovered and the method used.	**Scouring:** Declaration from the chemical supplier and safety data sheet for the scouring agents used and/or OECD or ISO test results showing compliance with the requirement.	**Scouring:** declaration of conformity - Annex 57 of the German Wastewater Ordinance or equivalent international test reports. The following test methods can be used here (based on a qualified random sample or a 2-hour mixed sample): NPEO, OPEO, NP, and OP: ISO 18857-1, ISO 18857-2, ISO 18254-1 or ASTM D7742-17.
Organic wool	**Requirement**	N.A	Certified organic wool: wool fibre certified as organic according to a standard approved in the IFOAM.	Wool, alpaca and cashmere must be sourced from controlled organic cultivation, controlled biological animal husbandry, or fibres from the conversion phase (transition from non-organic to organic farming) and comply with the requirements indicated in "verification". At all stages of the processing chain, it must be ensured that controlled biological fibres and products are not mixed with conventional fibres and products and controlled biological fibres are not contaminated due to contact with prohibited substances.
	Verification	N.A	Certification required: standards approved in the IFOAM, such as Regulation (EU) 2018/848, ISO 17065), USDA National Organic Program (NOP) (same as Blue Angel)	
			APEDA's National Programme for Organic Production (NPOP), China Organic Standard GB/T19630, GOTS certification. Also approved are GOTS and DEMETER and certification as "transitioning to organic cultivation". The certification body must have the accreditation required for the standard, such as IFOAM (same as Blue Angel).	The applicant shall declare compliance with the requirement. Fibres labels accepted: German organic logo (Bio-Siegel), the EU organic logo ("Euro leaf") In the case of alpaca, certification according to the Responsible Alpaca Standard 1.0 © 2021 Textile Exchange. The certification of products" in conversion" is possible.

Topic	Requirement/ Verification	EU Ecolabel [210]	Nordic Swan [211]	Blue Angel [212]
				In the case of cashmere, certification according to the Good Cashmere Standard® (GCS) by AbTF can be submitted as an alternative to certification of controlled biological animal husbandry.
Recycled wool	**Requirement**	Same as the general recycling requirement.	Recycled wool: As per the definition in the ISO 14021 standard. Both mechanically and chemically recycled fibres are included.	Same as the requirements for the recycled fibres.
	Verification	Same as the general recycling requirement.	Fulfilment with either a) or b): a) Global Recycled Standard certificate 4.0, Recycled Claim Standard certificate, or equivalent certification. b) Present documentation demonstrating that the recycled fibre was purchased as recycled and state the supplier.	Same as the requirements for the recycled fibres.
Acrylic	**Requirement**	The emissions to air of **acrylonitrile** (during polymerisation and up to the solution ready for spinning) shall be less than 1g/kg of fibre produced (same limit as Blue Angel) as an annual average. The workplace emissions to air of **N, N-dimethylacetamide** (127-19-5) during polymerisation and spinning shall not exceed an Indicative Occupational Exposure Limit Value of 10.0 ppm.	*If bio-based origin:* Must contain at least 90% bio-based raw material. Palm oil, soybean oil, and soy flour must not be used. They must meet either a) or b): a) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. b) If sugar cane is used, it must be certified to Bonsucro standard, version 5.1 or later version or certified to a standard that meets the requirements. The producer must have a CoC certification according to the standard by which the raw material is certified. Traceability must at least be ensured by mass balance. Book and claim systems are not accepted. The producer of the bio-based polymer must document its purchase of certified raw materials for polymer production. The raw materials must meet either c) or d): c) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. d) Primary raw materials not genetically modified. *If fossil origin:*	The emissions to air of **acrylonitrile** (during polymerisation and up to the solution ready for spinning), expressed as an annual average, must be less than 1 g/kg of fibre produced (same limit as EUEL) (this requirement does not apply to recycled fibres unless the recycling process breaks down the materials to the monomer level. If this is the case, this requirement also applies to recycled fibres) The **residual acrylonitrile content** in raw fibres leaving the fibre production plant must be less than 1.5 mg/kg (this requirement does not apply to recycled fibres unless the recycling process breaks down the materials to the monomer level. If this is the case, this requirement also applies to recycled fibres) N.A

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
			100% recycled material. This must not include recycled plastic from EFSA plants or FDA-approved food contact material or be marketed as compatible with these.	
	Verification	**Acrylonitrile**: Detailed documentation and/or test reports showing compliance with this criterion and a Declaration of Compliance from the fibre manufacturer.	*If bio-based origin:* -Test according to ISO 16620, ASTM D6866, or equivalent standards showing the content of bio-based raw material. - Declaration by the producer that palm oil, soybean oil and soy flour are not used. - For waste and residual products: Documentation that shows the requirement's definition of waste or residual products and traceability is met. - Sugar cane: Certification system sugar cane is certified for. CoC certificate or a certificate number. Documentation from the producer of the bio-based polymer showing the purchase of bio-based polymer from certified raw material in at least the same annual quantity as is used in the production of the bio-based polymer. Declaration stating that it has not been genetically modified. - For primary raw materials: Declaration stating that they have not been genetically modified. Name and geographical origin of the primary raw materials used. *If fossil origin:* - Declaration from the producer of the recycled raw material that it is not EFSA or FDA-approved. - Certificate from an independent certifier of the supply chain. - Documentation from the producer showing that the raw material is 100% recycled.	**Acrylonitrile** Compliance with the requirement and submission of confirmation from the suppliers of the fibres, as well as a test (according to specified methods) report from the suppliers of the fibres verifying compliance with this requirement.
		N, N-dimethylacetamide: Emissions values measured at those process stages in which the substances are used, expressed as an 8-hour average value. Test reports and monitoring data from the fibre manufacturer showing compliance with this criterion.		N.A

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
Elastane	**Requirement**	Bans organotin compounds. Limits exposure to 3 specific aromatic diisocyanates: (i) diphenylmethane-4,4'-diisocyanate (101-68-8) 0.005 ppm (ii) toluene-2,4-diisocyanate (584-84-9) 0.005 ppm (iii) N, N-dimethylacetamide (127-19-5) 10.0 ppm	*If bio-based origin:* Must contain at least 90% bio-based raw material. Palm oil, soybean oil, and soy flour must not be used. They must meet either a) or b): a) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. b) If sugar cane is used, it must be certified to Bonsucro standard, version 5.1 or later version or certified to a standard that meets the requirements. The producer must have a CoC certification according to the standard by which the raw material is certified. Traceability must at least be ensured by mass balance. Book and claim systems are not accepted. The producer of the bio-based polymer must document its purchase of certified raw materials for polymer production. The raw materials must meet either c) or d) c) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. d) Primary raw materials not genetically modified. *If fossil origin:* 100% recycled material. This must not include recycled plastic from EFSA plants or FDA-approved food contact material or be marketed as compatible with these. Synthetic fibre of fossil origin 100% recycled material in line with ISO 14021, EXCEPTION: • For elastane fibres that are STANDARD 100 by OEKO-TEX certified	Bans organotin compounds. Limits exposure to aromatic diisocyanates a 0.05 mg/m³ value expressed as an 8-hour average. It applies to recycled fibres, only if the recycling process breaks down the materials to the monomer level.

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
	Verification	Declaration of non-use from the Fibre manufacturer and measurement of emissions values, provided as an 8-hour average value. Test reports and monitoring data from the fibre manufacturer(s) demonstrating compliance are necessary.	*If bio-based origin:* -Test according to ISO 16620, ASTM D6866 or equivalent standards showing the content of bio-based raw material. - Declaration by the producer that palm oil, soybean oil and soy flour are not used. - For waste and residual products: Documentation which shows that the requirement's definition of waste or residual products is met, as well as traceability. - Sugar cane: Certification system sugar cane is certified for. CoC certificate or a certificate number. Documentation from the producer of the bio-based polymer showing the purchase of bio-based polymer from certified raw material in at least the same annual quantity as is used in the production of the bio-based polymer. Declaration stating that it has not been genetically modified. - For primary raw materials: Declaration stating that they have not been genetically modified. Name and geographical origin of the primary raw materials used. *If fossil origin:* - Declaration from the producer of the recycled raw material that it is not EFSA or FDA-approved. - Certificate from an independent certifier of the supply chain. - Documentation from the producer showing that the raw material is 100% recycled.	Declaration of the non-use of specific compounds and submit confirmation from the fibre suppliers, with the option to use suitable HPLC test methods recognised testing laboratories.

Topic	Requirement/ Verification	EU Ecolabel [210]	Nordic Swan [211]	Blue Angel [212]
Polyester	**Requirement**	a) The level of antimony present in the polyester fibres shall not exceed 260 ppm (same limit as Blue Angel). Polyester fibres manufactured from recycled PET bottles are derogated (same requirement as Blue Angel). b) Staple fibres shall contain a minimum content of 50 % and filament fibres 20 % of recycled PET (same requirement as Blue Angel). Micro-fibres are derogated from this requirement and shall comply with (c). c) Emissions of VOCs during the production of polyester limit 1.2 g/kg for PET chips (same limit as Blue Angel) and 10.3 g/kg for filament fibre (same limit as Blue Angel).	*If bio-based origin:* Must contain at least 90% bio-based raw material. Palm oil, soybean oil, and soy flour must not be used. They must meet either a) or b): a) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. b) If sugar cane is used, it must be certified to Bonsucro standard, version 5.1 or later version, or certified to a standard that meets the requirements. The producer must have a CoC certification according to the standard by which the raw material is certified. Traceability must at least be ensured by mass balance. Book and claim systems are not accepted. The producer of the bio-based polymer must document its purchase of certified raw materials for polymer production. The raw materials must meet either c) or d): c) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. d) Primary raw materials not genetically modified. *If fossil origin:* 100% recycled material. This must not include recycled plastic from EFSA plants or FDA-approved food contact material or be marketed as compatible with these. Synthetic fibre of fossil origin 100% recycled material in line with ISO 14021, EXCEPTION: • For white polyester (200-220 GG, Tint 0-3 or equivalent according to the CIE Whiteness Index) for professional textiles, an exception is given until June 30th, 2024. When using the exception, it is required that the fibres be STANDARD 100 by OEKO-TEX certified.	a) Limit the amount of antimony present in the polyester fibres 260 ppm (same limit as EUEL) or an elutable amount of 30 mg/kg. This requirement also applies to recycled fibres. b) The use of PET beverage packaging in the production of recycled fibres is permitted for a transitional period of two years (after this period, PET from beverage packaging is not permitted). Staple fibres shall contain a minimum content of 50 % and filament fibres 20 % of recycled PET (same requirement as EUEL) c) VOC emissions must not exceed 1.2 g/kg for PET chips (same limit as EUEL), 10.3 g/kg for filament fibres (same limit as EUEL) or 0.2 g/kg for produced polyester resin. This requirement does not apply to recycled polyester fibres unless the recycling process breaks down the materials to the monomer level. If this is the case, this requirement also applies to recycled polyester fibres.

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
	Verification	a) Declaration of non-use or a test report using the test methods indicated in the criterion. A declaration shall be provided for fibres manufactured from recycled PET bottles. b) Recycled content shall be traceable back to the reprocessing of the feedstock. c) The applicant shall provide monitoring data and/or test reports demonstrating compliance with EN 12619 (same standard as Blue Angel) or standards with an equivalent test method.	*If bio-based origin:* -Test according to ISO 16620, ASTM D6866, or equivalent standards showing the content of bio-based raw material. - Declaration by the producer that palm oil, soybean oil and soy flour are not used. - For waste and residual products: Documentation that shows the requirement's definition of waste or residual products and traceability is met. - Sugar cane: Certification system sugar cane is certified for. CoC certificate or a certificate number. Documentation from the producer of the bio-based polymer showing the purchase of bio-based polymer from certified raw material in at least the same annual quantity as is used in the production of the bio-based polymer. Declaration stating that it has not been genetically modified. - For primary raw materials: Declaration stating that they have not been genetically modified. Name and geographical origin of the primary raw materials used. *If fossil origin:* - Declaration from the producer of the recycled raw material that it is not EFSA or FDA-approved. - Certificate from an independent certifier of the supply chain. - Documentation from the producer showing that the raw material is 100% recycled.	a) Declaration of antimony-free polyester fibres and the corresponding declaration or a test report from the fibre suppliers to verify compliance. Leaching according to DIN EN ISO 105-E04 / determined according to ISO 17294-2 (ICP/MS). The recycling process must be described if recycled fibres are used a) and c) a Declaration of compliance with the requirement and submission of a declaration of conformity from the fibre suppliers, as well as a test report by DIN EN 12619 (same standard as EUEL). The recycling process must be described if recycled fibres are used.

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
Polypropylene	**Requirement**	Bans the use of lead based pigments.	*If bio-based origin:* Must contain at least 90% bio-based raw material. Palm oil, soybean oil, and soy flour must not be used. They must meet either a) or b): a) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. b) If sugar cane is used, it must be certified to Bonsucro standard, version 5.1 or later version or certified to a standard that meets the requirements. The producer must have a CoC certification according to the standard by which the raw material is certified. Traceability must at least be ensured by mass balance. Book and claim systems are not accepted. The producer of the bio-based polymer must document its purchase of certified raw materials for polymer production. The raw materials must meet either c) or d): c) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. d) Primary raw materials not genetically modified. *If fossil origin:* 100% recycled material. This must not include recycled plastic from EFSA plants, FDA-approved as food contact material, or marketed as compatible with these. Synthetic fibre of fossil origin 100% recycled material in line with ISO 14021,	Bans the use of lead based pigments.

Topic	Requirement/ Verification	EU Ecolabel (210)	Nordic Swan (211)	Blue Angel (212)
	Verification	Declaration of non-use.	*If bio-based origin:* -Test according to ISO 16620, ASTM D6866, or equivalent standards showing the content of bio-based raw material. - Declaration by the producer that palm oil, soybean oil and soy flour are not used. - For waste and residual products: Documentation that shows the requirement's definition of waste or residual products and traceability is met. - Sugar cane: Certification system sugar cane is certified for. CoC certificate or a certificate number. Documentation from the producer of the bio-based polymer showing the purchase of bio-based polymer from certified raw material in at least the same annual quantity as is used in the production of the bio-based polymer. Declaration stating that it has not been genetically modified. - For primary raw materials: Declaration stating that they have not been genetically modified. Name and geographical origin of the primary raw materials used. *If fossil origin:* - Declaration from the producer of the recycled raw material that it is not EFSA or FDA-approved. - Certificate from an independent certifier of the supply chain. - Documentation from the producer showing that the raw material is 100% recycled.	Declaration of non-use and confirmation from the fibre suppliers. The recycling process must be described if recycled fibres are used.
Man-made cellulose fibres	**Requirement**	Sustainable Forestry Management: A minimum of 25% of pulp Fibres must be manufactured from wood grown according to sustainable forestry management principles. The remaining proportion of pulp Fibres should be from legal forestry and plantations. Pulp from Cotton Linters: Pulp produced from cotton linters must meet the requirements of either cotton criterion 1a or 1b. Bleaching Process: Requirement (9c): The pulp used for fibre manufacturing must be bleached without elemental chlorine. Total chlorine and organically bound chlorine (OX) in finished Fibres must not exceed 150	*If bio-based origin:* Must contain at least 90% bio-based raw material. Palm oil, soybean oil, and soy flour must not be used. They must meet either a) or b): a) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. b) If sugar cane is used, it must be certified to Bonsucro standard, version 5.1 or later version or certified to a standard that meets the requirements. The producer must have a CoC certification according to the standard by which the raw material is certified. Traceability must at least be ensured by mass balance. Book and claim systems are not accepted. The producer of the bio-based polymer must document its purchase of certified raw materials for polymer production.	N.A

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
		ppm. AOX in wastewater from pulp manufacturing must not exceed 0.170 kg/ADt pulp.	The raw materials must meet either c) or d): c) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. d) Primary raw materials not genetically modified.	
		Value Recovery from Spent Process Liquors: Requirement (9d): A minimum of 50% of the pulp used for Fibre manufacturing must be purchased from dissolving pulp mills that recover value from spent process liquors through on-site electricity and steam generation or manufacturing chemical co-products.		
		Sulphur Content in Emissions (for Viscose and Modal Fibres): Requirement (9e): The sulphur content of emissions of sulphur compounds to air from Fibre production processes must not exceed specified performance values.		
	Verification	Sustainable Forestry Management: The applicant needs to obtain valid, independently certified chain of custody certificates from the Fibre manufacturer(s) demonstrating compliance with sustainable forestry management principles. Certifications from FSC, PEFC, or equivalent schemes are accepted.	If bio-based origin: -Test according to ISO 16620, ASTM D6866, or equivalent standards showing the content of bio-based raw material. - Declaration by the producer that palm oil, soybean oil and soy flour are not used. - For waste and residual products: Documentation that shows the requirement's definition of waste or residual products and traceability is met. - Sugar cane: Certification system sugar cane is certified for. CoC certificate or a certificate number. Documentation from the producer of the bio-based polymer showing the purchase of bio-based polymer from certified raw material in at least the same annual quantity as is used in the production of the bio-based polymer. Declaration stating that it has not been genetically modified. - For primary raw materials: Declaration stating that they have not been genetically modified. Name and geographical origin of the primary raw materials used.	N.A
		Pulp from Cotton Linters: Cotton must be certified by an independent control body, complying with regulations and standards. Non-genetically modified varieties of cotton should be verified according to specified regulations.		
		Bleaching Process: The applicant needs to provide a test report showing compliance with OX or AOX requirements using the appropriate test methods (OX: ISO 11480, AOX: ISO 9562).		
		Value Recovery from Spent Process Liquors: The applicant must provide a list of pulp suppliers, documentation, and evidence of energy generation and co-product recovery systems.		

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
		Sulphur Content in Emissions (for Viscose and Modal Fibres): The applicant needs to provide detailed documentation and/or test reports showing compliance with this criterion, along with a declaration of compliance		
Regenerated Cellulose fibres	**Requirement**	N.A	Recycled Content: Recycled raw materials for producing new regenerated cellulose fibres must be pre-consumer or post-consumer* cellulosic material. It must be documented that 100% is recycled material.	Recycled Content: Allows the use of recycled materials.
			Chain of Custody Certification: Chain of Custody certification (FSC or PEFC). Manufacturers using only recycled material are exempt from the Chain of Custody requirement	Chain of Custody Certification: Requires certain certifications for cellulose origin.
			Bleaching Restrictions: Prohibits the use of chlorine gas in bleaching.	Bleaching Restrictions: Restricts the use of elementary chlorine. Additional Bleaching Process Restrictions Place restrictions on using hypochlorite and set limits on chlorine dioxide consumption and AOX emissions to wastewater during bleaching.
			Emission Limits: Imposes emission limits for specific substances in the production process.	Emission Limits: Sets limits on emissions to wastewater and air, including COD, nitrogen, phosphorus, sulphur compounds, and dust.
			Tree Species Limitation: Restrictions on using virgin wood Fibres from specific tree species.	N.A
			Origin: Requires traceability of regenerated cellulose fibre or recycled textile fibre	Cellulose Origin: Requires cellulose from wood or bamboo cultivated according to sustainable forestry principles. It also allows using recycled materials and residues from the agricultural, timber, and food industries.
			N.A	Emission Limits Specific to Fibre Types: Sets specific emission limits for viscose and modal fibres, including sulphur content in emissions.
			N.A	Energy Consumption Limits: specifies limits on specific electrical and heating energy consumption in cellulose production.
			N.A	Halogen Content: Specifies a maximum halogen content for fibres.
			Traceability: Requires traceability of regenerated cellulose fibre or recycled textile fibre	N.A

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
	Verification	N.A	Recycled Content: Certificate from either Global Recycled Standard or Recycled Claim Standard	Recycled Content: Certificate from either Global Recycled Standard or Recycled Claim Standard or submission of purchasing and procurement receipts for waste material.
			Chain of Custody Certification: Verification with valid FSC/PEFC Chain of Custody certificates.	Chain of Custody Certification: Verification through valid, independently issued certificates from Fibre producers confirming sustainable forestry management for wood or bamboo Fibres.
			Bleaching Restrictions: Declaration from the cellulose mass and regenerated cellulose manufacturers or a valid EU Ecolabel License.	Bleaching Restrictions: Manufacturers to submit test reports and documentation showing adherence to the specified limits
			Emission Limits: Documentation of closed-loop processes and test reports for emission requirements	Emission Limits: compliance declarations, emission values, and test reports for various aspects of production, including emissions to air and water.
			Cellulose Origin: Declaration from the cellulose mass and regenerated cellulose manufacturers or a valid EU Ecolabel License.	Cellulose Origin: For cellulose sourced from bamboo, a transaction certificate must be submitted
			Tree Species Limitation: Documented with a certificate from either the Global Recycled Standard or the Recycled Claim Standard.	N.A
			N.A	Emission Limits Specific to Fibre Types: Compliance with emission limits for specific fibre types
			N.A	Energy Consumption Limits: Manufacturers need to ensure that the specific electrical and heating energy consumption in cellulose production meets the defined limits
			N.A	Halogen Content: Manufacturers must ensure that the halogen content of fibres does not exceed the specified maximum limit.
			Traceability: documented with a certificate from either the Global Recycled Standard or the Recycled Claim Standard.	N.A

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
Polyamide	**Requirement**	Polyamide products shall comply with at least one of the following: - Fibres shall be manufactured using a minimum content of 20 % recycled from pre and/or post-consumer waste. - The emissions to air of N2O from nylon monomer production, expressed as an annual average, shall not exceed 9.0 g N2O/kg of caprolactam or adipic acid.	*If bio-based origin:* Must contain at least 90% bio-based raw material. Palm oil, soybean oil, and soy flour must not be used. They must meet either a) or b): a) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. b) If sugar cane is used, it must be certified to Bonsucro standard, version 5.1 or later version or certified to a standard that meets the requirements. The producer must have a CoC certification according to the standard by which the raw material is certified. Traceability must at least be ensured by mass balance. Book and claim systems are not accepted. The producer of the bio-based polymer must document its purchase of certified raw materials for polymer production. The raw materials must meet either c) or d): c) Waste or residual products defined by (EU) Renewable Energy Directive 2018/2001. d) Primary raw materials not genetically modified. *If fossil origin:* 100% recycled material. This must not include recycled plastic from EFSA plants or FDA-approved food contact material or be marketed as compatible with these.	Polyamide products shall comply with at least one of the following: - Fibres shall be manufactured using a minimum content of 20 % recycled from pre and/or post-consumer waste. - The N2O emissions to air during the monomer production, expressed as an annual average, must not exceed 9 g/kg of caprolactam or adipic acid. In addition, reduction technologies must be used to produce caprolactam and adipic acid. It must be ensured that the degree of reduction in the N2O emissions during adipic acid production is at least 95%.

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
	Verification	Recycled content shall be traceable back to the reprocessing of the feedstock. This shall be verified by independent certification of the chain of custody or by documentation provided by suppliers and processors. The applicant shall provide documentation or test reports showing compliance based on monitoring data and a Declaration of Compliance from the fibre manufacturer and their feedstock providers.	*If bio-based origin:* -Test according to ISO 16620, ASTM D6866 or equivalent standard showing the content of bio-based raw material. - Declaration by the producer that palm oil, soybean oil and soy flour are not used. - For waste and residual products: Documentation that shows the requirement's definition of waste or residual products and traceability is met. - Sugar cane: Certification system sugar cane is certified for. CoC certificate or a certificate number. Documentation from the producer of the bio-based polymer showing the purchase of bio-based polymer from certified raw material in at least the same annual quantity as is used in the production of the bio-based polymer. Declaration stating that it has not been genetically modified. - For primary raw materials: Declaration stating that they have not been genetically modified. Name and geographical origin of the primary raw materials used. *If fossil origin:* - Declaration from the producer of the recycled raw material that it is not EFSA or FDA-approved. - Certificate from an independent certifier of the supply chain. - Documentation from the producer showing that the raw material is 100% recycled.	Declare compliance with the requirement and submit a DoC from the monomer producer and test reports for the raw and clean gas, verifying that a reduction of at least 95% has been achieved.
Recycled textile fibre	**Requirement**	Recycled content shall meet the requirements of the Criterion 13 Restricted Substance List.	An extensive list of substances and limits indicated Extractable metals, Organic tin compounds, Chlorophenols, Per- and polyfluorinated compounds, Phthalates, Surfactants, wetting agent residues, Dyes,	Provision of information on the recycled content, the type and composition of the recycled fibre, the origins and composition of the materials fed into the recycling process, and a description of the recycling process.
	Verification	Recycled content shall be traceable back to the reprocessing of the feedstock. This shall be verified by independent third party certification of the chain of custody or by documentation provided by feedstock suppliers and reprocessors. Annually	a) an Oeko-Tex standard 100 class I certificate or b) test report showing that the requirement is complied with. And a description of the procedure confirming an annual test.	Declaration from the manufacturer about the recycled content and origins, accompanied by one of the flowing certificates: • RCS (Recycled Claim Standard),• GRS (Global Recycled Standard),• International Sustainability and Carbon Certification (ISCC+), • Roundtable on Sustainable Biomaterials (RSB), • RedCert (only in Europe) •or a comparable certification system whose scope and requirement standards is equivalent to one of the named certification systems. An

Topic	Requirement/ Verification	EU Ecolabel ([210])	Nordic Swan ([211])	Blue Angel ([212])
				independent environmental verifier must confirm the equivalence of the certification system.

Table 108. Components and accessories – comparison among Ecolabels

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Fillings	**Requirement**	Fibre Restrictions: defined fibre restrictions for fillings in alignment with their respective standards		Fibre restrictions: Not explicitly mentioned
		Chemical Substances: emphasis on the chemical substances used in fillings and their laundering processes. The criteria include biocides, formaldehyde emissions, fabric softeners, and other relevant chemicals.	Chemical Substances: restricts chemical substances used in additives and treatments applied to fillings. It does not mention the laundering process.	Chemical Substances: references substance restrictions from the REACH "list of candidates," the CLP Regulation (EC/1272/2008), and limits from the ZDHC MRSL, provided they are stricter than REACH. It does not mention the laundering process.
		Polyurethane and Latex: not specifically address polyurethane and latex fillings.	Polyurethane and Latex: focuses on restrictions related to blowing agents	Polyurethane and Latex: concentration limits and VOC (Volatile Organic Compounds) emissions for polyurethane and latex. The concentration of aromatic diisocyanates and blowing agents are also restricted in PUR.
		Foamed Synthetic Materials: Formaldehyde emissions restrictions resulting from the laundering process.	Foamed Synthetic Materials: Limits on emissions from substances used in foamed synthetic materials, including formaldehyde and others.	Foamed Synthetic Materials: Latex foam and specifies restrictions regarding its concentration and volatile organic compounds (VOC) emissions.
		Polycyclic Aromatic Hydrocarbons (PAHs): Not referenced	Polycyclic Aromatic Hydrocarbons (PAHs): For foamed synthetic materials such as polyurethane, latex, and expanded polystyrene, the content of each PAH stated in the requirement shall be below 0.5 mg/kg.	Polycyclic Aromatic Hydrocarbons (PAHs): Not mentioned

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
	Verification	Fibres: follow their fibre verification methods		Fibres: Not explicitly mentioned
		Emissions from PUR and latex foams: not mentioned	Emissions from PUR and latex foams: same standard for verification, but different verification methods.	
		Polyurethane: not mentioned	Polyurethane: Declaration of Conformity (DoC) regarding blowing agents	Polyurethane: Declaration of Conformity (DoC) and test reports on limit values for additives and emissions (CFCs and VOCs).
		PAHs: not mentioned	PAHs: tested by ISO 18287 or ZEK 01.2-08 (GC/MS)	PAHs: not mentioned
Feathers and downs	**Requirement**	N.A	Ethical requirements: prohibit using feathers and down plucked from live birds or forced feeding birds	
			Includes recycled down and feather	N.A
			Microbial cleanliness: must document microbial purity and comply with the oxygen index number of max. 10 and fat content	Microbial cleanliness: requirements for down and feathers regarding oxygen index, microbiological state, mesophil aerobic bacteria count, faecal streptococci count, sulphite reducing clostridium count, presence of salmonella, oil and grease content, turbidity, pH
			Labelling: requires labelling feathers and down-filling materials; Blue Angel Ecolabel does not mention it.	Labelling: Does not mention it.
			Wastewater: The given text does not provide specific wastewater discharge standards.	Wastewater: detailed wastewater discharge standards, including limits for various parameters and pH and temperature requirements.
	Verification	N.A	Adherence to the Down Standard or an equivalent.	Submission of audit reports from testing institutions.
			For recycled materials, either a Recycled Global Standard certificate or supplier documentation is required.	N.A
			N.A	For wastewater: compliance with the requirements. A declaration of conformity from the processing plant operator and test reports.

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Coating, laminates and membranes	**Requirement**	Focuses on specific criteria for polyurethane and polyester, including workplace emissions, antimony content, and VOC emissions. Addresses restrictions on phthalates in polymers. Allows the use of fluoropolymer membranes and laminates but with restrictions on PFOA. Does not mention adhesives.	It covers requirements for textiles used as substrates, including materials for coatings, laminates, and membranes. Specifies criteria for recycled and biobased raw materials, including palm oil, soybean oil, and soy flour restrictions. Specifically, if a polymer constitutes more than 5% by weight of the finished fabric, it must be either 100% recycled or composed of at least 90% bio-based raw material. Prohibits halogenated polymers and sets requirements for additives (CLP Regulation 1272/2008) in polymers. Lists various prohibited substances and materials, such as siloxanes, flame retardants, PFCs, and heavy metals. Covers adhesives used in the laminating process.	Focuses on requirements for laminates and membranes used in products. Addresses textile and membrane materials. Requires compliance with recycled materials (at least 30%) or avoiding organic solvents for polyurethane membranes. Allows only specific types of adhesives (thermoplastic or reactive hot melt) and prohibits solvent-based adhesives. Using reactive polyurethane-based hot melt adhesives sets limits for aromatic diisocyanates in workplaces. Includes criteria for functional products, with exclusion criteria for certain substances and materials, such as biocides, flame retardants, PFCs, and VOCs.
	Verification	For polyester components, compliance involves meeting standard fibre criteria. There are specific requirements related to antimony content and VOC emissions.	Verification procedures align with specified fibre criteria. A Declaration of Conformity confirms the absence of blowing agents for polyurethane components.	Verifies textiles against fibre criteria. They have specific requirements related to recycled materials and antimony content. Verification relies on the Declaration of Conformity (DoC) process.
Accessories	**Requirement**	N.A	Zippers, buttons, and non-textile accessories are limited if they do not have a practical purpose.	N.A
		Concentration of metals: Nickel migration 0.5 µg/cm2/week Lead 90 mg/kg Cadmium -> Intended for children under 3 y -> 50 mg/kg Others 100 mg/kg Chrome 60 mg/kg Mercury 60 mg/kg	Concentration of metals: Lead (Pb): 90 mg/kg. Cadmium (Cd): 40 mg/kg Nickel (Ni): migration limit must be less than 0.5 micrograms/cm^2/week	Concentration of metals: Lead 90mg/kg; Cadmium: 50 mg/kg; Chromium: 60 mg/kg. Nickel: migration value for metal alloys is 0.5 ug/cm^2/week.
		Plastic accessories cannot have phthalates		
		N.A	Restrictions on chlorinated plastics	N.A

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
	Verification	Nickel test migration and testing for other metals.		
		Phthalate Testing	Declaration from the manufacturer of the plastic material that the plastic meets the requirement.	Phthalate Testing
		N.A	Declaration from the Licensee that no details or accessories are used without a practical function.	N.A

Table 109. Fitness for use - comparison among Ecolabels

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Dimensional changes during washing and drying	**Requirement**	This does not apply to fibres or yarn labelled "dry clean only." or equivalent, and furniture fabrics that are not removable and washable. Knitted products +-4.0% Chunky knit +-6% Interlock +-5% Woven fabrics: cotton, cotton mix +-3%, wool mix and synthetic fibres +-2% Socks and hosiery, bathroom linen +-8% Washable and removable woven upholstery +-2% Woven Mattress ticking +-3% Non-woven mattress ticking +5% All other non-woven fabric +6%	Not apply to fibres or yarn, products labelled “dry clean only”, and upholstery fabrics not removable and washable. Knitted products and hosiery +-5.0% 100% Wool knitwear +-10% Curtains and upholstery cover removable and washable +-2% Woven fabrics for duvets and pillows +-5% Woven textiles of wool blend and synthetic fibres +-2% Woven textiles not covered by the categories above +-3% Bedding, tablecloths and napkins +-5% Terry towels and washcloths +-7%	Not apply to fibres or yarn, products labelled “dry clean only”, not removable and washable furniture fabrics. Knitted products +-5.0% Chunky knit +-6% House and home textiles +-8% Woven fabrics: cotton, cotton mix, linen, flax and silk +-3%, cotton and cotton mix for bedding and wool mix +-5%, and synthetic fibres +-2% Socks and hosiery +-5% Bathroom linen, including terry towelling and fine rib fabrics +-8% Regenerated and synthetic woven fabrics +-3% Regenerated and synthetic knitted fabrics +-5%
	Verification	For domestic washing, EN ISO 6330 combined with EN ISO 5077. For commercial washings, ISO 15797 combined with EN ISO 5077.	For domestic washing, EN ISO 6330 combined with EN ISO 5077. For commercial washings, ISO 15797 combined with EN ISO 5077. Woven products for duvets and pillows with feathers and down filling tested with EN 13186	DIN EN ISO 6330 combined with EN ISO 5077.

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Tear Strength	**Requirement**	N.A	Trousers, shorts, skirts 1.5daN Jackets and coats 1.2daN Sportswear, ski clothing, and other outdoor wear 1.2daN Lingerie, pyjamas, and other nightwear 0.8daN T-shirts, blouses, shirts, and dresses 0.8daN Swimwear 1.0 daN Bed linen and sheets 0.8daN Towels 0.8daN	N.A
	Verification	N.A	ISO 13937	N.A
Tensile Strength	**Requirement**	N.A	Trousers, shorts, skirts 18daN Jackets and coats 15daN Sportswear, ski clothing, and other outdoor wear 18daN Lingerie, pyjamas, and other nightwear 12daN T-shirts, blouses, shirts, and dresses 12daN Swimwear 15 daN Bed linen and sheets 12daN Towels 12daN	N.A
	Verification	N.A	ISO 13934-2	N.A
Seam Strength	**Requirement**	N.A	Woven fabrics The seam in the lining 80N Textile with fabric weight <220g/m2 150N Textile with fabric weight >220g/m2 200N Backpacks and bags 200N	N.A
	Verification	N.A	ISO 13935-2	N.A

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Seam Slippage resistance	**Requirement**	N.A	*If testing with EN-ISO 13936-1* Trousers, shorts, skirts 4mm at 14 daN load Jackets and coats 4mm at 14 daN load Sportswear, ski clothing, and other outdoor wear 4mm at 14 daN load Lingerie, pyjamas, and other nightwear 4mm at 10 daN load T-shirts, blouses, shirts, and dresses 4mm at 11 daN load Swimwear 4mm at 14 daN load Bed linen and sheets 4mm at 10 daN load *If testing with EN-ISO 13936-2* Trousers, shorts, skirts 12 daN load at 3mm Jackets and coats 12 daN load at 4mm Sportswear, ski clothing, and other outdoor wear 12 daN load at 4mm Lingerie, pyjamas, and other nightwear 6 daN load at 3mm T-shirts, blouses, shirts, and dresses 6 daN load Swimwear 4mm at 14 daN load at 3mm Bed linen and sheets 6 daN load at 3mm	N.A
	Verification	N.A	ISO 13936-1 or ISO 13936-2	N.A
Colour fastness to washing	**Requirement**	At least 3-4 for colour change and staining It does not apply to products labelled “dry clean only”, to white products or products that are neither dyed nor printed or to non-washable furniture fabrics.	Level 3-4 for colour change and discolouration It does not apply to white products, products that are neither dyed nor printed or non-washable furniture fabrics.	At least levels 3-4 according to ISO 105-A03 or A04 and A02 or A05. It does not apply to products labelled “dry clean only,” indigo-dyed denim, or end products that are neither dyed, printed nor non-washable furniture fabrics.
	Verification	For domestic washing, ISO 105 C06. For industrial washing, ISO 15797 combined with ISO 105 C06.	Test method for wash: ISO 105 C06. Test method for dry cleaning: ISO 105 D01	ISO 105-C06
Colour fastness to perspiration	**Requirement**	At least levels 3-4 according to ISO 105. It does not apply to white products, products neither printed or dyed, furniture fabrics, curtains, and similar textiles intended for interior decoration	Underwear, sportswear, and t-shirts must meet: For discolouration: level 4 -For staining: level 4	At least levels 3-4 according to ISO 105-A03 or A04 and A02 or A05. It does not apply to printed or dyed products, curtains, and similar textiles intended for interior decoration except cushions.

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
(acid alkaline)			Level 3 is permitted for textiles that are dark in colour and/or made from recycled wool. It does not apply to white products or end products that are neither dyed nor printed.	
	Verification	ISO 105 E04		
Colour fastness to saliva	**Requirement**	N.A	Baby clothes must meet the following standards: -For discolouration: level 4 -For staining: level 4 Level 3 is permitted for textiles that are dark in colour and/or made from recycled wool. This requirement does not apply to white products or end products that are neither dyed nor printed.	Colour fast level 5 for baby and children products according to DIN 53160-1. This requirement does not apply to end products that are neither dyed nor printed.
	Verification	N.A	ISO 105-A06	§64 of the LFGB, B 82. 92-3 and BVL B 82.92-13 in combination with DIN 53160-1
Colour fastness to wet rubbing	**Requirement**	At least level 2-3. Level 2 allowed for dark-dyed denim. Level of 1 for all other denim colour shades It does not apply to white products, products neither printed nor dyed.	At least level 3-4 It does not apply to white products, products neither printed nor dyed Dark coloured denim level 1-2 Medium-coloured denim level 2-3	At least levels 2-3. For dark colours level 2, according to DIN EN ISO 105-A03 or A04 and A02 or A05. It does not apply to dyed or printed.
	Verification	ISO105 X12		
Colour fastness to dry rubbing	**Requirement**	At least level 4. Levels 3-4 are allowed for dark-dyed denim. Level of 2-3 for all other denim colour shades It does not apply to white products, products neither printed nor dyed, curtains, and similar textiles intended for interior decoration.	At least level 4. It does not apply to white products, products neither printed nor dyed, curtains, and similar textiles intended for home furnishing textiles. Dark-coloured denim level 3	At least levels 3-4 for dark colours and level 3 for denim. It does not apply to dyed or printed interior decoration.
	Verification	ISO105 X12		
Colour fastness to light	**Requirement**	At least level 5 for furniture, curtains, or drapes. At least level 4 for all other products. It does not apply to mattress ticking, mattress protection, or underwear.	At least level 5 for outwear, swimwear, UV-protecting clothing, furniture, curtains, and drapery. The requirement does not apply to white textiles, mattress covers, and mattress protectors.	At least level 5 for furniture, curtains, or drapes. At least level 4 for all other products, This requirement does not apply to mattress ticking, protection, or underwear.

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
	Verification	ISO105 B02		
Wash resistance and absorbency of cleaning products	**Requirement**	Woven and non-woven products for wet cleaning 80 washes, 40ºC Microfibre products for dusting 200 washes, 40ºC Products deriving from recycled textile fibres 20 washes, 30ºC Mop for washing floors 200 washes, 60ºC Cloths for washing floors 5 washes 30ºC Absorbency of cleaning products Products deriving from recycled textile fibres, Microfibre products for surface and floor cleaning, woven and non-woven products for wet cleaning, and products for washing floors <= 10 seconds	N.A	N.A
	Verification	EN ISO 6630	N.A	N.A
Resistance to abrasion	**Requirement**	N.A	Number of rubs/abrasions (Martindale) 50.000 cycles for commercial upholstery 30.000 cycles for workwear for outdoor use and domestic upholstery 20.000 cycles for workwear for indoor use, trousers, shorts and skirts, sportswear, ski clothing and other outdoor wear, swimwear 16.000 cycles for jackets and coats 12.000 cycles for T-shirts, blouses, shirts and dresses 10.000 cycles for lingerie, pyjamas, and other nightwear, bed linen, and sheets 8.000 cycles for knitting	N.A
	Verification	N.A	EN ISO 12947-2	N.A
Resistance to pilling	**Requirement**	Minimum of 3 for non-woven fabrics and knitted garments, accessories, and blankets made of wool, wool blends, and polyester woven cotton. Minimum of 2 for polyamide tights and leggings.	Minimum of 4 for clothing woven fabric, fleece, and upholstery for professional use. Minimum of 3-4 for upholstery for private use and upholstery of wool or wool blends for professional use. Minimum of 2-3 for clothing woven fabric with raised surface and knitting.	Non-woven fabrics and knitted garments, accessories, and blankets made of wool, wool mixes, and polyester must resist pilling up to a minimum rating of 3. Woven cotton fabrics used for garments must also resist pilling up to a minimum rating of 3. Polyamide tights and leggings must resist pilling up to a minimum rating of 2.
	Verification	-Knitted and non-woven: ISO 12945-1 Pill box method -Woven: ISO 12945-2 Martindale method	ISO 12945-2	-Knitted and non-woven: ISO 12945-1 Pill box method -Woven: ISO 12945-2 Martindale method

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Durability of function	**Requirement**	Oil repellents shall retain the functionality of 3.5 out of 4 Stain repellents shall retain functionality of 3.0 out of 5.0 Washable products shall retain functionality after 50 industrial wash and tumble dry cycles at a minimum of 75ºC. Non-washable products shall retain their functionality after a soak test. Natural fibres shall achieve an SA-3 fabric smoothness grade. Blended natural and synthetic fibres with an SA-4 fabric smoothness grade after 10 domestic wash and tumble-drying cycles at 40ºC.	N.A	Water repellents shall retain the functionality of 80 out of 90 after 5 domestic wash and tumble dry cycles at 40ºC or after 5 industrial washing and drying cycles at a minimum of 75ºC. Industrial washing temperatures may be reduced to 60ºC for garments with taped seams. Care instructions on the reimpregnation of the product must be supplied with the textile. Washable products shall retain functionality after 25 industrial wash and tumble dry cycles by care instructions. Non-washable products shall retain their functionality after a soak test. Natural fibre products shall achieve an SA-3 fabric smoothness grade. Blended natural and synthetic fibres with an SA-4 fabric smoothness grade after 10 domestic wash and tumble-drying cycles at 40ºC.
	Verification	Water repellent function Domestic washing ISO 6330 in combination with ISO 4920 Industrial washing ISO15797 in combination with ISO 4920 Oil repellent function Domestic washing ISO 6330 in combination with ISO 14419 Industrial washing ISO 15797 in combination with ISO 14419 Stain repellent function Domestic washing ISO 6330 in combination with ISO 22958 Industrial washing ISO 15797 in combination with ISO 22958 Flame retardant Domestic washing ISO 6330 in combination with ISO 12138 Industrial washing ISO10528 in combination with ISO 12138 Easy care function ISO 7768	N.A	Water repellent function Domestic washing ISO 6330 in combination with ISO 4920 Industrial washing ISO15797 in combination with ISO 4920 Flame retardant Domestic washing ISO 6330 in combination with ISO 12138 Industrial washing ISO10528 in combination with ISO 12138 Easy care function ISO 7768

Table 110. Chemicals and processes - comparison among Ecolabels

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Substance restrictions or specific chemical requirements	**Requirement restricted substances**	The 3 labels refer to restrictions imposed by REACH (1907/2006/EC), the Candidate List of substances of very high concern for Authorisation with reference to ECHA, and CLP Regulation (EC/1272/2008) and Restricted Substances List (RSL by REACH), with the following indications: *EUEL and BA approach per process/service; meanwhile, NS focuses on categorising ingoing substances. *at the general level, EUEL lists products included in product categories. Meanwhile, NS and BA highlight the general substance category, except where lists are also indicated. *most substances with requirements indicated in the 3 ecolabels coincide, including most of the testing methods, with some exceptions, and are presented in different manners that could be different naming and quantification (as units of measurement).		
		Halogenated carriers (referred to in Nordic Ecolabel and Blue Angel as chlorinated agents) for bleaching and dyeing	Chlorinated solvents as carriers agents (referred to as Halogenated carriers in EUEL)	Chlorinated solvents and carriers agents (Halogenated carriers in EUEL) for bleaching. The only label indicating limits for chlorinated benzenes and toluenes.
		Azo dyes (25 azo dyes listed)	Azo dyes (35 azo dyes listed): additional from EUEL and Blue Angel are the 10 following: 2-amino-4-nitrophenol 99-57-0 m-phenylenediamine 108-45-2 2-amino-5-nitrothiazole 121-66-4 2-amino-5-nitrophenol 121-88-0 p-aminophenol 123-30-80 p-phenetidine 156-43-4 2-methyl-phenylenediamine,2,5diaminotoluene 615-50-9 2-methyl-phenylenediamine,2,5diaminotoluene 95-70-5 2-methyl-phenylenediamine, 2,5 diaminotolunene 25376-45-8 6-chloro-2,4-dinitroaniline 3531-19-9	Azo dyes (25 azo dyes listed)
		CMR dyes and Potentially sensitising dyes	Not specifically mentioned	CMR dyes and potentially sensitising dyes
		Chrome mordant dyes are not permitted.	Mention of chromium in metal dyes	Chrome mordant dyes are not permitted
		Metal complex dyes based on copper, chrome, and nickel shall only be permitted for dyeing: wool, polyamide, and blends of wool and/or polyamide with man-made cellulose fibres.	Only metal complex dyes and pigments based on copper that comprise a maximum of 5% by weight may be used to dye wool, polyamide, a blend of wool, and/or polyamide with regenerated cellulose fibre.	No specific mention (but testing measures for direct and indirect discharge of wastewater)
		Plastisol binders banned	mentioned just in Re-used textiles, hides/skins, leather	restriction less than 1,000mg/Kg
		Biocide finishes banned	Biocides and antibacterial banned	Biocides are banned, but in-con preservatives are permitted
		Anti-felting and shrink resistance restricted	not specifically mentioned	Anti-felting and shrink resistance restricted

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
		Water, stain and oil repellent treatments	not specifically mentioned	Water, stain and oil repellent treatments
		Flame retardants (list of banned substances included)	Flame retardants (general term) banned	Flame retardants (general term) banned
		not specifically mentioned	not specifically mentioned	Cerium compounds restricted
		Biodegradability: 95% (additional indication: eliminable in wastewater treatment plants)	Biodegradability: similar requirements 95% indicated	Biodegradability: 90% (additional indication: eliminable in wastewater treatment plants)
		APEO generally indicated		APEO specified in the treatment of wool and water discharges
		EDTA, DTPA, and more are generally prohibited substances	EDTA and DTPA in generally prohibited substances	EDTA and DTPA are mentioned only in bleaching processes in regenerated fibres
		N,N-Dimethylacetamide % limits of 0.001%w/w for babies and children under 3 products, 0.005% w/w for products in direct contact with skin and garments with limited contact and interior textiles	not specifically mentioned	N, N-dimethylacetamide, dimethylformamide, and N-methyl pyrrolidone are restricted to 0.1% by mass.
		Formaldehyde residues measured in ppm (16 ppm), but the same verification tests		Formaldehyde residues are measured in mg/kg (20 mg/kg), but the same verification tests.
		Organotin compounds and Chlorophenols are generally indicated and listed	Organotin compounds and Chlorophenols generally indicated	Organotin compounds and Chlorophenols (limits indicated) extended list compared to EUEL and NS
		Prohibited phthalates listed	Prohibited phthalates generally mentioned	Prohibited phthalates listed
		Extractable metals (mg/kg) apply to products intended for babies and children under 3 years old and accessories; the list does not coincide.	Extractable metals - Referred to as Heavy metals measured in ppm, the list does not coincide.	Extractable metals (mg/kg), the same list as EUEL, are also included in accessories.
		Carcinogenic substances referred to in Article 57 of REACH	Carcinogenic substances indicated in the document	Carcinogenic substances referred to in Article 57 of REACH
		Endocrine disruptors in Article 57 of REACH	Endocrine disruptors referencing the EU ED LISTS	Endocrine disruptors in Chapter 1 of the ZDHC MRSL
		Substances referred to in Article 59 of REACH	not specifically mentioned	Substances referred to in Article 59 of REACH
		not specifically mentioned		refers to ZDHC MRSL
		not specifically mentioned	Nanomaterial generally approached	Nanomaterials with H (hazard) phrases
		not specifically mentioned	Silicones, Linear alkylbenzene sulphonates (LAS)	not specifically mentioned
		not specifically mentioned	Polycyclic aromatic hydrocarbons are not comparable with Blue Angel	Polycyclic aromatic hydrocarbons are not similar with Nordic Swan
		not specifically mentioned		Mineral oil defoamers, enzymatic processes, content of soluble proteins from natural rubber, Free aniline in jeans products,

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
				Perfluorinated and polyfluorinated chemicals (PFCs) in hydrophobised textiles, Chinoline/quinoline
	Requirement hazardous substances	Additional hazards are indicated in comparison to Nordic Swan and Blue Angel. Below are the differentiating elements: Acute toxicity: H304 (R65) and EUH070 (R39/41) -different than Nordic Swan Specific target organ toxicity: H371 (R68/20, R68/21, R68/22) and H373 (R48/20, R48/21, R48/22) -different than Nordic Swan Respiratory and skin sensitisation, carcinogenic, mutagenic or toxic for reproduction (divided in Nordic Swan: Germ cell mutagenicity*, Carcinogenicity*, Reproductive toxicity*), Hazardous to the aquatic environment, (H412 (R52/ 53) and H413 (R53)-different than Nordic Swan)Respiratory and skin sensitisation, carcinogenic, mutagenic or toxic for reproduction (divided in Nordic Swan: Germ cell mutagenicity, Carcinogenicity, Reproductive toxicity), Hazardous to the aquatic environment, (H412 (R52/ 53) and H413 (R53)-different than Nordic Swan) Hazardous to the ozone layer (EUH059 (R59)-different than Nordic Swan).	Less than EUEL and Blue Angel. Below are missing hazard phrases: Acute toxicity: H304 (R65) and EUH070 (R39/41)-different than EUEL and Blue Angel Acute toxicity: H304 (R65) and EUH070 (R39/41)-different than EUEL and Blue Angel Specific target organ toxicity: H371 (R68/20, R68/21, R68/22) and H373 (R48/20, R48/21, R48/22)-different than EUEL and Blue Angel Respiratory and skin sensitisation, carcinogenic, mutagenic or toxic for reproduction (divided in Nordic Swan: Germ cell mutagenicity*, Carcinogenicity*, Reproductive toxicity*) -different than EUEL and Blue Angel Respiratory and skin sensitisation, carcinogenic, mutagenic or toxic for reproduction (divided in Nordic Swan: Germ cell mutagenicity, Carcinogenicity, Reproductive toxicity) -different than EUEL and Blue Angel Hazardous to the aquatic environment: H412 (R52/ 53) and H413 (R53)-different than EUEL and Blue Angel Hazardous to the ozone layer (EUH059 (R59)- different than EU EL but identical with Blue Angel due to H420).	Less than EUEL. Below are missing hazard phrases: Acute toxicity: EUH070 (R39/41) -different than EU EL Specific target organ toxicity: no difference with EU EL Respiratory and skin sensitisation, carcinogenic, mutagenic, or toxic for reproduction (referred to in Blue Angel as Carcinogenic, mutagenic, and reprotoxic substances)-no difference with EU EL Hazardous to the aquatic environment (referred to in Blue Angel as Water-hazardous substances)-no difference with EU EL Hazardous to the ozone layer (EUH059 (R59)-different than EU EL but identical with Nordic Swan due to H420).
	Verification	Mainly, the provision of declarations of compliance with the requirements is supported by evidence such as technical datasheets or test reports showing fulfilment of the requirement. Manufacturing facilities, associated chemical providers, and analytical labs must adhere to the outlined testing procedures. Where required, product analysis tests shall be conducted yearly throughout the licensing term, and the results must be forwarded to the relevant authoritative organisation for confirmation.		
Washing, drying and curing energy efficiency	**Requirement**	Similar general BAT themes: 1. general energy management, 2. washing and rinsing, and 3. drying and curing using stretchers		
		Similar 15 techniques among the 3 ecolabels	2 additional techniques are almost identical to Blue Angel: 1) Combining multiple wet treatments into one process. 2) Using solar thermal panels, solar photovoltaic panels, or a heat recovery system for hot water, aiming to generate energy amounting to 30% of what the process requires.	Almost identically presented techniques with Nordic Swan
	Verification	The same testing: I SO 50001 or equivalent systems for energy or carbon dioxide emissions		

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Treatment of emissions to water	**Requirement**	Emissions to water: TREATED: 20 g COD/kg textiles processed: applied to weaving, dyeing, printing, and finishing processes used to manufacture the product(s). Measured downstream of on-site wastewater treatment plant and/or off-site wastewater treatment plant receiving wastewater from these processing sites. DIRECT DISCHARGE: IF Effluent is treated on-site and discharged directly to surface waters: 1) pH between 6,0 and 9,0 (unless the pH of the receiving water is outside this range) 2) temperature of less than 35C (unless the temperature of the receiving water is above this value) If colour removal is required:436 nm (yellow sector) 7 m-1, (ii) 525 nm (red sector) 5 m-1, (iii) 620 nm (blue sector) 3 m-1- with BA	Emissions to water: TREATED: COD (chemical oxygen demand) in wastewater from wet processes which is discharged to surface water after treatment shall not exceed 150 mg/L DIRECT DISCHARGE: The pH value of the wastewater released to the surface water shall be between 6 and 9 (unless the pH value in the recipient lies outside this interval). The wastewater released to the surface water shall be lower than 40°C (unless the temperature in the recipient is higher).	Emissions to water: •COD: 100 mg/l (expressed as an average yearly value), • BOD5: 30 mg/l, • Sulphite: 1 mg/l, • Ammonium nitrogen: 10 mg/l, • Total nitrogen: 15 mg/l, • Total phosphorous: 2 mg/l, The dye must comply with the following values: Spectral absorption coefficient at with EUEL *436 nm (yellow spectral region) 7 m-1 *525 nm (red spectral region) 5 m-1 *620 nm (blue spectral region) 3 m-1 • Toxicity to fish eggs GEI: 2 • The pH value of the wastewater discharged to surface waters must be between 6 and 9 (unless the pH value of the receiving waters is outside this range), and the temperature must be below 35 °C (unless the temperature of the receiving waters is already above this limit). Before mixing (direct and indirect discharge) • AOX: 0.5 mg/l, • Sulphide: <=1 mg/l, • Copper: 0.4 mg/l, • Nickel: 0.2 mg/l, • Total chromium: 0.3 mg/l, • Tin: 2 mg/l, • Zinc: 0.8 mg/l, • Antimony: 1.2 mg/l

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
	Verification	Detailed documentation and test reports, using ISO 6060 and ISO 7887 as relevant+ compliance with this criterion based on monthly averages for the six months preceding the application	COD content shall be tested by ISO 6060 or equivalent. test report+ procedure in place for annual testing in line with the requirement and for ensuring compliance with the requirement Report showing average monthly calculations of COD, pH, and temperature for at least three of the past 12 months	Declare compliance, declaration of conformity from the operator of the textile finishing plant and test reports verifying compliance TEST METHODS: COD: ISO 6060 or DIN 38409-41 or DIN 38409-44 or DIN ISO 15705, BOD: DIN EN 1899-2 or ISO 5815-1, Copper and nickel: ISO 8288, Total chromium: ISO 9174 or DIN EN 1233, Sulphide: DIN 38405-27 or ISO 10530, Sulphite: DIN EN ISO 10304-3, Toxicity to fish eggs: DIN EN ISO 15088, AOX (chloride content < 5g/l): DIN EN ISO 9562, Spectral absorption coefficient: DIN 38404-3, Ammonium nitrogen: DIN EN ISO 11732, Total nitrogen: DIN EN ISO 12260, Total phosphorus: DIN EN ISO 11885, Tin: DIN EN ISO 11885, Zinc: DIN EN ISO 11885, Antimony: DIN EN ISO 11885 The wastewater treatment plant must be regularly monitored(at least every six months)
Treatment of emissions to air	**Requirement**	Emissions to air: Emission of organic compounds (not comparable with the other eco-labels) from thermosetting, thermosoling, coating, and impregnating textiles, including their respective drying (centre) facilities.	Emissions to air: Emissions from printing pastes and foamed synthetic materials indicating different substances (not comparable with other ecolabels)	Emissions to air: Emission of organic compounds to air in the textile finishing process in thermosetting, thermosoling, coating, impregnating, or finishing of textiles (not comparable with the other ecolabels) Additional emission from firing systems in the textile finishing process in thermosetting, thermosoling, coating, impregnating, or finishing of textiles with a strict list of limitations

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
	Verification	Compliance according to EN 12619 or other equivalent standards. Monthly averages for the total emissions of organic compounds from production sites shall be provided for the six months preceding the application.	Declaration from the producer or supplier and emission testing according to the ISO 16000 standard, parts 3, 6, 9, & 11	Compliance by DIN EN 12619 (total gaseous organic carbon), DIN CEN/TS 17638 (formaldehyde) and DIN EN ISO 21877 (ammonia). For firing systems: testing: Depending on the heating capacity, the heating boilers must be tested as follows: - 0.3 MW to 2 MW every 3 years - > 2 MW at least yearly - > 5 MW continuously

Table 111. Corporate social responsibility - comparison among Ecolabels

Topic	Requirement / Verification	EU Ecolabel	Nordic Swan	Blue Angel
Fundamental principles and rights at work	**Requirement**	Worker principles based on ILO Conventions. UN Global Compact and OECD Guidelines for Manufacturing Principles.	Must comply with the relevant national laws and regulations and the ILO Conventions. Some extra requirements were added for product licenses.	Must comply with the social and human rights requirements for the Green Button 2.0
	Verification	Third-party verification, including site visits by auditors. In countries where the ILO Labour Inspection Convention, 1947 (No 81) has been ratified, ILO supervision indicates that the national labour inspection system is effective and verification by labour inspector(s) appointed by a public authority shall be accepted.	Third-party verification (BSCI audit report) or SA8000 certificate for manufacturing. Description of code of conduct, policy and routine for produce licence.	Test report from an auditing body or SA8000 certificate.
Restriction on the sandblasting of denim	**Requirement**	Manual and mechanical sandblasting is prohibited.	Manual and mechanical sandblasting is prohibited. The use of potassium permanganate is not permitted.	
	Verification	The applicant must provide details of all production sites—evidence of the alternative processes to achieve distressed denim finishes.	Declaration stating the method used and that the requirement is fulfilled.	The applicant must provide details of all production sites. Evidence of the alternative processes used to achieve distressed denim finishes. Confirmation that no mechanical sandblasting or potassium permanganate is used.

Table 112. Miscellaneous criteria - comparison among Ecolabels

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Information appearing on the Ecolabel	**Requirement**	The label may optionally contain text like: - More sustainable fibre production or a text defined in ECOLABEL, depending on product content. -Less polluting production processes -Restrictions on hazardous substances -Tested for durability	Mandatory information: - Product Type - Name and the fibre composition -All fabrics, their name, and % by weight -Membranes/coatings, impregnations or laminates -Details/accessories with information on the material type -Fillings and stuffing with information of the material type -Information on all recycled or biobased materials -If reused	Fibres are used by Regulation EC 1007/2011. Care and cleaning information (textile care symbols) by GINETEX or ISO EN DIN3758 and ISO10023 for industrial washing textiles. Information on repairable or replaceable parts of the textile.
	Verification	Label sample + DoC	Schematic overview	Label sample + DoC
Packaging	**Requirement**	N.A	PVC must not be used -It shall be possible to recycle the main material - Only monomaterials shall be used. Multi-material hangers are allowed if reused in a textile manufacturer's take-back system. - Plastic packaging shall be made from PE, PP, or PET. - Coloured plastic cannot be used for virgin plastic feedstock. Only if at least 50% by weight of the plastic is recycled material is colouring permitted. - Information on how it can be sorted for recycling - Chlorophenols and their salts, PCB, and organotin compounds shall not be used in transport or storage.	Mandatory description. Unnecessary packaging must be avoided. Composite packaging is not permitted and may not contain any dimethyl fumarate. The requirements apply to repackaging and transport, sales, and delivery of packaging directly used by the applicant. Clothes hangers are exempt.
	Verification	N.A	Declaration of Compliance about who is responsible for the product's primary packaging. Declaration of Compliance about PVC from the manufacturer of plastic material. Description of the main material and how it can be recycled. Description of primary packaging documenting compliance. Multi-material hangers: textile manufacturer's procedure describing the take-back system for hangers. Product labels or artwork providing information on recycling. Suppliers must declare that chlorophenols are not used in the yarn, fabric, or end product or have a valid license certificate for the EU Ecolabel.	DoC and a description of the intended packaging solution, designation and composition, raw materials and their origin, and a sample of the product packaging where relevant.
Unsold textiles	**Requirement**	N.A	Unsold textiles must not be sent for incineration or dumped in landfills. The brand owner must inform Nordic Swan Ecolabelling and state how they deal with unsold products on their website.	N.A

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
			Products with contaminations that are harmful to the environment or health are exempt. Military and police uniforms are exempt.	
	Verification	N.A	Description of how unsold products are dealt with and its procedure.	N.A
Reused textiles	**Requirement**	N.A	The material shall not come from workwear and other textiles used in the chemical and oil industry -The material must not contain plastisol print - Textiles from the health care sector must be washed, inactivating microorganisms. - Material originally eco-labelled with the Nordic Swan Ecolabel, the EU Ecolabel, GORS, or Bra Miljöval or have Oeko-Tex 100 or only be used for furnishing fabrics such as rugs, tablecloths If re-designed for professional use, the product must fulfil the expected function. If processed with chemical products, the requirements for chemicals must be accomplished.	N.A
	Verification	N.A	Invoice or label on the textile -Documentation showing that the textile used is reused - Declaration that the textile has been washed in an industrial laundry in a microbiological wash - Declaration that The material does not contain PVC	N.A
Reduced washing	**Requirement**	N.A	The text "Reduce the number of washes and help save energy and reduce climate impact" must be included.	N.A
	Verification	N.A	Photo	N.A
Production Chain	**Requirement**	N.A	Description of all the production methods/treatment techniques, including production by suppliers. -Name of the fibres, yarns, and fabrics -Information of all the actors in the production chain	N.A
	Verification	N.A	Schematic overview	N.A

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Materials limitations	**Requirement**	N.A	The sewing thread is not covered -Embroidery thread applies chemical requirements -Belt buckles of metals must not exceed 25% by weight -Fibre types with less than 5% by weight are exempt. -Small textile elements present between 5% to 10% by weight may be exempted from the requirements of the textile element has an EU-Ecolabel or GOTS or Oeko Tex 100 class I certificate - For elastic bands, up to a total of 25% of the product's weight may be exempted from the requirements if GOTS or Oeko-Tex 100 class I certification - Information printed directly on the textile product must meet the requirements of prohibited substances	N.A
	Verification	N.A	Declaration of Compliance and certificate where applicable. If Oeko Tex 100: Statement regarding fluorinated organic compounds	N.A
Quality and regulatory requirements	**Requirement**	N.A	Written documentation obtained annually showing that suppliers are familiar with Nordic Swan Ecolabel's requirements. Supplier changes must be approved. An individual responsible for ensuring the fulfilment should be appointed. The licence must guarantee the quality of the labelled product during the validity period. Written notice must be given in case of changes. Nonconformities must be reported. Traceable product.	N.A
	Verification	N.A	Documentation, operational chart and procedures description.	N.A
Traceability of the Nordic Swan Ecolabelled product	**Requirement**	N.A	The brand owner is responsible for ensuring that a Nordic Swan Ecolabelled product can be traced back to a production licence.	N.A
	Verification	N.A	-The brand owner must submit the information specified in the requirement. - A description of the procedure, which shows how it is ensured that the information held by Nordic Ecolabelling is kept updated.	N.A

Table 113. Dyes restriction - comparison among Ecolabels

Topic	Requirement/ Verification	EU Ecolabel	Nordic Swan	Blue Angel
Carcinogenic aromatic amines	**Requirement**	The same 25 dyes listed, limitation: 30 mg/kg for each amine	Prohibited: the same 25 dyes listed + 10 additional dyes	The same 25 dyes listed limitation: 20 mg/kg for each amine
	Verification	Test results: EN 14362-1 and 3.	Prohibited: Declaration from the chemical manufacturer or chemical supplier that the requirement is fulfilled	Test results: EN 14362-1 and 3.
List of dyes that may cleave to carcinogenic aromatic amines	**Requirement**	An extended list of prohibited disperse, basic, acid and direct dyes limitation: 30 mg/kg for each amine	There is no specific dyes list, but in the section addressed to recycled fibres, there are limitations for cleavable dyes according to Oeko-Tex 100 Annex 5	Azo dyes that may cleave to one of the aromatic amines must not exceed a limit value of 20 mg/kg.
	Verification	Test results: EN 14362-1 and 3.	Cleavable, classified as carcinogenic in Oeko-Tex Annex 5: Total 20 mg/kg Cleavable aniline as listed in Oeko-Tex Annex 5: Total 100 mg/kg Test reports or Oeko-Tex 100 class I certificate showing fulfilment of the requirement	20 mg/kg for each dye Test results by the test method DIN EN 14362-1 and, DIN EN 14362-3 (for arylamine), and DIN 54231 (for dispersion dyes).
Dyes that are carcinogenic, mutagenic or toxic to reproduction	**Requirement**	List of prohibited dyes	There is no specific dyes list but criterion O34. Prohibition of CMR substances refers to carcinogenic, mutagenic or toxic to reproduction substances in general.	Extended list of prohibited dyes
	Verification	Prohibited. Declaration of non-use from the chemical supplier supported by SDS.	Declaration from the chemical producer that the requirement has been fulfilled.	Declaration from the chemical producer that the requirement is fulfilled and test results by the test method DIN EN 14362-1 and DIN EN 14362-3 (for arylamine)
Disperse dyes that are potentially sensitising	**Requirement**	List of prohibited dyes	There is no specific dyes list but criterion O33. Classification of chemical products refers to sensitising on inhalation or skin contact substances.	Extended list of prohibited dyes
	Verification	Prohibited. Declaration of non-use from the chemical supplier supported by SDS.	Declaration from the chemical producer that the requirement has been fulfilled.	Declaration from the chemical producer that the requirement is fulfilled and test results by the test method DIN EN 14362-1 and DIN EN 14362-3 (for arylamine)+

10.8 Supporting information about public procurement

10.8.1 The Common Procurement Vocabulary (CPV) codes for products in the scope

Table 114. The Common Procurement Vocabulary (CPV) codes for products in the scope

Product category	Common Procurement Vocabulary (CPV) code
T-shirts	18000000-9*: Clothing, footwear, luggage articles and accessories 18300000-2*: Garments 18318400-5: Vests 18330000-1*: T-shirts and shirts 18331000-8: T-shirts 18235400-9: Waistcoats 18400000-3*: Special clothing and accessories 18410000-6*: Special clothing 18411000-3*: Baby clothing
Shirts and blouses	18000000-9*: Clothing, footwear, luggage articles and accessories 18300000-2*: Garments 18318000-1*: Nightwear 18318100-2: Nightshirts 18318200-3: Dressing gowns 18318300-4*: Pyjamas 18318500-6: Nightdresses 18330000-1*: T-shirts and shirts 18332000-5: Shirts 18333000-2: Polo shirts 18400000-3*: Special clothing and accessories 18410000-6*: Special clothing 18411000-3*: Baby clothing
Sweaters and mid-layers	18000000-9*: Clothing, footwear, luggage articles and accessories 18235000-5: Pullovers, cardigans and similar articles 18235100-6: Pullovers 18235200-7: Cardigans 18235300-8: Sweatshirts 18300000-2*: Garments 18400000-3*: Special clothing and accessories 18410000-6*: Special clothing 18411000-3*: Baby clothing
Jackets and coats	18000000-9*: Clothing, footwear, luggage articles and accessories 18200000-1: Outerwear 18210000-4: Coats 18211000-1: Capes 18212000-8: Cloaks 18213000-5: Wind jackets 18220000-7: Weatherproof clothing 18221000-4: Waterproof clothing 18221100-5: Waterproof capes 18221200-6: Anoraks 18221300-7: Raincoat 18223000-8: Jackets and blazers 18223100-9: Blazers 18223200-0: Jackets 18224000-5: Clothing made of coated or impregnated textile fabrics 18230000-0: Miscellaneous outerwear 18300000-2*: Garments 18400000-3*: Special clothing and accessories 18410000-6*: Special clothing 18411000-3*: Baby clothing
Pants and shorts	18000000-9*: Clothing, footwear, luggage articles and accessories 18233000-1: Shorts 18234000-8: Trousers 18300000-2*: Garments 18318000-1*: Nightwear 18318300-4*: Pyjamas 18400000-3*: Special clothing and accessories 18410000-6*: Special clothing 18411000-3*: Baby clothing

<table>
<tr><th>Product category</th><th>Common Procurement Vocabulary (CPV) code</th></tr>
<tr><td>Dresses: Skirts and jumpsuits</td><td>18000000-9*: Clothing, footwear, luggage articles and accessories
18222100-2: Suits
18222200-3: Ensembles
18231000-7: Dresses
18232000-4: Skirts
18300000-2*: Garments
18400000-3*: Special clothing and accessories
18410000-6*: Special clothing
18411000-3*: Baby clothing</td></tr>
<tr><td>Leggings: Stockings: Tights and socks</td><td>18315000-0: Stockings
18316000-7: Tights
18317000-4: Socks</td></tr>
<tr><td>Underwear</td><td>18310000-5: Underwear
18311000-2: Slips
18312000-9: Underpants
18313000-6: Panties
18320000-8: Brassieres, corsets, suspenders and similar articles
18321000-5: Brassieres
18322000-2: Corsets
18323000-9: Suspenders</td></tr>
<tr><td>Swimwear</td><td>18412800-8: Swimwear</td></tr>
<tr><td>Accessories</td><td>18421000: Handkerchiefs
18422000: Scarves
18423000: Ties
18424000: Gloves
18425000: Belts</td></tr>
</table>

* These CPV codes were assigned to more than one product category

Source: own elaboration based on CPV description provided by BIP Solutions ([213])

[213] BIP Solutions. CPV codes. Available at this link. Last accessed on 12 January 2024.

10.8.2 Number of Contract Award procuring apparel in EU

Table 115. Number of Contracts Award procuring apparel in EU Member States in 2015

Country	CPV 181	CPV 182	CPV 183	CPV 184	CPV 351	CPV 358	CPV 374	Total in the country
Austria	2	NA	NA	3	NA	NA	NA	5
Belgium	10	1	9	4	NA	1	NA	25
Bulgaria	31	1	NA	NA	NA	4	NA	36
Croatia	2	4	1	2	NA	7	NA	16
Cyprus	NA	1	NA	NA	NA	1	NA	2
Czechia	5	5	2	11	1	5	1	30
Denmark	4	NA	NA	6	NA	NA	NA	10
Estonia	NA	2	1	3	1	NA	1	8
Finland	3	NA	4	4	NA	NA	NA	11
France	93	6	11	11	3	5	2	131
Germany	17	10	11	19	3	17	1	78
Greece	1	NA	NA	NA	NA	NA	NA	1
Hungary	1	NA	NA	NA	NA	NA	NA	1
Ireland	NA	NA	NA	NA	NA	NA	NA	0
Italy	8	7	2	3	NA	3	NA	23
Latvia	3	NA	NA	2	NA	NA	NA	5
Lithuania	8	1	3	5	2	5	NA	24
Luxembourg	NA	NA	NA	NA	NA	NA	NA	0
Malta	NA	1	NA	NA	NA	NA	NA	1
Netherlands	3	4	1	4	1	1	NA	14
Poland	18	13	9	21	3	11	NA	75
Portugal	7	1	NA	NA	NA	NA	NA	8
Romania		1	1	4	NA	2	NA	8
Slovakia	2	1	NA	5	NA	NA	NA	8
Slovenia	5	2	NA	NA	NA	3	NA	10
Spain	5	NA	NA	1	NA	1	NA	7
Sweden	13	NA	2	2	NA	NA	2	19
Total per CPV code	241	61	57	110	14	66	7	556

CPV 181: CPV 181XXXXX-X Occupational clothing, special workwear and accessories;
CPV 182: CPV 182XXXXX-X Outerwear;
CPV 183: CPV 183XXXXX-X Garments;
CPV 184: CPV 184XXXXX-X Special clothing and accessories;
CPV 351: CPV 351134XX-X Protective and safety clothing;
CPV 358: CPV 3581XXXX-X Individual and support equipment;
CPV 374: CPV 3741XXXX-X Sport goods and equipment.

Source: own elaboration based on Tenders Electronic Daily (TED) (csv subset) – public procurement notices (129).

Table 116. Number of Contracts Award procuring apparel in EU Member States in 2016

Country	CPV 181	CPV 182	CPV 183	CPV 184	CPV 351	CPV 358	CPV 374	Total in the country
Austria	6	NA	4	1	NA	1	1	13
Belgium	11	4	2	3	NA	3	NA	23
Bulgaria	23	1	NA	1	NA	16	NA	41
Croatia	4	1	1	NA	1	4	NA	11
Cyprus	NA	NA	1	NA	NA	1	NA	2
Czechia	5	9	2	6	2	7	NA	31
Denmark	4	NA	3	1	1	2	1	12
Estonia	2	NA	1	1	NA	1	NA	5
Finland	7	NA	2	1	NA	1	NA	11
France	106	9	11	7	11	10	3	157
Germany	25	10	10	4	6	17	NA	72
Greece	1	NA	NA	NA	NA	NA	NA	1
Hungary	1	NA	NA	1	NA	4	1	7
Ireland	NA	NA	NA	2	NA	NA	NA	2
Italy	5	6	6	1	2	10	NA	30
Latvia	1	NA	1	NA	NA	2	NA	4

Country	CPV 181	CPV 182	CPV 183	CPV 184	CPV 351	CPV 358	CPV 374	Total in the country
Lithuania	3	2	4	9	2	5	1	26
Luxembourg	1	NA	NA	NA	NA	NA	NA	1
Malta	1	NA	NA	NA	NA	NA	NA	1
Netherlands	9	6	1	1	1	1	NA	19
Poland	14	11	4	7	9	12	1	58
Portugal	9	NA	NA	NA	NA	1	NA	10
Romania	2	NA	2	NA	NA	2	NA	6
Slovakia	2	6	2	1	NA	NA	NA	11
Slovenia	11	3	NA	NA	1	7	NA	22
Spain	NA	NA	NA	NA	NA	1	NA	1
Sweden	32	NA	3	NA	1	NA	3	39
Total per CPV code	285	68	60	47	37	108	11	616

CPV 181: CPV 181XXXXX-X Occupational clothing, special workwear and accessories;
CPV 182: CPV 182XXXXX-X Outerwear;
CPV 183: CPV 183XXXXX-X Garments;
CPV 184: CPV 184XXXXX-X Special clothing and accessories;
CPV 351: CPV 351134XX-X Protective and safety clothing;
CPV 358: CPV 3581XXXX-X Individual and support equipment;
CPV 374: CPV 3741XXXX-X Sport goods and equipment.
Source: own elaboration based on Tenders Electronic Daily (TED) (csv subset) – public procurement notices ([129]).

Table 117. Number of Contracts Award procuring apparel in EU Member States in 2017

Country	CPV 181	CPV 182	CPV 183	CPV 184	CPV 351	CPV 358	CPV 374	Total in the country
Austria	5	1	1	2	1	1	1	12
Belgium	13	1	NA	NA	1	3	NA	18
Bulgaria	25	1	2	5	2	22	NA	57
Croatia	5	4	NA	2	NA	5	NA	16
Cyprus	NA	NA	NA	1	NA	NA	NA	1
Czechia	16	32	24	12	2	21	1	108
Denmark	6	1	2	4	NA	1	1	15
Estonia	2	NA	3	2	NA	NA	NA	7
Finland	9	NA	1	NA	NA	1	NA	11
France	126	7	14	12	12	6	2	179
Germany	37	16	8	5	4	16	2	88
Greece	NA	NA	1	NA	NA	1	NA	2
Hungary	5	NA	NA	2	1	4	NA	12
Ireland	1	NA	NA	NA	NA	NA	NA	1
Italy	9	4	2	3	4	8	NA	30
Latvia	3	NA	NA	4	NA	5	NA	12
Lithuania	5	NA	2	8	2	3	NA	20
Luxembourg	NA	NA	NA	NA	NA	NA	NA	0
Malta	1	1	2	NA	NA	1	NA	5
Netherlands	10	4	2	3	2	4	NA	25
Poland	19	16	16	19	13	18	1	102
Portugal	NA	NA	NA	NA	1	NA	NA	1
Romania	1	NA	1	3	NA	2	NA	7
Slovakia	5	3	4	2	1	1	NA	16
Slovenia	23	2	NA	8	2	6	NA	41
Spain	5	NA	NA	NA	NA	NA	NA	5
Sweden	29	NA	3	NA	2	4	NA	38
Total per CPV code	360	93	88	97	50	133	8	829

CPV 181: CPV 181XXXXX-X Occupational clothing, special workwear and accessories;
CPV 182: CPV 182XXXXX-X Outerwear;
CPV 183: CPV 183XXXXX-X Garments;
CPV 184: CPV 184XXXXX-X Special clothing and accessories;
CPV 351: CPV 351134XX-X Protective and safety clothing;
CPV 358: CPV 3581XXXX-X Individual and support equipment;
CPV 374: CPV 3741XXXX-X Sport goods and equipment.
Source: own elaboration based on Tenders Electronic Daily (TED) (csv subset) – public procurement notices ([129]).

Table 118. Number of Contracts Award procuring apparel in EU Member States in 2018

Country	CPV 181	CPV 182	CPV 183	CPV 184	CPV 351	CPV 358	CPV 374	Total in the country
Austria	5	5	4	NA	NA	NA	NA	14
Belgium	26	NA	4	2	1	NA	NA	33
Bulgaria	28	5	3	2	4	25	NA	67
Croatia	3	3	2	1	NA	4	NA	13
Cyprus	NA	NA	NA	NA	NA	NA	NA	NA
Czechia	17	31	20	18	10	22	2	120
Denmark	13	1	NA	6	2	2	NA	24
Estonia	4	3	6	4	1	4	NA	22
Finland	3	3	NA	2	NA	1	NA	9
France	108	4	14	7	15	9	3	160
Germany	33	10	10	4	7	6	NA	70
Greece	2	1	NA	NA	NA	1	NA	4
Hungary	10	NA	NA	1	NA	9	NA	20
Ireland	NA	NA	NA	1	NA	NA	NA	1
Italy	22	2	4	4	2	6	NA	40
Latvia	3	NA	4	9	NA	18	NA	34
Lithuania	12	2	4	4	2	6	2	32
Luxembourg	1	NA	NA	NA	NA	NA	NA	1
Malta	1	1	NA	NA	NA	2	NA	4
Netherlands	8	5	1	3	5	1	NA	23
Poland	39	10	15	26	12	22	NA	124
Portugal	NA	NA	NA	NA	1	NA	NA	1
Romania	21	2	4	NA	NA	9	NA	36
Slovakia	5	2	2	4	1	NA	NA	14
Slovenia	21	1	NA	10	5	10	NA	47
Spain	1	NA	NA	NA	1	NA	NA	2
Sweden	45	2	2	3	NA	1	3	56
Total per CPV code	431	93	99	111	69	158	10	971

CPV 181: CPV 181XXXXX-X Occupational clothing, special workwear and accessories;
CPV 182: CPV 182XXXXX-X Outerwear;
CPV 183: CPV 183XXXXX-X Garments;
CPV 184: CPV 184XXXXX-X Special clothing and accessories;
CPV 351: CPV 351134XX-X Protective and safety clothing;
CPV 358: CPV 3581XXXX-X Individual and support equipment;
CPV 374: CPV 3741XXXX-X Sport goods and equipment.
Source: own elaboration based on Tenders Electronic Daily (TED) (csv subset) – public procurement notices ([129]).

Table 119. Number of Contracts Award procuring apparel in EU Member States in 2019

Country	CPV 181	CPV 182	CPV 183	CPV 184	CPV 351	CPV 358	CPV 374	Total in the country
Austria	4	NA	6	NA	NA	1	NA	11
Belgium	13	2	NA	1	5	2	1	24
Bulgaria	20	4	2	3	4	38	NA	71
Croatia	2	4	NA	NA	NA	3	NA	9
Cyprus	NA	1	NA	1	NA	1	NA	3
Czechia	26	35	41	22	16	34	NA	174
Denmark	9	1	4	1	1	1	NA	17
Estonia	3	3	5	2	NA	1	NA	14
Finland	6	NA	3	1	NA	2	NA	12
France	156	11	10	14	15	6	8	220
Germany	50	14	18	12	8	18	NA	120
Greece	6	1	2	1	2	2	1	15
Hungary	8	NA	NA	1	2	2	NA	13
Ireland	NA	1	NA	NA	1	NA	NA	2
Italy	15	7	7	5	4	10	NA	48
Latvia	6	1	NA	20	1	3	NA	31
Lithuania	23	2	6	13	2	7	NA	53

Country	CPV 181	CPV 182	CPV 183	CPV 184	CPV 351	CPV 358	CPV 374	Total in the country
Luxembourg	NA	NA	NA	NA	NA	NA	NA	0
Malta	NA	NA	1	NA	NA	NA	NA	1
Netherlands	7	10	1	2	3	3	NA	26
Poland	62	15	16	17	27	28	NA	165
Portugal	1	NA	NA	NA	NA	NA	NA	1
Romania	48	11	6	9	1	36	1	112
Slovakia	2	NA	4	4	NA	NA	NA	10
Slovenia	18	NA	2	8	5	8	NA	41
Spain	3	NA	NA	NA	NA	NA	NA	3
Sweden	45	1	4	5	6	NA	4	65
Total per CPV code	533	124	138	142	103	206	15	1261

CPV 181: CPV 181XXXXX-X Occupational clothing, special workwear and accessories;
CPV 182: CPV 182XXXXX-X Outerwear;
CPV 183: CPV 183XXXXX-X Garments;
CPV 184: CPV 184XXXXX-X Special clothing and accessories;
CPV 351: CPV 351134XX-X Protective and safety clothing;
CPV 358: CPV 3581XXXX-X Individual and support equipment;
CPV 374: CPV 3741XXXX-X Sport goods and equipment.
Source: own elaboration based on Tenders Electronic Daily (TED) (csv subset) – public procurement notices ([129]).

10.8.3 Contributions to the initial questionnaire

Table 120. Type of respondents that contributed to the section on EU GPP during the initial questionnaire

Type of respondent	Number	Percentage compared to the total (%)
University or research institute	1	3
Certified laboratory	1	3
Government (local, regional, or national)	12	35
Non-governmental organisation – Environment	3	9
Non-governmental organisation – Consumers	0	0
Industry – manufacturing	6	18
Industry – manufacturing - association	2	6
Industry – waste collection, sorting and treatment	1	3
Industry – waste collection, sorting and treatment - association	1	3
Distributer/Retailer	0	0
Distributer/Retailer association	1	3
Other	6	18
TOTAL	34	100

Source: own elaboration

10.9 Supporting information on relevant aspects

10.9.1 Qualitative assessment based on technical, socioeconomic and environmental dimensions

In this section, a qualitative assessment is carried out, focusing on three dimensions, with information collected via literature review. Only those aspects that are considered relevant after the assessment based on key guiding questions are evaluated (therefore, every aspect except ‘possibility of recovery of materials’ is evaluated in this section).

10.9.1.1 Durability

Durability is the ability of a product to maintain over time its function and performance under specified conditions of use, maintenance and repair. In the context of textile apparel, durability can be classified as intrinsic and extrinsic (emotional).

Intrinsic durability refers to physical and measurable characteristics of products, such as fabric strength, abrasion resistance, pilling, wrinkling, colour fastness, dimensional changes, seam slippage, etc. Intrinsic durability is often related with product quality, as described in Piippo et al., (2022).

Quality is a fundamental aspect of the durability and usability of clothing, and thus plays a role on its lifespan (Aakko and Niinimäki, 2021). Extrinsic durability refers to subjective and perception aspects of products, such as emotional attachment by users. This section focuses only on the intrinsic durability of textile apparel because it best corresponds to the durability definition provided by the ESPR.

Characteristics of the products in the scope

Durability is directly related with product lifespan. It must be noted that the lifetimes of textile apparel are, to a degree, subjective (Cooper and Claxton, 2022c). In fact, there is no common approach to assess or guarantee the physical durability of textile apparel; nor are there legislative standards that apply directly to textile apparel, other than the general requirement under consumer legislation that goods are ‘fit for purpose’ (Cooper and Claxton, 2022c).

Literature review suggests that there is room for improvement in the average durability of textile apparel. In the current market, many products are well made and have lifetimes that would generally be considered satisfactory. However, the lifetime of many other products is unduly short due to inadequate performance, in part due to pressure to meet predetermined price points (Cooper and Claxton, 2022c). It is possible to influence the intrinsic durability of products with many factors, which include the use of different fibres: for instance, in the manufacturing of denim products, the utilization of synthetic fibres, linen and hemp -rather than 100% cotton- can help to produce high-durability denim products particularly with respect to tensile and abrasion resistance (Elmogahzy, 2020).

The most common physical failures in textile apparel are related to colour fading (particularly for jersey and woven fabrics) and pilling of knitwear and jersey items. Fabric breakdown (fraying or thinning around the hems) and wear round the crotch of trousers and jeans, and accidental damage due to stains, tears and rips, are also common. Other failures include loss of dimensional stability, logo failure, discolouration, holes in seams and trim failure (Cooper and Claxton, 2022c). Even though they are not the main cause for physical failures, priority parts such as zippers, buttons, etc., may also have a relevance in product durability.

Environmental

Extending the lifetime of textile apparel has been highlighted as the most effective method of reducing the impact of the industry on the environment. For instance, extending the average life of clothes by 3 months’ usage per item could reduce carbon, water and waste footprints by 5-10% (Goworek, Lynn Oxborrow, et al., 2020). Extending the average life of clothes by nine months of active use per item would typically lead to a reduction in the carbon, water and waste footprints of 27%, 33% and 22%, respectively (Cooper and Claxton, 2022c).

Moreover, almost all life-cycle stages of textile apparel entail significant energy consumption (as described in Section 3.3.2). Some processes, such as the extraction of raw materials or production processes -such as spinning, knitting and weaving- are highly energy demanding. The longer the products are in active use by consumers (the more durable the products), the more likely it is to offset the manufacturing of new products, thus reducing the industry’s impacts related to energy.

Socioeconomic

Durability in the context of textile apparel collides with one of the prevalent business models, based on fast trend turnovers and short production times. This business model does not offer space for developments to improve durability of products, as it focuses on short times between design and product availability, and aims to low pricing obtained with production of large volumes manufactured in specific locations and conditions (Dan and Ostergaard, 2021). Therefore, an increase in the durability of products may affect negatively manufacturers whose strategy is based on such business models, since the prevailing commercial drive is to save costs (Goworek et al., 2020); whereas it could affect positively manufacturers which are already focusing on the durability of products.

An increase in the durability of textile apparel could stimulate the establishment of other product-related businesses. Increasing textile apparel durability could be supported by an increase in the number of companies providing clothing repair services. Moreover, products with enhanced durability seem a necessary condition for the existence of businesses based on product renting or sharing. These businesses could extend the use of products and potentially reduce the purchase of new items if they do not incentivise overconsumption.

It is worth noting where the socioeconomic changes of product durability would be perceived. Whereas any changes in product manufacturing would mostly take place outside the EU (which is where most manufacturing takes place today) (Section 5.1), the effects related with repair, renting and sharing services would be experienced within the EU.

Consumers are increasingly interested in textile products with enhanced durability: around 90% of consumers think that apparel should be made to last longer (European Commission, 2019). There are consumers in different age groups and markets who consider durability, in connection with quality, when making fashion purchases, even if sustainability is not their main motivation (Goworek et al., 2020).

Durability has been highlighted as one of the top three aspects to influence the decision to purchase apparel such as coats or jackets (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018). Around 43% of consumers in some Member States express a willingness to buy long-lasting apparel despite the price (AK Wienn and Greenpeace, 2023b).

It is also worth noting that design for physical durability involves the development and testing of yarns, fabrics and textile apparel to meet specified performance standards that can withstand prolonged wear (Claxton and Kent, 2020b), which could have an effect on product purchase price.

Qualitative assessment of relevance

Based on the above, durability is considered a relevant product aspect in the context of textile apparel.

10.9.1.2 Reliability

Reliability is the probability that a product functions as required under given conditions for a given duration without an occurrence which results in a primary or secondary function of the product no longer being performed.

In the context of textile apparel, reliability can be understood as the ability of a product to retain the physical characteristics that allow its use. Therefore, reliability is directly linked with the intrinsic durability of products. Ensuring that textile apparel are durable inherently makes them more reliable. Reliability of textile apparel can be interpreted as the ability of a product to avoid or delay damages related with colour fading, discolouring, pilling, wear and tear, dimensional stability or seam defects, among others.

Characteristics of the products in the scope

Most of the rationale provided for durability in section 10.9.1.1 is applicable for reliability. There is room for improvement in the reliability of textile apparel: many products in the market have lifetimes that would generally be considered satisfactory, whereas in other products, lifetime is unduly short due to inadequate performance. The choice of fibres and the way they are processed can have an influence on the reliability of products: for instance, in the manufacturing of denim products, the utilization of synthetic fibres, linen and hemp -rather than 100% cotton- can help to produce denim products with higher tensile and abrasion resistance (Elmogahzy, 2020). It must be noted that, on occasions this can affect negatively the recyclability of the product. As in the case of durability, even though priority parts are not the main cause for physical failures, they may also have a relevance in product reliability.

Environment

Enhancing the reliability of textile apparel can contribute to lifetime extension. Textile lifespan extension is essential to avoid virgin natural resources withdrawals, either energy or material technologies (Amicarelli et al., 2022). Moreover, it can be concluded that the longer the products are in active use by consumers, the more likely it is to offset the manufacturing of new products, thus reducing the industry's impacts related to energy.

Socioeconomic

Reliability in the context of textile apparel is not aligned with business models based on fast trend turnovers and short production times. As a textile apparel manufacturer expressed it in (Goworek et al., 2020), "product longevity loses sales". Therefore, enhancing the reliability of products may affect negatively those manufacturers whose strategy is based on fast trend turnovers and short production times; whereas it could affect positively manufacturers which are already focusing on the reliability of products.

An increase in the durability of textile apparel could stimulate the establishment of other product-related businesses. For instance, products with enhanced reliability seem one of the necessary conditions for the existence of businesses based on product renting or sharing (a more reliable product is more likely to withstand the more intensive use within such business models). Quality considered as durability is a crucial aspect of textile apparel in the second hand markets, which enable extending the textile apparel use times after the initial user (Aakko and Niinimäki, 2021).

As in the case of durability, whereas any changes in product manufacturing to enhance the reliability of products would mostly take place outside the EU (Section 5.1), the effects related with renting and sharing services would be experienced within the EU.

Most of the rationale provided for durability in section 10.9.1.1 is applicable for reliability. Around 90% of consumers think that apparel should be made to last longer (European Commission, 2019), therefore would be interested in more reliable products.

Qualitative assessment of relevance

Based on the above, reliability is considered a relevant product aspect in the context of textile apparel.

10.9.1.3 Reusability

Reusability is the ability of a product or component that is not waste to be used again for the same purpose for which it was conceived.

In the context of textile apparel, reusability can have different interpretations. For instance, it can refer to extending the lifetime of products (for instance via repair) so that the same owner can continue using the product. It can also refer to transferring products to a new owner via donating to charity or second hand shops, renting, inheriting, trading, swapping and borrowing (Shirvanimoghaddam et al., 2020).

Characteristics of the products in the scope

Reusability and durability are also intertwined (as it happened between reliability and durability). Enhancing the performance of textile apparel increases durability, and thus enables increased use times (Aakko and Niinimäki, 2021).

There is a great potential to further increase reuse, as clothing items typically are disposed of long before the end of their technical service life (Sandin and Peters, 2018). Many products in the market have lifetimes that would generally be considered satisfactory, whereas in other products, lifetime is unduly short due to inadequate performances. As stated for reliability, the choice of fibres and the way they are processed can have an influence on the reusability of products: textile apparel with higher tensile and abrasion resistance are more likely to be reused. As in the case of durability, even though priority parts are not the main cause for physical failures, they may also have a relevance in product reusability.

An aspect related with textile product reusability is the discrepancy between technical lifetime (how long the product is designed to last) and average real use time by consumers. In Section 5.8, it has been highlighted that textile products nowadays remain in use for shorter periods, with an ever decreasing trend (some authors estimate that t-shirts are used for an average of 22 days in total). It appears that many textile products are currently underused during their initial lifetime, it can be expected that reusability strategies can counteract the negative effects of this product underuse.

Environment

Enhancing the reusability of textile apparel can contribute to lifetime extension, which is essential to avoid virgin natural resources withdrawals (Amicarelli et al., 2022). Moreover, it can be concluded that the longer the products are in active use by consumers, the more likely it is to offset the manufacturing of new products, thus reducing the industry's impacts related with energy. If the average life of textile apparel is extended by 3 years (for instance, via reuse), the carbon and water footprint and waste generation can be reduced by 5-10% (Shirvanimoghaddam et al., 2020).

Socioeconomic

Reusability in the context of textile apparel is also in opposition with business models based on fast trend turnovers and short production times. Therefore, enhancing the reusability of products may affect negatively those manufacturers whose strategy is based on such business models; whereas it could affect positively manufacturers which are already focusing on the reusability of products (some companies claim that their products are not designed or made for use by only one user, but many users (Piippo et al., 2022b).

Textile apparel reuse has been related with collaborative consumption. Increase product reuse could boost product-service systems, commercial sharing systems and access-based consumption (Shirvanimoghaddam et al., 2020). These business models can contribute to intensifying their use and reducing the purchase of new items. In this context, the relationship between performances and durability arises again: high technical performance enables textile apparel to be used for a longer time and enables further uses through, for example, renting, leasing and second-hand markets (Piippo et al., 2022b). However, it must be noted that, although reuse of textile apparel takes place today, supply exceeds demand and many wearable items end up either exported (Cooper and Claxton, 2022c) or in landfills (Goworek et al., 2020).

Reusability can also be associated with take-back services and second-hand shops. In such schemes, companies maintain and sell the products again, enabling a new life for the product with a new consumer (Piippo et al., 2022b).

For some consumers, buying high-quality second-hand clothes (in other words, reusing textile apparel) represents ethical consumption, since it enables prolonging the lifespan of existing products and avoiding the traditional fashion production chain (Aakko and Niinimäki, 2021). Moreover, in section 6.2.5 it has been mentioned that second-hand textile apparel are experiencing fast growth. Around 37% of the population actively engages in buying second-hand apparel (D&B, 2020b). It must be noted, however, that reusability does not change overconsumption and overproduction patterns.

Qualitative assessment of relevance

Based on the above, reusability is considered a relevant product aspect in the context of textile apparel.

10.9.1.4 Upgradability

Upgradability is the ability of a product to be accessible for implementing actions to enhance its functionality, performance, capacity, safety or aesthetics of a product.

In the context of textile apparel, upgradability can also be considered a factor that contributes to the overall durability of a product. An item of textile apparel that is upgradeable will have more chances to extend its lifetime, and therefore be more durable.

Characteristics of the products in the scope

An upgradable item of textile apparel may be one with modular components –such as detachable or interchangeable parts- that allow for updates and style changes without replacing the entire item. Although some upgradable products and designs may exist today, these type of modular designs are innovative, but not yet part of the mainstream market. Despite this lower relevance in the market today, upgradability is one of the possible strategies that can contribute to product lifetime extension. Upgradability is mostly associated with products made of physically durable fabrics.

Environment

Possibly due to the lower relevance in the market today, the authors have not found any study that highlights the potential environmental benefits of increasing the upgradability of textile products. In any case, if it is assumed that upgradability can contribute to extend the lifetime of textile apparel, it could also be concluded that upgrading products may have environmental benefits similar to the ones reported in section 10.9.1.1 on durability.

Socioeconomic

Although upgradable textile products can still be considered to be a niche in the market today, it can be concluded that they are also in opposition to business models based on fast trend turnovers and short production times. Modular products that can be upgraded will last longer and therefore prevent the sales of new products. Therefore, promoting the upgradability of products may affect negatively those manufacturers whose strategy is based on such business models; whereas it could affect positively manufacturers which focus on their upgradability.

There is currently no evidence that suggests that increasing the upgradability of products may stimulate the creation of alternative business models based on renting or sharing. It could contribute to the creation of jobs on the clothing repair sector, which could undertake some of the activities related with product upgrade that cannot be carried out by consumers (replacing older by upgraded modules, for instance).

Possibly due to the lower relevance in the market today, the authors have not found any evidence on the willingness of consumers to purchase upgradable textile products. The price to upgrade a product, compared with the price of a new product, may also be a factor for the willingness of consumers to upgrade textile apparel.

Qualitative assessment of relevance

Based on the above, upgradability is considered a relevant product aspect in the context of textile apparel.

10.9.1.5 Repairability

Repairability is the ability of a defective product or waste object to return to a condition where it fulfils its intended use. In the context of textile apparel, repairability is directly linked with durability. One of the factors that makes a product more durable is its potential to be repaired. Repair makes it possible to increase product lifespans as well as value creation (Laitala and Klepp, 2021b). Either as an activity carried out by the consumer or as a service provided by a company, repair is another way in which to extend use-time of textile apparel (Piippo et al., 2022b).

Characteristics of the products in the scope

The repairability of textile apparel can be influenced at the design stage, for instance, considering their ease of disassembly, ensuring that products can be taken apart to replace worn or damaged components (Cooper and Claxton, 2022c).

The presence of priority parts has been mentioned in previous sections on durability and reliability. Priority parts are particularly relevant for repairability, since these are the components with the highest frequency of failure and functional relevance. In the case of textile apparel, a possible list of priority parts (non-exhaustive) comprises fabrics, zips, buttons and embellishments such as sequins, gems and beads. It is worth noting that relatively few pieces of textile apparel with these components have failures, which suggests that the relevance of repairability is lower than, for instance, the relevance of reliability. Missing buttons and broken zips are the main problems, followed by missing embellishments (Cooper and Claxton, 2022c).

Environment

Repair of textile apparel has environmental benefits. As highlighted in (Luo et al., 2023c), the frequent use of a product will cause wear and tear and shorten its service life, while the repair process will extend the service life of the product and consequently reduce the purchase of new products and excessive waste of resources. It must be noted that providing spare parts for repairability increases the environmental impact of the product, if such parts are finally not used.

Socioeconomic

Currently, the professional services used for repair of clothing are companies mostly independent of the production and sales of clothes (Laitala and Klepp, 2021b). A rise in the availability of more reparable clothing could stimulate the creation of business related with clothing repair.

Repair could also be stimulated by the same product manufacturers, either providing clothing repair as a service, or providing information to consumers on how to carry out simple repairs. Some brands offer more service-oriented solutions, such as repair and alterations, while others are designing modular or more adaptable clothing (Gowerek et al., 2020).

In fact, the number of repairs conducted privately is at least three times more frequent than professional repairs, since minor mending of textiles often only requires needle and thread, a limited amount of time and only rather basic skills (Laitala and Klepp, 2021b).

Repair of clothing carried out by consumers is diminishing, due to the current low skills of consumers, influenced by the scarcity of available time to carry out repairs, the lack of appropriate equipment and price (Finnish Ministry of the Environment, 2023b). Therefore, only 11% of consumers consider repairability to be important when purchasing apparel items such as coats and jackets (Consumers, Health, Agriculture and Food Executive Agency. et al., 2018).

The price of repair is a fundamental factor in the case of textile apparel. The price of repairing clothes depends a lot on the type of textile apparel and repair needed. A general trend observed is that consumers are not willing to pay much for the repair of textile apparel, and especially not for low-priced textile apparel. Consumers compare the price to a new textile apparel, which often is the same or even lower than repair or adjustments done by the tailor (Laitala and Klepp, 2021b). The authors have not found specific data regarding the willingness of consumers to pay for the repair of textile apparel. Using as a reference values from other product groups, the willingness to pay for repairs of small electronics is between 20% and 40% of the replacement cost (Cordella, Sanfelix, et al., 2019; Svensson-Hoglund et al., 2021).

In essence, clothes would be worn longer if repair services were cheaper (or products more expensive): 27% of consumers agree that they would wear their textile apparel longer if they were better at repairing them (Laitala and Klepp, 2021b). For those few consumers that do carry out repairs, it is worth noting that textile apparel has a much higher share of successful repairs than other products such as electrical appliances.

Qualitative assessment of relevance

Based on the above, repairability is considered a relevant product aspect in the context of textile apparel.

10.9.1.6 Possibility of maintenance

The possibility of maintenance is the ability of a product to be kept in a condition where it is able to fulfil its intended purpose through one or more actions. In the context of textile apparel, it consists of the set of activities that a consumer carries out, fundamentally during the use phase of the product, in order to maintain it in a condition that satisfies all their needs associated to the product. This can include activities such as washing, drying, ironing, folding, storing, wearing in specific environments and conditions, etc.

Characteristics of the products in the scope

Washing is potentially the most relevant maintenance activity for textile apparel, which are prone to getting dirty or soiled. The ability to remove dirt and stains can be influenced by design, for instance by the choice of materials. Inherent fibre properties affect the soiling characteristics of textile apparel. Cotton gets dirty easily, but can be washed efficiently and thus cleaned. In contrast, wool resists staining and develops less odour, but stains are difficult to remove (Laitala and Klepp, 2018b). Similar trade-offs can be expected for other maintenance activities such as drying or ironing.

Environment

Textile apparel maintenance activities, because they are repeated often and by all people in the world, constitutes a significant environmental impact. Washing, drying and wrinkle removal are repeated on a regular basis. The longer an item of textile apparel is used, the more important this phase will be for the overall environmental impact of the textile apparel (Laitala and Klepp, 2018b).

Maintenance can contribute to extend the lifetime of products and therefore reduce their environmental impact. It is important for keeping products in use and for motivating consumers to repair them when needed (Laitala and Klepp, 2021b). Extending textile apparel lifetimes should also take into account how more durable textile apparel items can be cared for sustainably by consumers, for example by avoiding dry-clean only fabrics (Goworek, Lynn Oxborrow, et al., 2020).

Socioeconomic

Manufacturers of textile apparel emphasize that optimal care and maintenance is a significant factor for extending product life. For them, it is important to determine which products customers need, but also how they use and care for these products. Since it is often the customers who care for the products, it is important for companies to share information on correct maintenance (Piippo et al., 2022b).

The possibility of maintenance can also be a factor in take-back services. In such schemes, companies maintain the products they sold, in order to sell them again, enabling a new life for the product with a new consumer (Piippo et al., 2022b).

Similarly to previous product aspects, the possibility of maintenance is in opposition with business models based on fast trend turnovers and short production times. A product which is easier to be maintained will delay the sale of new products, delaying their replacement. Therefore, promoting the possibility of maintenance of products may affect negatively those manufacturers whose strategy is based on such business models; whereas it could affect positively manufacturers which focus on product maintenance.

Maintenance of textile products relies mostly on users. Most of the laundering and storing of textiles is carried out by the owner of the apparel. Manufacturers already provide maintenance instructions to users on how to wash and take care of textile products, on a voluntary basis. As pointed out in Section 6.3.2, a significant percentage of users follow these care instructions, but the adherence diminishes after the initial wash.

Qualitative assessment of relevance

Based on the above, possibility of maintenance is considered a relevant product aspect in the context of textile apparel.

10.9.1.7 Possibility of refurbishment

The possibility of refurbishment is the ability of a product or a discarded product to be prepared, cleaned, tested, serviced and, where necessary repaired to restore its performance or functionality within the intended use and range of performance originally conceived at the design stage at the time of the placing of the product on the market. In the context of textile apparel, it can be interpreted as a very similar –or equivalent- aspect to repairability. In essence, when a product is repaired, it may also follow the steps described in the definition of possibility of refurbishment (preparing, cleaning, testing, servicing and repairing). As in the case of repair, the possibility of refurbishing is directly linked with durability.

Characteristics of the products in the scope

As in the case of repairability, the possibility of refurbishing of textile apparel can be influenced at the design stage, for instance, considering their ease of disassembly, ensuring that products can be taken apart to replace worn or damaged components (Claxton and Kent, 2020). The presence of priority parts has been mentioned in previous sections on durability, reliability and repairability. Priority parts are also particularly relevant for the possibility of refurbishing, since these are the components with the highest frequency of failure and functional relevance, and therefore the parts which more likely may need to be substituted in a potential refurbishing activity. Refurbishment is strictly connected to the physical durability of priority parts and the price related to refurbish a used product or waste rather than manufacturing a new one.

Environment

Possibly due to the similarities with product repair, the authors have not found scientific literature highlighting the potential environmental benefits of textile apparel refurbishing.

Socioeconomic

Similarly to the case of previous product aspects, the possibility of refurbishment is in contrast with the business models based on fast trend turnovers and short production times. A product that can be refurbished will reduce the opportunity of selling new items. Therefore, promoting the possibility of maintenance and refurbishment of products may affect negatively those manufacturers whose strategy is based on such business models; whereas it could affect positively manufacturers which focus on product maintenance and refurbishment.

A rise in the availability of products which are easier to be refurbished could stimulate the creation of business related with textile apparel repair.

Qualitative assessment of relevance

Based on the above, possibility of refurbishment is considered a relevant product aspect in the context of textile apparel.

10.9.1.8 Presence of substances of concern

The presence of substances of concern should be understood as the existence of chemicals in products that for reasons of their intrinsic hazards pose risks to human health or the environment, or that otherwise negatively affects the reuse and recycling of materials in the product in which they are present. This may bring about the need to consider regulatory action, improved management and/or substitution with safer alternatives, whenever feasible. ESPR specifically requires to track the presence of these substances in products.

In ESPR, a substance of concern means a substance that:

(a) meets the criteria laid down in Article 57 of Regulation (EC) No 1907/2006 and is identified in accordance with Article 59(1) of that Regulation;

(b) is classified in Part 3 of Annex VI to Regulation (EC) No 1272/2008 in one of the following hazard classes or hazard categories:

i. carcinogenicity categories 1 and 2;

ii. germ cell mutagenicity categories 1 and 2;

iii. reproductive toxicity categories 1 and 2;

iv. endocrine disruption for human health categories 1 and 2;

v. endocrine disruption for the environment categories 1 and 2;

vi. persistent, mobile and toxic or very persistent, very mobile properties;

vii. persistent, bioaccumulative and toxic or very persistent, very bioaccumulative properties;

viii. respiratory sensitisation category 1;

ix. skin sensitisation category 1;
x. hazardous to the aquatic environment — categories chronic 1 to 4;
xi. hazardous to the ozone layer;
xii. specific target organ toxicity — repeated exposure categories 1 and 2;
xiii. specific target organ toxicity — single exposure categories 1 and 2;

(c) is regulated under Regulation (EU) 2019/1021; or

(d) negatively affects the reuse and recycling of materials in the product in which it is present;

<u>Characteristics of the products in the scope</u>

As already pointed out in Section 3.3.2, the raw materials extraction and manufacturing of textile apparel involve the use of a wide variety of chemical substances and mixtures, which includes pesticides, solvents, surfactants, dyes, pigments, stain repellents, flame retardants or biocides, among others, as well as water. The demand of chemical compounds by the textile industry is estimated to use around 25% of global chemical production (Raj et al., 2022). Many of the chemicals used during textile manufacturing are associated with spinning and weaving and wet processing. A single European textile-finishing company uses over 466 g of chemicals per 1 kg of textile (Niinimäki et al., 2020).

Chemicals are used in the manufacturing of textile apparel with a specific purpose, such as providing a certain level of resistance to abrasion, adding colour, waterproofing, etc. The presence of substances of concern can be influenced at the design stage, via substitutions by safer alternatives (often with trade-offs) (Zhang and Hale, 2022).

<u>Environment</u>

Chemicals have an influence in almost all lifecycle stages of a textile product. Chemicals used during manufacturing are often discharged or results in releases and get in direct contact with soil and water bodies. Consumers are directly exposed to chemicals in the textile during the use phase. Chemicals may also have an influence at end-of-life, either hindering processes such as recycling or being released to the environment if apparel is landfilled or incinerated.

Eliminating or reducing the presence of substances of concern has been highlighted as one of the key areas with potential of improvement regarding ecodesign (Ellen MacArthur Foundation, 2017; Bauer, Watson, Gylling, Remmen, Lysemose, Catharina Hohenthal, et al., 2018; Niinimäki et al., 2020). For instance, natural cotton fabric dyeing using dyes of plant origin (white onion) can reduce the impacts on human health and ecosystems (Amicarelli et al., 2022).

<u>Socioeconomic</u>

Companies in the textile apparel sector aim to reduce production costs through manufacturing in locations with lower production costs and where often environmental regulation is laxer or pollution-mitigating technologies are not legally required. This approach to manufacturing often leads not only to high environmental impacts from use of chemicals but increased health risks for factory workers, cotton farmers and fashion consumers (Niinimäki et al., 2020).

Despite being in direct contact with chemicals when wearing apparel, 60% of respondents to a survey in the EU perceived chemicals in apparel fabrics as representing a minimal risk (European Commission, 2019).

<u>Qualitative assessment of relevance</u>

Based on the above, presence of substances of concern is considered a relevant product aspect in the context of textile apparel.

10.9.1.9 Energy use and energy efficiency

Energy use can be defined as the total use of energy in all lifecycle stages of a product. Energy efficiency is the ratio of output of performance, service, goods or energy to input of energy.

<u>Characteristics of the products in the scope</u>

Almost all life-cycle stages of apparel have significant energy consumption, particularly the extraction of fibres such as silk; production processes such as spinning, knitting and weaving; or thermal treatments during production (see Section 3.3.1). Although manufacturing covers about 70-80% of total lifecycle energy consumption (Sandin, Roos, Spak, et al., 2019; Quantis, 2021), energy is also consumed in the use phase for laundering, ironing and drying.

There is a wide range of materials available for manufacturers, with different performance in terms of energy use and energy efficiency. Considering the manufacturing stage, some fibres are less energy intensive than others. However, reductions in energy use may come with trade-offs in other properties of the fibre (Niinimäki et al., 2020).

Considering the use phase, the electricity consumed during domestic washing amounts to 2% of household usage, while tumble drying accounts for 4.5% (Zhang et al., 2022). There are also examples of energy efficiency improvement potential areas in the use phase, described in (Zhang et al., 2022). For instance, products made from hygroscopic fibres require higher energy in tumble drying than their hydrophobic fast-drying synthetic counterparts (Zhang et al., 2022). Reductions in the number of launderings can also be achieved by manufacturing clothes with odour reduction thanks to fabrics enabled with silver, which has antimicrobial properties (Amicarelli et al., 2022). Some fibres require lower temperatures for laundering than others (less energy use). Some materials require ironing to achieve a minimum aesthetic performance, whereas others do not need to be ironed. However, different fibres will provide different performance and aesthetics. Design strategies tend to be aimed at reducing rather than eliminating the negative impacts of the use phase, typically in the design of clothes for less frequent washing and use of lower laundering temperatures to prolong textile apparel life (Claxton and Kent, 2020b)

There is room for improvement in the energy efficiency of textiles manufacturing as well. In (Zhang et al., 2022), several examples are provided: low-twist spinning technology introduces false twisters between the front roller and the yarn guide, and can achieve a twist reduction of 20-40%; significant energy saving in air humidification can be achieved by using energy-efficient nozzles and variable-frequency drives based on the real-time humidity conditions in the spinning and weaving process; or high-volume, low-pressure nozzles can save up to 26% of energy thanks to their optimized nozzle geometry (Zhang et al., 2022). In the case of denim apparel, the industry is transitioning from stonewashed denim to more energy-efficient methods such as enzyme treatment, mechanical abrasion, ozone fading, water jet fading and laser treatment (Elmogahzy, 2020). It is worth noting that, in the context of the Industrial Emissions Directive, the Reference Document for the Textiles Industry (Roth et al., 2023) addresses energy use for installations located in the EU and points out the Best Available Techniques.

<u>Environmental</u>

As pointed out in Section 5.4.3, considering the manufacturing stage, the energy consumption in the global textile industry was estimated to be 2% of the global energy consumption. Section 3.3.1 reports that almost all stages of the textile apparel value chain are energy demanding. Indirectly related with energy, the apparel industry is reported to be responsible for about 6.5% of global GHG emissions (Niinimäki et al., 2020).

The substantial consumption of electricity in the use stage of textiles was also revealed to have a significant impact on the environment due to repeated use and care operations, in some cases even exceeding the contribution of the production stage (Luo et al., 2023c).

<u>Socioeconomic</u>

As mentioned in Section 5.4.3, the cost of energy plays an important role in the textile industry. In fact, the increase of the cost of energy in the EU in 2022 negatively affected the EU textile production. Moreover, the national energy strategies influence the establishment of textile industry focussing on specific stages of the value chain.

Textile apparel are generally not perceived by consumers as energy-related products. Possibly because of that, the authors have not found any evidence on the willingness of consumers to purchase energy efficient textile products.

Users can have an influence on the energy consumed during the lifecycle of apparel, mostly in the laundering, ironing and drying activities. Following the instructions available in labelling in terms of water temperature can help to reduce energy consumption. Reducing the frequency of ironing may also save energy. Substituting the use of tumble driers by air-drying (when possible) can also have a positive effect.

<u>Qualitative assessment of relevance</u>

Based on the above, energy use and energy efficiency is considered a relevant product aspect in the context of textile apparel.

10.9.1.10 Water use and water efficiency

Water use is the use of water in all lifecycle stages of a product. Water efficiency is the ratio of output of performance, service, goods to input of water.

Characteristics of the products in the scope

Apparel manufacturing requires enormous volumes of water in fabric production (Jia et al., 2020). Typically, 70-250 l of water are used for every kilogram of finished textiles (Zhang et al., 2022). Water is also consumed during the use phase in laundering activities.

There is a wide range of materials available for manufacturers, with different performance in terms of water use and water efficiency. Cotton and hemp are the most water-demanding among textile fibres, whereas polyester and polypropylene need the least amount of water. However, reductions in water use may come with trade-offs in other properties of the fibre (Niinimäki et al., 2020).

There is room for improvement in the water efficiency of textiles manufacturing. In (Zhang et al., 2022), several examples are provided: a foam-laying technique has been studied as a replacement for the wet-laying non-woven process, using 20% of the water and saving energy simultaneously; for synthetic fibres, colourless polymers can be structurally coloured with nano-sized pigment inclusions via spin dyeing, achieving 50% water savings; recycling wastewater generated from spent dyeing and rinsing baths through catalytic ozonation with carbon aerogel is a method to minimize water consumption.

There are also examples of water efficiency improvement potential areas in the use phase (for laundering), described in (Zhang et al., 2022). For instance, products made from hygroscopic fibres require more water than their hydrophobic fast-drying synthetic counterparts. It is worth noting that, in the context of the Industrial Emissions Directive, the Reference Document for the Textiles Industry (Roth et al., 2023) addresses water use for installations located in the EU and points out the Best Available Techniques.

Environmental

Considering the initial stages of textile apparel production, water consumption for materials extraction and manufacturing is estimated to account for 4% of global freshwater extraction (Ellen MacArthur Foundation, 2017). Just cotton is estimated to account for 2.5% of water consumed globally every year (Amicarelli et al., 2022). In the EU, the production of textile apparel, footwear and household textiles purchased in 2020 was around 4 000 million m^3 of blue water ([214]).

Considering the use stage of textile apparel, the substantial consumption of water in the use stage of textiles was revealed to have a significant impact on the environment due to repeated use and care operations, in some cases even exceeding the contribution of the production stage (Luo et al., 2023c).

Socioeconomic

As described in Section 5.7, the global value chain of textile apparel causes most of its environmental impacts in the production stages, and most of these stages occur outside of the EU. In particular, in countries that allow production at lower costs (due to poor labour conditions and less stringent measures on environmental protection). This is particularly relevant for water consumption, an aspect which is directly related with the specific location. For instance, cotton has the highest water footprint of any fashion fibre (Niinimäki et al., 2020). For making a cotton t-shirt, 2 700 litres of water are used (Shirvanimoghaddam et al., 2020).

Textile apparel are generally not perceived by consumers as water-related products. Possibly because of that, the authors have not found any evidence on the willingness of consumers to purchase water efficient textile products. However, water is also consumed during the use phase in laundering activities, which are mostly influenced by the users. As highlighted in previous sections, different washing habits are observed across countries, with factors such as age and societal norms also having an influence. User perceptions about hygiene and convenience may impact washing frequency, influencing the consumption of water during the use phase. There is also a relevant interaction with laundry detergents (some of them might require more water than others to achieve the same level of cleanliness).

Qualitative assessment of relevance

[214] Blue water refers to fresh surface and groundwater

Based on the above, water use and water efficiency is considered a relevant product aspect in the context of textile apparel.

10.9.1.11 Resource use and resource efficiency

Resource use is the use of raw materials, mainly abiotic (minerals, metals, fossil fuels), in all lifecycle stages. It can also include biotic resources such as land, air, ecosystems. The use of natural resources can be accounted for as the volumes of resources consumed (materials) or used (land, air, ecosystems), or the impacts derived from the use of resources. Water and energy are not considered within resources under the scope of ESPR given these are addressed as separate product aspects. Resource efficiency is the ratio of output of performance, service, goods to input of resources, raw materials, air, land, soil and ecosystem services.

Characteristics of the products in the scope

The textile apparel industry is resource-intensive (Piippo et al., 2022b). Most of these resources are consumed in the raw material extraction and manufacturing stages. This product aspect is therefore related with product parameters, reported in Annex I to ESPR, such as ‘use or content of sustainable renewable materials’ and ‘reduction of materials consumption’, among others.

Considering textile manufacturing, there are a wide variety of techniques, each of them with a different level of resource efficiency. Taking cotton as an example, it may be produced following organic farming, conventional farming or regenerative agriculture and using different quantities of land, water, chemicals and energy according to the climate and the ecosystem where it is cultivated. Each specific cultivation practice in a given location has a specific crop yield (or efficiency in the use of resources). Similarly, manmade cellulosic fibres can be produced using cellulose from recycled wood, agricultural waste, virgin wood coming from sustainably managed forests, virgin wood coming from deforestation-free forests or from unknown sources, etc. All these options use different resources and affect different ecosystems.

Resource efficiency can also be linked with the process of reducing the weight of products to improve their environmental performance. This practice, aimed at decreasing material use throughout the product lifecycle, it is also known as lightweighting. Denim fabrics, for instance, can be made in many weights. Light denim will be suitable for dresses or shirts where drape, softness and flexibility are required. Heavy denims are typically used for blue jeans trousers and skirts (Elmogahzy, 2020). Although light weights use less material, they also provide different properties to textile apparel. Heavier weight fabrics are generally more durable and less susceptible to abrasion and wear, while fabrics with a tighter, more compact construction are also more resistant to damage (Cooper and Claxton, 2022c). Therefore, the authors consider that lightweighting is not a relevant product parameter for textile apparel.

Environmental

The textile industry is the fifth industrial sector for primary use of materials, mainly related to the extensive production of natural origin fibres and man-made cellulosic fibres. The estimates of textile fibre production were around 116-124 million tonnes in 2022 (Textile Exchange, 2022b).

Socioeconomic

Similarly to energy efficiency and water efficiency, resource efficiency does not appear to be a relevant aspect influencing the behaviour of consumers when purchasing textile apparel.

Qualitative assessment of relevance

Based on the above, resource use and resource efficiency is considered a relevant product aspect in the context of textile apparel.

10.9.1.12 Recycled content

Recycled content is the proportion, by mass, of recycled material, from pre- and post-consumer waste, in a product or packaging. In the case of textile apparel, it is generally expressed with reference to the amount of fibres, which are at least 80% of the weight of the product.

Characteristics of the products in the scope

The possibility to use recycled material in textile apparel has been mentioned in some studies as a relevant product aspect to consider (Ellen MacArthur Foundation, 2017; Bauer, Watson, Gylling, Remmen, Lysemose, Catharina Hohenthal, et al., 2018; Niinimäki et al., 2020).

When considering the possibility of having recycled content in a product, a key aspect is the availability of recycled material in the market. In the case of textile apparel, as pointed out in Section 3.3.2, there is enough post-consumer waste from which material could be recycled and reintroduced in the manufacturing process of textile apparel. In Section 5.4.1, it has also been mentioned that a 30% increase in textile waste is expected for 2030-2035, so the supply of feedstock for recycled material seems guaranteed for the coming years.

However, when designing a product with recycled content it must be taken into account that, depending on the recycling technology, recycled fibres tend to be of lower performance than their virgin equivalents and are normally limited to single fibre content fabrics (Claxton and Kent, 2020b). For instance, a maximum of 20% post-consumer mechanically recovered cotton fibres can be blended with virgin cotton before strength is compromised (Niinimäki et al., 2020).

There is room for improvement to increase the recycled content in textile apparel. For instance, chemical recycling works by breaking down fibres through a chemical dissolution process to the level of a polymer and is suitable for cellulose fibres. The process preserves fibres better than the mechanical recycling and is, therefore, anticipated to enable textile apparel to be produced with higher percentages of recycled fibres (Niinimäki et al., 2020).

Environmental

Some studies highlight that the use of recycled materials in textile apparel reduces their environmental impact. For instance, by using recycled cotton for spinning it is possible to decrease 60% of the emitted CO_2eq, reduce the consumption of oil equivalent by 11% and water by almost 80%. Similarly, the use of recycled cotton fibre has a huge potential to reduce environmental impacts, since it is possible to avoid the production of virgin cotton, with a reduction of up to 98% in water use. Substituting primary by secondary materials in a polyester jacket shows a reduction in impacts between 50%-80% in the categories of photochemical smog formation, human toxicity and water scarcity (Amicarelli et al., 2022).

Socioeconomic

Increasing the content of recycled material in textile apparel could contribute to job creation in different areas. For instance, in the collection and sorting of textiles, as well as in transport and recycling operations. The increase in recycled content might also incentivise the recycling of end-of-life waste material.

In contrast with other aspects such as durability or repairability, consumers give little importance to the use of recycled materials in apparel (11%, as highlighted in Section 6.2.7).

Qualitative assessment of relevance

Based on the above, recycled content is considered a relevant product aspect in the context of textile apparel.

10.9.1.13 Possibility of remanufacturing

The possibility of remanufacturing is the possibility of producing through actions a new product from objects that are waste, products or components and through which at least one change is made that may affect the performance, purpose or type of the product.

In the context of textile apparel, it must be noted that product attributes that make it fit for repair (such as ease of disassembly) also make it fit for remanufacturing.

Characteristics of the products in the scope

As in the case of repairability, the possibility of remanufacturing of textile apparel can be influenced in the design stage, for instance, considering their ease of disassembly, ensuring that products can be taken apart to replace worn or damaged components (Claxton and Kent, 2020b).

The presence of priority parts has been mentioned in previous sections on durability, reliability, repairability and possibility of refurbishing. Priority parts are also particularly relevant for the possibility of remanufacturing, since these are the components with the highest frequency of failure and functional relevance, and therefore the parts which more likely may need to be substituted in a potential remanufacturing activity.

Environment

Possibly due to the similarities with product repair, the authors have not found scientific literature highlighting the potential environmental benefits of textile apparel remanufacturing.

Socioeconomic

Similarly with previous product aspects, the possibility of remanufacturing is in opposition with business models based on fast trend turnovers and short production times. A product which is easier to be remanufactured will reduce the opportunity of selling new items. Therefore, promoting the possibility of remanufacturing of products may affect negatively those manufacturers whose strategy is based on such business models; whereas it could affect positively manufacturers which focus on product remanufacturing.

A rise in the availability of products which are easier to be remanufactured could stimulate the creation of business related with textile apparel repair. The cost of remanufacturing may also be a significant factor for the expansion of this activity.

Qualitative assessment of relevance

Based on the above, possibility of remanufacturing is considered a relevant product aspect in the context of textile apparel.

10.9.1.14 Recyclability

Recyclability is the ability of waste materials originating from products to be reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

Characteristics of the products in the scope

It is possible to recycle textile apparel, either via mechanical, chemical or enzymatic technologies. However, due to different fibre material combinations, auxiliaries such as buttons and zippers, and various thermal treatments, fibre to fibre recycling is a complex and hardly practiced treatment (Eppinger et al., 2022). In fact, chemical and enzymatic recycling do not seem to be ready for industrial scale application, where the automatic sorting of collected textile products is crucial to effectively identifying fibre type and determining the appropriate recycling method (Zhang et al., 2022). Mechanical recycling is therefore the most common recycling technology nowadays.

Recycling may be closed loop (when materials are recycled back into the same or similar products) or open loop (when materials are converted into different types of products). In the case of textile apparel, most of the recycling processes today are open loop. As the length of the fibres and the constituent molecules are reduced by wear and laundry, fabric and fibre recycling typically yields materials of lower performances than materials made from virgin fibres (Sandin and Peters, 2018). For instance, materials recycled via mechanical recycling can be used to produce insulating materials for cars and buildings, fibre-reinforced composites and disposable non-woven products such as sanitary wipes, napkins and diapers (Zhang et al., 2022). Moreover, there are many opportunities to use cotton and textile waste for various applications including composites, microbial fuel cell, potassium-ion exchange, biochar applications, sound absorbents, thermal insulation, EMI shielding, etc. (Shirvanimoghaddam et al., 2020).

Mechanically recycled fibres generally show weakened properties (Zhang et al., 2022). This process gives the best results when the material still has some level of performance. If very poor (high wear and tear) material is mechanically recycled, up to 30-50% of virgin material needs to be added so that the performance of the material becomes sufficient (Piippo et al., 2022b). This can also be observed in the case of denim products. The common approach to recycle denim products is through fabric shredding into fibres, which can be used in many applications. The success will primarily depend on the characteristics of fibres obtained from the recycling process (Elmogahzy, 2020).

There is room for improvement in the possibilities of recycling textile apparel and this may be influenced at the design stage. For instance, most apparel products currently in use are fibre blends of multiple polymers. Recycling is complicated by textile apparel being constructed of fibre blends, which require separation (Niinimäki et al., 2020). Mono-materiality in textiles has long been recognized for its great recycling efficiency without need for disassembly, making it one of the most effective design strategies for proactive material recovery and perhaps the basis for a new textile paradigm (Zhang et al., 2022).

Environmental

Some studies highlight that the use of recycled materials in textile products decreases their environmental impact (Cai and Choi, 2020; Niinimäki et al., 2020; Amicarelli et al., 2022). The environmental analysis of section 10.9.1.12 on recycled content provides some insight on the benefits of recycling textile apparel. Upcycling textile waste into new products or even recycling textile waste in another sector (e.g. as part of composite material in the automotive industry) is an important approach in a circular economy (Piippo et al., 2022b).

Socioeconomic

In Section 5.4.1, a summary was provided in terms of availability of textile recycling plants. Europe, Asia and North America host 50%, 33% and 11% of global textile recycling plants, respectively. Most of these plants are able to process textile products made of many textile fibres. Increasing the recyclability in textile products could contribute to job creation in different areas: textile collection, sorting, transport and recycling.

However, at global level, only 12% of textile materials are currently recycled (Zhang et al., 2022). Only 15% of post-consumer textile waste was collected separately for recycling purposes in 2015, and less than 1% of total production was recycled in closed loop. Most of the recycled textiles were recycled into other, lower-value applications, such as insulation material, wiping cloths and mattress stuffing (Niinimäki et al., 2020).

In Solis et al (2024), the authors investigated the socioeconomic impacts of different waste management scenarios for textiles. They concluded that mechanical recycling of cotton, polyester, polycotton and polyamide achieved lower costs than incineration. However, if other recycling pathways (such as mechanical recycling of viscose, open-loop recycling, chemical recycling of cotton, polyester and polycotton) are to be competitive from the socio-economic perspective relative to incineration, technology costs need to decrease significantly.

In terms of employment, preparing for reuse and recycling create significantly more jobs than incineration and landfilling (Solis et al., 2024).

Recyclability does not seem a relevant aspect for consumers when purchasing textile apparel.

It has been mentioned above that fibre blends make the process of recycling more complex. To overcome this, mono-material apparel and footwear engineered for mechanical recycling may be manufactured from thermoplastic materials via a combination of existing machinery and processes. However, the huge variation in consumer preference is not easily satisfied by a single material (Zhang et al., 2022).

The recyclability of textile apparel can also be influenced by increasing their collection at end of life, an aspect where consumers also have an influence. Moreover, the Waste Framework Directive requires Member States to set up separate collection for textiles by 1 January 2025. It also promotes the establishment of Extended Producer Responsibility Schemes for textile products in several Member States.

Qualitative assessment of relevance

Based on the above, recyclability is considered a relevant product aspect in the context of textile apparel.

10.9.1.15 Environmental impacts

Environmental impacts refer to any change to the environment, whether adverse or beneficial, wholly or partially resulting from a product during its life cycle.

Characteristics of the products in the scope

Textile apparel include a wide variety of products, including t-shirts, shirts and blouses, sweaters, jackets, pants, dresses and accessories, among others. These products have different applications and therefore a very diverse range of performance requirements. Related with the variety of products and applications, a wide variety of possible materials and manufacturing processes arise, each one providing different characteristics to textile apparel.

This wide variety of possibilities in terms of products, materials and manufacturing processes causes that the nature of the environmental impacts is also wide. Some materials and processes might have a larger impact due to energy use and greenhouse gas emissions, whereas other have a larger impact due to water use, resource use, release of chemicals or generation of waste.

Environmental aspects

As highlighted in Section 3.3.2, textile apparel has relevant effects on the environment throughout its lifecycle, on different areas. For instance:

- The textile industry's water consumption is estimated to account for 4% of global freshwater extraction (Ellen MacArthur Foundation, 2017).

- In 2004, the energy consumption in the global textile industry was estimated to be equal to 2% of the global energy consumption. Additionally, the production of 1 kg of generic textile product was estimated to require about 126 MJ (about 35 kWh) of energy (Muthu, 2015).
- Numerous life-cycle stages of textile apparel involve the use of chemical substances and mixtures. Some of them are pesticides, solvents, surfactants, dyes and pigments, water and stain repellents, flame retardants, biocides and many more (Ellen MacArthur Foundation, 2017) .
- In 2019, the EU generated about 12.6 Mt of textile waste, including post-industrial, pre-consumer and post-consumer waste, representing 11%, 3% and 86% of the total, respectively.
- The European Environment Agency estimated that textile consumption in the EU in 2020 emitted 121 million tonnes of greenhouse gases. Around 75% of the emissions occurred outside Europe, specifically in Asian countries (EEA et al., 2022).
- Textile fragmentation is also a relevant aspect for the environmental impacts of textile apparel. It has been reported that one of the leading sources of microplastics pollution is the fragmentation of synthetic textiles (Boucher and Friot, 2017). Current patterns indicate that emissions of microplastics from textiles are projected to rise by approximately 22% by the year 2030 (DG ENV, 2023).
- The BREF on textiles (Roth et al., 2023) identifies and addresses the main pollutants during the manufacturing process of textile apparel, such as COD, SOx, NOx, energy consumption and water consumption.

Socioeconomic

Many of the impacts mentioned above occur outside the EU. Third countries producing textiles often have less stringent environmental and labour requirements. This allows manufacturers to reduce costs and offer final products at a lower purchase price than EU production, at the expense of environmental degradation and health issues of the workers and the communities working around the manufacturing plants. Promoting products with a lower environmental impact would contribute to the reduction of impacts across the whole value chain.

As pointed out in Section 6.2.2, most of EU consumers argue that environmental impact of products is 'very' or 'rather important' in their purchasing decisions (European Commission. Directorate General for Environment., 2023). Information is a key aspect to convey messages on the environmental performance of products: around 82% of consumers believe there is insufficient information available on environmental aspects associated with apparel (European Commission, 2019).

Qualitative assessment of relevance

Based on the above, environmental impact is considered a relevant product aspect in the context of textile apparel.

10.9.1.16 Expected generation of waste

The expected generation of waste is the generation of any substance, or object that the holder discards or intends or is required to discard.

Characteristics of the products in the scope

Waste is generated in different lifecycle stages of textile apparel. Depending on that, waste can be classified as (Huygens et al., 2023):

- Post-industrial waste: waste generated during the manufacturing of textile products and their precursors.
- Pre-consumer waste: waste generated at retail stages (e.g. unsold textiles).
- Post-consumer waste: textiles that have been disposed of after consumption and use by the citizen or end-users of commercial and industrial activities (hotel, healthcare, etc.), commonly referred to as household and commercial post-consumer textile waste, respectively.

Therefore, waste is relevant in different stages of the textile product value chain. There seems to be room for improvement in the expected generation of waste. In terms of post-industrial waste, methods have been developed to design textile apparel that minimises cutting waste and puts nearly all offcuts into production (Niinimäki et al., 2020). Most of the leftover material from textile apparel manufacturing (post-industrial waste) ends up dumped or burned (Aus et al., 2021). It is technically feasible to increase the separate collection of textile products, especially those with highly valuable materials. Directive 2008/98/EC requires Member States to ensure the separate collection of textiles by 2025. Moreover, a proposal for a targeted revision of this Directive is currently in co-decision and is expected to introduce more detailed collection and sorting requirements and the establishment of Extended Producer Responsibility (EPR) for certain textile and footwear products in Member States.

Environmental aspects

The impacts from the fashion industry include over 92 million tonnes of waste produced per year, accounting for up to 22% of mixed waste worldwide (Niinimäki et al., 2020). As mentioned in Section 3.3.2, the EU generated in 2019 around 12.6 Mt of textile waste. Around 86% of that waste is post-consumer waste. The current management of textile waste is considered suboptimal, as landfilling and incineration are the predominant treatment methods (Solis et al., 2024), releasing harmful substances and contributing to global warming, among other environmental impacts.

In Europe, on average 37% of textiles waste are separately collected (Amicarelli et al., 2022). The majority of post-consumer waste that is separately collected is sent outside the EU as used products intended for re-use. However due to the saturation of the global market for such used products many items are instead discarded in third countries causing negative environmental and social impacts (Huygens et al., 2023).

Strategies aiming at reducing the amount of waste generated, or at increasing the amount of textile waste collected and sorted at end of life, would have a significant benefit on the environment.

Socioeconomic

As pointed out in Section 5.6, the exports of used textiles from the EU reached 1 700 000 tonnes in 2019. Usually, these products are exported to Africa for a first screening in local markets, then down-cycled into industrial rags or filling, or re-exported to Asia for recycling. A significant amount of this waste ends up in Asian and South American landfills.

Reducing the amount of waste that is sent to landfill could also stimulate the creation of jobs, related to the collection, sorting and recycling of textiles.

The expected generation of waste is directly related with consumers. The apparent consumption of textile apparel has doubled after the opening of the EU market to products coming from China, as explained in section 5.2. Section 6.4.1 already highlighted the main factors influencing disposal decisions (perceived quality being one of the key aspects). Material defects, inappropriate size, loss of shape, or not liking the item, are also important factors (Kleinhückelkotten et al., 2018b). Sharing with social circles, donating or swapping are common ways to dispose of apparel no longer being used. Throwing away usable apparel is generally perceived as a socially reproachable behaviour (despite this, large amounts of textile waste are still generated nowadays, as pointed out above).

Qualitative assessment of relevance

Based on the above, expected generation of waste is considered a relevant product aspect in the context of textile apparel.

10.9.2 Supporting information on parameters affecting the physical durability

Table 121 reports the main fibre characteristics playing a role in the physical durability of textile apparel. Additionally, **Table 122** and **Table 123** report definitions of yarn and fabric characteristics and main process parameters, respectively. This information supports the description of interlinks among several factors in the textile apparel production.

Table 124 reports the influence of fibre characteristics on yarn and fabric characteristics. **Fibre length** influences the strength, smoothness, and uniformity of the fabric, with longer fibres enhancing the physical performance of yarns and fabrics. **Fibre strength** is critical to the physical durability of the yarn and has a direct impact on the ability of the textile apparel to withstand wear and tear. **Fibre fineness** is important for producing finer yarns, which are essential for creating smoother, softer and more uniform products, enhancing the texture, comfort and appearance of textile apparel. **Fibre elasticity**, which is the ability of fibres to return to their original shape after stretching, is vital for the resilience and shape retention of the fabric. Additionally, the type of fibre, whether natural or chemical, plays a significant role. More details are reported in **Table 124.**

Fibre characteristics are largely influenced by various external factors. **Environmental conditions** such as climate and soil characteristics significantly affect natural fibres, while the diet and health of animals impact the characteristics of fibres like wool and silk. **Chemical exposures**, including pesticides and pollutants, can degrade fibre characteristics. Additionally, the mechanical and chemical processing techniques used during fibre production can alter their strength, elasticity, and overall integrity. Finally, **moisture and temperature during the storage** of fibres plays a crucial role in preventing damage like mould growth or material degradation, ensuring fibres maintain their desired properties (Hearle and Morton, 2008) (Mishra, 2000) (Rahman et al., 2023).

Understanding the influence of fibre characteristics on yarn, processing and fabric is essential for optimizing manufacturing processes and achieving desired textile performance and aesthetics.

Table 121. Description of the main fibre characteristics

Fibre characteristic	Definition	Description of natural fibres	Description of chemical fibres	Source
Fibre length	The length of the individual staple fibre[215]	Natural fibre lengths are generally categorised into: Short (S) – Less than 25mm; Medium (M) – 25-30mm; Long (L) – 30-37mm; and Extra Long Staple (ELS) – Over 37mm. Specific natural fibre lengths: **Silk** (continuous): 50 000 to 1 500 000 cm **Hemp:** average 182.88 cm **Flax**: up to 90 cm **Wool:** • Fine wool: 3.8 to 12.7 cm • Medium wool 6.35 to 15.24 cm • Courser or long 12.7 to 38.1 cm **Cotton:** • Very short-staple cotton: ≤2.1 cm • Short staple cotton: >2.2 cm and <2.5 cm • Medium Staple cotton: >2.6 cm and < 2.8 cm • Ordinary long-staple cotton: >2.9 cm and < 3.4 cm • Extra-long staple cotton: ≥3.4 cm	Chemical fibre lengths can be considered continuous	https://textileexchange.org/glossary/fibre-length/ https://www.textilecoach.net/post/cotton-fibre#:~:text=Short%20staple%20cotton%3A%20%3E22mm%20and,staple%20cotton%3A%20%E2%89%A534%20mm https://www.fao.org/natural-fibres-2009/about/15-natural-fibres/en/
Fibre strength	The strength of an individual fibre	It is generally measured by tenacity, defined as the breaking force of the fibre divided by the weight of 1000 m of fibre (e.g. cN/tex[216]). Minimum fibre strength =6 cN/tex is technically acceptable for spinning processes.		(Lamb, 2009) https://textilelearner.net/properties-of-silk-fibre/#:~:text=Tenacity%3A,Silk%20loses%20strength%20on%20wetting. https://omnexus.specialchem.com/polymer-property/strength-at-break-tensile (Rahman Khan et al., 2011) https://cmdgroup.in/physical-properties-of-fibres.php https://old.swicofil.com/products/223polyamideimide.html https://www.tp-industrial.com/files/specs-polyamide-1.pdf
		Significant breaking strengths of most used natural fibres for textile apparel: **Hemp:** 65.5-72.5 cN/tex **Silk:** 29.1-42.3 cN/tex **Cotton:** 15-40 cN/tex **Wool**: 12-18 cN/tex **Flax**: 7.37 cN/tex	Significant breaking strengths of most used chemical fibres for textile apparel: **Polyamide**: 65-82 cN/tex **Polyester:** 35-60 cN/tex **Acrylic:** 19.6-29.4 cN/tex **Viscose:** 19.6 cN/tex **Acetate:** 12.7 cN/tex	

[215] Considering that man-made fibres are assigned infinite length.
[216] cN/tex= centi Newton / Tex is a unit allowing to qualify the elastic capacity of a textile or a yarn

Fibre characteristic	Definition	Description of natural fibres	Description of chemical fibres	Source
Fibre cleanliness	Refers to the degree of fibre contamination with impurities[217]	Impurities are classified into ranges and according to the impurities grade and are mainly common in natural fibres, but they can appear in chemical fibres due to the treatment agents such as lubricants and oils in chemical fibres production.		http://www.definetextile.com/2013/04/fibre-cleanliness.html
		Range of impurities: • ≥7 %- Very dirty • 4-7 %- Dirty • 2-4%- Medium • 1.2-2- Clean • ≤1.2- Very clean Impurities grade (AFIS[218]): • ≤15 µm- Breathable dust • 15-50 µm- Micro dust • 50-500 µm- Dust • ≥500 µm-Trash		
Fibre fineness	Determines the number of fibres that can made up the cross-section of a yarn with a specific thickness.	Measures units of mass per unit of length to assess linear density (e.g. dtex[219]) According to the classification of Sekhri (Sekhri, 2016), fibre fineness can be classified as it follows: • Thick fibres >7 dtex • Semi-fine fibres: 7-2.4 dtex • Fine fibres: 2.4-1 dtex • Microfibres: 1-0.3 dtex • Super microfibres <0.3 dtex		http://www.definetextile.com/2013/04/fibre-fineness.html
		Hemp: 48.1–186.9 dtex **Wool:** 3.5 dtex **Flax:** 1.39- 1.7 dtex **Cotton:** 1.6 dtex **Silk:** 0.95-1.6 dtex	The minimum fineness that the raw material and technology permits obtaining for the conventional applications is presented below, considering that the fineness can be increased depending on the application: **Polyester:** 0.8-3 dtex (ultrafine or microfibre 0.55 dtex) **Polyamide:** minimum 1 dtex **Acrylic:** minimum 0.9 dtex **Viscose:** minimum 1.2 dtex **Acetate:** minimum 1.5 dtex	(Ramey, 2018) (Fibre Fineness - an overview | ScienceDirect Topics, n.d.) (Rahman Khan et al., 2011) (Banale, 2017) (Chapter 3. Fibre fineness and transverse dimensions, 2008) (Goudar and Kulloli, 2022)

217 The impurities may be natural from the cultivation process, but also generated by processing. Generally, impurities must be eliminated via a cleaning process.
218 AFIS (Advanced Fibre Information System)
219 dtex (deci-tex): Grams per 10.000 metres of yarn

Fibre characteristic	Definition	Description of natural fibres	Description of chemical fibres	Source
Fibre colour	The colour of the fibre affects the ability of a yarn or fabric to be to dyed or bleached.	The performance of yarn during dyeing or bleaching is influenced by the natural colour of the fibre. This characteristic is mainly relevant to natural fibres. The colour of man-made fibres can be controlled during the production process.	This does not apply to chemical fibres.	https://www.fao.org/natural-fibres-2009/about/15-natural-fibres/en/
Fibre stiffness	Fibre stiffness refers to the ability of a fibre to resist deformation or bending when subjected to a load	Commonly measured using parameters like Young's modulus or bending modulus, which characterise the material resistance to deformation. It depends on the fibre substance and the relationship between fibre length and fibre fineness: • The length of the fibre is proportional to the bending modulus. The following relationship can be indicated: • Thick fibres are generally stiff, firm and wrinkle-resistant. Fine fibres are soft, flexible and generate good drape.		(Ferrándiz et al., 2021)

7834 *Source: own knowledge and sources indicated in the table*

7835 **Table 122.** Definitions of yarn and fabric characteristics

Intermediate textile product	Characteristic	Definition	Source
Yarn	Evenness	Yarn evenness refers to the uniformity of the yarn in terms of thickness and weight along its length.	(Elmogahzy, 2019)
	Hairiness	Yarn hairiness refers to the presence and extent of fibre ends and loops protruding from the main body of the yarn.	(Elmogahzy, 2019)
	Strength	Yarn strength refers to the ability of a yarn to withstand tensile forces without breaking.	(Elmogahzy, 2019)
	Appearance	Yarn appearance refers to the visual and physical characteristics of yarn, including diameter, hairiness, and defects, which affect its performance and the physical durability of the final fabric.	(Tahvildar et al., 2019; Li et al., 2020)
Fabric	Handle	Fabric handle refers to the tactile qualities of a fabric, encompassing its softness, smoothness, flexibility, and overall sensation when touched, which contribute to its comfort and user experience	(Tahvildar et al., 2019; Li et al., 2020)
	Lustre	The visual aspect of a fabric or yarn that reflects light in a way that creates a shiny or glossy appearance.	(Kim et al., 2004)
	Strength	Fabric strength can be defined as the ability of a fabric to withstand various forces and stresses without breaking or deforming	(Mobarak Hossain, 2016)
	Appearance	Fabric appearance encompasses the overall look and visual appeal of the fabric, which is influenced by factors such as weave structure, yarn compactness, and finishing processes.	(Tahvildar et al., 2019)
	Drape	Fabric drape refers to how the fabric hangs in three dimensions, retaining its shape from when it is laid flat or adapting to new contours.	(Choudhary and Bansal, 2017)
	Smoothness	Fabric smoothness refers to the fabric surface resistance to a sliding tangential force applied.	(Mao et al., 2016)
	Softness	Fabric softness refers to the tactile sensation or comfort level experienced when touching or wearing a fabric.	(Ferrándiz et al., 2021)
	Breathability	Breathability in fabrics is the ability of water vapours to successfully permeate through that fabric via diffusion and, henceforth, facilitate cooling via evaporation.	(İnovenso Teknoloji Ltd.Şti and Mustafa, 2023)
	Insulation	Fabric insulation refers to a fabric's ability to retain heat and provide warmth by reducing the transfer of heat from the body to the surrounding environment.	(Matusiak Malgorzata and Sikorski Renata, 2011)
	Anti-wrinkle	Anti-wrinkle is a finishing method for textiles that prevents creases and wrinkles, enhancing the appearance of the articles.	(Van den Bergen and Parker, 2023)

Intermediate textile product	Characteristic	Definition	Source
	Resistance to stains and water	Resistance to stains refers to the ability of a fabric to repel or prevent the absorption of various staining substances, thereby maintaining its appearance and cleanliness over time. Resistance to water, also known as water repellency, describes the capacity of a fabric to prevent water from penetrating its surface, thus keeping the material dry and maintaining its structural integrity.	(Rowen and Gagliardi, 1947) (Roy Choudhury, 2017)

Source: AITEX's knowledge and references reported in the last column

Table 123. Definitions of main process parameters

Process parameter	Definition	Sources
Spinning method	The spinning method encompasses various techniques used to transform raw fibres into yarn. These methods involve processes that draw out and twist the fibres, creating a continuous strand of yarn. For detailed descriptions of different spinners, refer to section 10.2.2.	(Elmogahzy, 2019) (Sinha and Chattopadhyay, 2007) (Mahmoudi, 2010) (Tyagi, 2010) (Mobarak Hossain, 2016) (Rahman et al., 2023)
Spinning limit	The spinning limit defines the range of yarn counts achievable from a given fibre using a specific spinning system. It depends on the number and thickness of individual fibres (for natural fibres) or filaments (for chemical fibres) twisted together.	
Spinning Productivity	Spinning productivity can be defined as the production of the finest yarn count from a given fibre ensuring acceptable performance and minimising end breakage rates.	
Twist level	Twist level is defined by the number of turns per unit length (per inch or per meter) in a spun yarn. It describes yarn density.	
Twists number	The twist number quantifies the number of turns about its axis per unit length of a yarn or textile strand. It is expressed as turns per inch (TPI), turns per meter (TPM), or turns per centimetre (TPCM).	
Spinning tension	Spinning tension represents the resistance or force applied to the yarn during the spinning process.	
Speed of spinning	The speed of spinning defines the rate at which fibres are converted into yarn during spinning.	
Rolling, revolving, and twisting movements	These fundamental movements in spinning: Rolling: Rotation of fibres to align them, Revolving: Circular motion of the spindle, Twisting: Imparting twists to the fibres, resulting in yarn formation	
Yarn manufacturing process development	Encompasses the life cycle stage for converting raw fibres into yarn.	
Conditioning (steaming)	It involves moistening the yarn using saturated steam or wet steam.	
Spinning twist limit	The spinning twist limit defines the upper range of yarn count achievable for a given fibre and spinning system, determining the maximum fineness of yarn produced.	
Temperature and humidity control	Maintaining optimal temperature and humidity levels is crucial. High humidity improves yarn properties, while excessive moisture can lead to issues.	
Dyeing process	Dyeing involves applying colour to yarn or fabric.	
Characteristics of components and machinery	The characteristics of components and machinery directly affects yarn production. Well-maintained, precise equipment ensures consistent yarn properties.	
Defects control	Defect control focuses on minimising flaws in yarn, such as knots or irregularities, enhancing yarn desired performances, and reducing waste.	
Thread count	Thread count refers to the number of yarns (threads) per unit length in woven fabrics, and it affects fabric density and texture.	
Weight of fabric	The weight of fabric is determined by the total mass of yarn used per unit area, influencing fabric thickness and durability.	

Process parameter	Definition	Sources
Weave pattern	The weave pattern describes how warp and weft yarns interlace to form fabric	

Source: AITEX's knowledge and references reported in the last column

Table 124 Influence of the fibre characteristics on yarn and fabric characteristics and parameters of manufacturing processes

Characteristic or parameter		Fibre length (1)	Fibre strength	Fibre cleanliness	Fibre fineness	Fibre colour	Fibre stiffness (2)
Yarn characteristics	Evenness	Yarn evenness increases during drafting[220] proportionally with the fibre length.	Yarn evenness increases proportionally with the increase of fibre strength (smaller extent).		Yarn evenness increases proportionally with the increase of fibre fineness. (5)		
	Hairiness (3)	Yarn hairiness decreases with the increase of fibre length.	Yarn hairiness decreases with the increase of fibre strength.		Yarn hairiness increases with the increase of fibre fineness. (5)		
	Strength	Yarn strength increases proportionally with fibre length increase.					
	Appearance			Yarn appearance improves with the increase of fibre cleanliness. (4)			
Yarn manufacturing (spinning) parameters	Twist limit				Twist limit decreases with the increase of fibre fineness, after the optimal working range.		
	Spinning limit	Spinning limit increases proportionally with the increase of fibre length.	Spinning limit increases proportionally with the increase of fibre strength.		Spinning limit increases proportionally with the increase of fibre fineness.		
	Spinning productivity	Spinning productivity increases with the increase of fibre length.	Spinning productivity increases with the increase of fibre strength.		Spinning productivity increases with the increase of fibre fineness.		

[220] Drafting is the process of reducing the thickness of fibres to achieve specific fineness and strength for yarns (Rahman et al., 2023).

Characteristic or parameter		Fibre length (1)	Fibre strength	Fibre cleanliness	Fibre fineness	Fibre colour	Fibre stiffness (2)
	Rolling, revolving, and twisting movements						
	Spinning process development			Spinning process improves with the increase of fibre cleanliness. (4)			Spinning process worsens with the increase of fibre stiffness.
Finishing processes parameters	Dyeing					Dyeing process efficiency decreases with the increase of fibre natural colour. (6)	
Fabric characteristics	Handle	Fabric softness increases with the increase of fibre length.			Fabric softness increases with the increase of fibre fineness.		
	Luster	Fabric shininess increases with the increase of fibre length.			Fabric shininess increases with the increase of fibre fineness.		
	Strength		Fabric resistance to tear strength increases with the increase of fibre strength.				
	Appearance			Fabric appearance improves with the increase of fibre cleanliness. (4)			
	Drape				Fabric drape improves with the increase of fibre fineness.		

(1) Most commonly related to natural fibres and mechanically recycled synthetic or other man-made fibres. It defines the spinnability of the fibre.
(2) A fibre that is too stiff has difficulty in adapting to process movements. The lower the springiness generates more creation of neps (entangled and knotted fibres generated by increased stiffness).
(3) Unwanted parameter
(4) Impurities generate a bad yarn drying, with broken ends increased, generating a worse appearance. Additionally, impurities interfere with the process development affecting the strength of the material to be processed. Finally, impacts the appearance and physical characteristics of the fabric and finished product.
(5) A finer the fibre allows a multitude of fibres/filaments in the cross-section, allowing a better distribution in the yarn. Fibre fineness decreases after the optimal working range and yarn hairiness will increase.
(6) The intrinsic colour of the fibre interferes with the dyeing process.

*Source: AITEX's knowledge and **Figure 21***

Yarn manufacturing, the spinning process combining rolling, revolving and twisting movements, is defined by parameters that influence the final yarn characteristics.

Table 125 reports the effect of main process parameters on the characteristics of the yarn. The selection of the spinning method influences the evenness, softness and strength of the yarns. Nevertheless, the twist level and number impact the strength and softness of the yarns. Controlling optimal spinning tension and speed is important due to the impact on the strength of the yarn. Proper yarn conditioning has the potential to enhance characteristics such as flexibility, strength and evenness. Manufacturing process parameters such as temperature and humidity control and the characteristics of components and machinery, completed with performance control, influence overall the mechanical-related strength of the yarns.

Understanding and controlling these processing parameters enables manufacturers to customise yarn characteristics for precise end applications, like textiles for fashion such as underwear, jackets, or accessories. Adjustments in these parameters can result in notable differences in yarn physical performance and durability, demonstrating the importance of precise control and monitoring during the spinning process.

Table 125. Influence of spinning parameters on yarn characteristics

Yarn characteristics	Spinning method	Twist level	Twists number	Spinning tension (2)	Speed of spinning	Conditioning (steaming)	Temperature and humidity control	Characteristics of components and machinery	Defects control
Yarn evenness	Air-Jet Spinning → highly uniform yarns			Constant tension: uniform yarn		Enhances evenness	Proper humidity prevents static electricity, material processing issues, equipment damage, and fabric shrinkage.	High quality of the machinery produces consistent yarns. Ensures improved efficiency, safety, productivity, and product performance	Critical for maintaining high-performance standards and preventing imperfections in yarn and fabric
Yarn elasticity						Enhances flexibility			
Yarn softness	Air-Jet Spinning → highly smooth yarns	Low Twist: softer yarns							
Yarn strength	Ring Spinning→ very high-strength and finer yarns Rotor (Open-End) Spinning → bulkier yarns with reduced strength Air-Jet Spinning → less durable yarns	High Twist: stronger yarns	Yarn strength increases with twist to a peak (1), then decreases.	Uneven Tension: can cause breakages during subsequent processing	Higher Speeds: can cause breakages	Enhances strength			

(1) Optimal twist depends on fibre length, fineness, strength, and friction.
(2) Spinning tension: Essential for evaluating ring spinning machine performance.

*Source: AITEX's knowledge and **Figure 21***

In the **fabric manufacturing**, the industry opts for either weaving or knitting techniques, depending on the intended use of the final products. The parameters involved in weaving significantly impact the characteristics of the fabric. These are the yarn count, weight of fabric, and weave pattern, among others. **Table 126** reports the influence of the main weaving parameters on the fabric characteristics. A higher thread count defines smoother, softer, and more breathable fabrics. Meanwhile, the weight of the fabric improves the resistance to tear but decreases breathability and drape. Finally, the selection of the weave pattern impacts the resistance to tear and is done according to the desired functionality, such as smoothness, anti-wrinkle, and resistance to stains and water.

Table 126. Influence of weaving parameters on fabric characteristics

Parameter	Type	Fabric characteristic							
		Smoothness	**Softness**	**Breathability**	**Tear strength**	**Insulation**	**Anti-wrinkle**	**Resistance to stains and water**	**Drape**
Thread count (1)	Higher the number of threads	Increases fabric smoothness	Increases fabric softness	Decreases fabric breathability					
Weight of fabric (2)	Heavier fabric			Decreases fabric breathability	Increases resistance to tear	Increases fabric insulation properties			Decreases fabric drape
Weave pattern (3)	Plain (eg. Chiffon, organza)	Increases fabric smoothness		Increases fabric breathability					
	Diagonal (eg. twill)				Increases resistance to tear		Increases fabric anti-wrinkle capacity	Increases fabric resistance to stains and water	
	Satin	Increases fabric smoothness			Decreases fabric resistance to tear				

(1) Generally, more important for fabrics intended to be used in contact with the skin (e.g. beddings, textile apparel). The optimal thread count can vary depending on the desired fabric use and feel, and sometimes higher thread counts are achieved by using multiple-ply yarns, which can affect the fabric differently.

(2) The weight is influenced by the yarn's thickness and the tightness of the weave or knit. Generally more important for fabrics such as upholstery or drapery.

The fabric construction parameters, including weave pattern, yarn count, fabric thickness, and compaction, influence tear strength. Fabrics with denser weaves, higher yarn counts, and thicker constructions tend to exhibit higher tear resistance.

The weight or mass of the fabric per unit area is indicative of fibre concentration and arrangement. Heavier fabrics with higher yarn density typically offer better tear strength. The denser packing of fibres in the fabric structure increases resistance to tearing forces.

(3) Each weaving pattern offers unique characteristics that can be leveraged for specific applications, impacting not only the aesthetics of the fabric but also its performance in various uses

*Source: AITEX's knowledge and **Figure 21***

Table 127 reports the influence of finishing processes on fabric characteristics. **Fabric finishing** is a crucial stage in manufacturing that imparts specific aesthetic and technical functionalities to the fabric. **Dyeing** plays a significant role, as the choice of dye and dyeing technique can greatly influence colour fastness ([221]), hand feel, colour depth, and evenness. **Table 65** reports information on the relationship between fibre type and dye affinity. **Printing** affects the vibrancy of colours and the handle of the fabric. **Chemical finishing** imparts various properties to the fabric, such as improved handle and repellency to water, oil, and stains, thereby enhancing its physical durability. Mechanical finishing alters the fabric's physical properties, contributing to smoothness or improving the handle, such as adding fluffiness. **Coating and laminating** processes are used to enhance fabric performance by adding waterproofing capabilities and increasing breathability or resistance to abrasion (Rahman et al., 2023).

Table 127. Influence of finishing processes on fabric characteristics

Finishing process type	Primary influence on fabric characteristics
Dyeing	Colour depth, evenness, and fastness
Printing	Pattern precision, vibrancy, and hand feel
Chemical Finishing	Functional properties like softness, repellence
Mechanical Finishing	Physical properties like smoothness, plushness
Coating and Laminating	Protective and performance-enhancing characteristics such as waterproofing, breathability

*Source: AITEX's knowledge and **Figure 21***

Three main components affect the physical durability during **confectioning** of the textile apparel: the sewing physical characteristics, precision of cuts, and seam strength. **Sewing physical characteristics** include the straightness of seams, consistency of stitch length, and the absence of skipped stitches. These affect both the appearance and physical durability of the textile apparel. The **strength and type of seams** used in fabric assembly determine the physical durability of the textile apparel and its ability to endure wear and stress. Inadequately constructed seams may result in rapid deterioration. **Precise cutting** following patterns is essential for ensuring that the textile apparel fits properly. Mistakes in cutting can result in poorly fitting textile apparel, directly affecting consumer satisfaction (Rahman et al., 2023) (Elhawary, 2015b).

[221] Colour fastness refers to the resistance of a fabric's colour to fading or running when exposed to various conditions, such as washing, sunlight, rubbing, and perspiration

10.9.3 Supporting information on test methods to describe the physical durability

Table 128. Description of standardised test methods to assess key parameters of physical durability

Parameter	Testing method	Short description of the scope of the test	Type of result obtained
Abrasion resistance	ISO 12947-2:2016[222] Textiles — Determination of the abrasion resistance of fabrics by the Martindale method Part 2: Determination of specimen breakdown	It specifies a method for determining the abrasion resistance of textile fabrics using the Martindale method, by determining when a textile fabric reaches breakdown by inspecting it at regular intervals. It applies to all textile fabrics, including nonwovens, except for fabrics with a specified low abrasion wear life. These results help to determine the durability and longevity of the fabric when subjected to repetitive friction.	Number of rubs or cycles The results are typically expressed as the Number of Rubs or Cycles, which indicates the number of abrasion cycles the fabric can withstand before showing significant wear or damage.
Bursting resistance	ISO 13938-2:2019 [223](50cm^2) Textiles — Bursting properties of fabrics. Part 2: Pneumatic method for determination of bursting strength and bursting distension	It specifies a method for determining the bursting strength and expansion of textile fabrics using a pneumatic method. When tested using a specimen size of 50 cm^2. These measurements provide critical information about the fabric's resistance to pressure and its ability to stretch before failing.	Kilopascals (kPa) The results are typically expressed as kilopascals (kPa), indicating the pressure required to burst the fabric.
Colour fastness to chlorinated water	ISO 105-E03:2010[224] Textiles - Tests for colour fastness - Part E03: Colour fastness to chlorinated water (swimming-pool water) (ISO 105-E03:2010)	It specifies a method for determining the resistance of textile colours, on fabrics, to active chlorine, like the concentrations used in swimming pool water for disinfection. These grades indicate how well a fabric's colour resists fading and staining when exposed to chlorinated water, which is crucial for textiles used in swimwear and other water-related applications.	Grading scale The results obtained from this test are typically expressed as Colour Fastness Grade: This is assessed using the Grey Scale for Colour Change and the Grey Scale for Staining, which range from 1 to 5, where: Grade 1: Very poor colour fastness. Grade 2: Poor colour fastness. Grade 3: Moderate colour fastness. Grade 4: Good colour fastness. Grade 5: Excellent colour fastness.
Dimensional change	ISO 3759:2011[225] Textiles — Preparation, marking and measuring of fabric specimens and textile apparel in tests for determination of dimensional change	Provides a method for preparing, marking, and measuring textile fabrics, textile apparel, and fabric assemblies to test how they change in size after treatments like washing, dry cleaning, soaking, or steaming. These treatments must follow procedures from specific ISOs. It applies to woven and knitted fabrics and finished textile articles but does not apply to certain upholstery coverings.	Percentage (%) This percentage reflects the dimensional change, such as shrinkage or stretching of the fabric after washing or dry cleaning. The percentage change is calculated based on the difference between the original and the post-treatment dimensions.
Elasticity of fabric	ISO 20932-3:2018[226]	It specifies a method for determining the elasticity of textile fabrics using a cyclic testing procedure. These results help to assess the fabric's ability to recover its	Percentage (%) When tested after one minute, the results are typically expressed as extension at specified load: Measured in

[222] ISO 12947-2:2016 Textiles — Determination of the abrasion resistance of fabrics by the Martindale method Part 2: Determination of specimen breakdown. Available at this link.
[223] ISO 13938-2:2019 Textiles — Bursting properties of fabrics Part 2: Pneumatic method for determination of bursting strength and bursting distension. Available at this link.
[224] ISO 105-E03:2010 Textiles — Tests for colour fastness Part E03: Colour fastness to chlorinated water (swimming-pool water). Available at this link.
[225] ISO 3759:2011 Preparation, marking and measuring of fabric specimens and textile apparel in tests for determination of dimensional change. Available at this link.
[226] ISO 20932-3:2018 Textiles — Determination of the elasticity of fabrics Part 3: Narrow fabrics. Available at this link.

Parameter	Testing method	Short description of the scope of the test	Type of result obtained
	Textiles — Determination of the elasticity of fabrics Part 3: Narrow fabrics	original shape after being stretched, which is important for applications where elasticity and shape retention are critical.	percentage (%), this indicates the amount of stretch or elongation that occurs when a specified load is applied to the fabric.
Colour fastness to artificial light	ISO 105-B02: 2014[227] Textiles — Tests for colour fastness Part B02: Colour fastness to artificial light: Xenon arc fading lamp test	It specifies a method for determining the colour fastness of textile fabrics to artificial light: the Xenon arc fading lamp test, outlining a method for testing how the colour of textiles, including white or bleached fabrics, reacts to artificial light similar to natural daylight (D65). It allows the use of two different sets of blue wool references, though the results from these references may vary. These grades indicate how well a fabric's colour resists fading when exposed to artificial light, which is crucial for maintaining textiles' appearance over time.	Grading scale The results are typically expressed as Colour Fastness Grade: This is assessed using the Blue Wool Scale, which ranges from 1 to 8, where: Grade 1: Very poor light fastness. Grade 2: Poor light fastness. Grade 3: Moderate light fastness. Grade 4: Fair light fastness. Grade 5: Good light fastness. Grade 6: Very good light fastness. Grade 7: Excellent light fastness. Grade 8: Outstanding light fastness.
Pilling resistance	ISO 12945-2:2020[228] (2000 cycles) Textiles — Determination of fabric propensity to surface pilling, fuzzing or matting Part 2: Modified Martindale method	Tests of textiles' pilling resistance are typically expressed as pilling grade. This is a visual assessment of the fabric surface after it has been subjected to 2000 cycles of abrasion.	Grading scale The grading scale usually ranges from 1 to 5, where 1 indicates severe pilling and 5 indicates no pilling. Grade 1: Severe pilling with dense pilling covering the entire fabric surface. Grade 2: Pronounced pilling with significant pilling affecting a large area of the fabric. Grade 3: Moderate pilling with noticeable pilling over a moderate area of the fabric. Grade 4: Slight pilling with some pilling visible but not extensive. Grade 5: No pilling with no visible pilling on the fabric surface.
Colour fastness to sea water	ISO 105-E02:2013[229] Textiles — Tests for colour fastness Part E02: Colour fastness to sea water	It specifies a method for determining the colour fastness of textiles to sea water. These grades indicate how well a fabric's colour resists fading and staining when exposed to sea water, providing important information for textiles intended for marine or coastal use.	Grading scale The results obtained from this test are typically expressed as Colour Fastness Grade: This is assessed using the Grey Scale for Colour Change and the Grey Scale for Staining, which range from 1 to 5, where: Grade 1: Very poor colour fastness. Grade 2: Poor colour fastness. Grade 3: Moderate colour fastness. Grade 4: Good colour fastness.

227 ISO 105-B02:2014 Textiles — Tests for colour fastness Part B02: Colour fastness to artificial light: Xenon arc fading lamp test. Available at this link.
228 ISO 12945-2:2020 Textiles — Determination of fabric propensity to surface pilling, fuzzing or matting Part 2: Modified Martindale method. Available at this link.
229 ISO 105-E02:2013 Textiles — Tests for colour fastness Part E02: Colour fastness to sea water). Available at this link.

Parameter	Testing method	Short description of the scope of the test	Type of result obtained
			Grade 5: Excellent colour fastness.
Seam resistance	ISO 13935-2:2014[230] Textiles — Seam tensile properties of fabrics and made-up textile articles Part 2: Determination of maximum force to seam rupture using the grab method	It specifies a method for determining the seam strength of textile fabrics by using the grab method, indicating methods for determining the maximum force of sewn seams when force is applied perpendicularly, using the grab test. It primarily applies to woven fabrics, including those with stretch characteristics, but may also apply to other fabric types. These measurements provide critical information about the strength of textile fabrics, which is essential for ensuring the durability and performance of sewn products.	Newtons (N) The results are typically expressed as Seam-Breaking Force measured in Newtons (N); this indicates the force required to break the seam.
Tensile strength	ISO 13934-1:2014[231] Textiles — Tensile properties of fabrics Part 1: Determination of maximum force and elongation at maximum force using the strip method	This specifies a method for determining the maximum force and elongation at the maximum force of textile fabrics using a strip method. It mainly applies to woven fabrics, including those with stretch properties from elastomeric fibres, and mechanical or chemical treatments.	Newtons (N) This value reflects the maximum force, which indicates the highest force the fabric can withstand before breaking.
Visual inspection for: (1) Colour change (2) Pilling (3) Trimmings aspect (4) Self-staining	ISO 15487:2018[232] Textiles — Method for assessing appearance of apparel and other textile end products after domestic washing and drying	It specifies a method for assessing the appearance of apparel and textile products after one or more cleaning cycles. The evaluation includes factors such as colour change, pilling, fuzzing, matting, fabric smoothness, seam appearance, retention of pressed-increases, and damage to components like buttons or fasteners. It applies to any washable textile product, regardless of fabric construction, as supplied by the manufacturer.	Grading scale The grading scale usually ranges from 1 to 5, where 1 indicates severe distortion or damage, and 5 indicates no visible distortion or damage. Grade 1: Severe distortion or damage, significant loss of fabric integrity. Grade 2: Pronounced distortion or damage, noticeable but not severe. Grade 3: Moderate distortion or damage, visible but not significantly affecting the fabric's usability. Grade 4: Slight distortion or damage, minimal and only noticeable upon close inspection. Grade 5: No visible distortion or damage, fabric maintains its original appearance.

Source: cited standards

[230] ISO 13935-2:2014 Textiles — Seam tensile properties of fabrics and made-up textile articles Part 2: Determination of maximum force to seam rupture using the grab method. Available at this link.

[231] ISO 13934-1: 2014 Textiles - Tensile properties of fabrics - Part 2: Determination of maximum force using the grab method. Available at this link.

[232] ISO 15487:2018 Textiles — Method for assessing appearance of apparel and other textile end products after domestic washing and drying. Available at this link.

7902 ## 10.9.4 Supporting information on maintenance

7903 **Table 129.** Comparison of international labelling systems

Characteristic	International Care Labelling System (Ginetex)[233]	ASTM Care Labelling System[234]	Canadian Care Labelling System[235]	British Care Labelling System[236]	Japanese Care Labelling System[237]	Australian Care Labelling System[238]	China Care Labelling System[239]	ISO Care Labelling System[240]
Governing Body	GINETEX	ASTM International	Canadian General Standards Board (CGSB)	British Standards Institution (BSI)	Japanese Industrial Standards (JIS)	Standards Australia and ACCC	China National Textile and Apparel Council (CNTAC)	International Organization for Standardization (ISO)
Region	Global	United States	Canada	United Kingdom	Japan	Australia	China	Global (especially for export procedures)
Primary Symbols	Washing, Bleaching, Drying, Ironing, Professional Care	Washing, Bleaching, Drying, Ironing, Professional Care	Washing, Bleaching, Drying, Ironing, Professional Care	Washing, Bleaching, Drying, Ironing, Professional Care	Washing, Bleaching, Drying, Ironing, Professional Care	Washing, Bleaching, Drying, Ironing, Professional Care	Washing, Bleaching, Drying, Ironing, Professional Care	Washing, Bleaching, Drying, Ironing, Professional Care
Temperature Units	Celsius	Fahrenheit (with some symbols using Celsius)	Celsius and Fahrenheit	Celsius	Celsius	Celsius	Celsius	Celsius (with some flexibility for export)
Text Requirement	No text required	Text required alongside symbols	Text required alongside symbols (bilingual: English and French)	No text required	Text is often included for clarity	Text required alongside symbols	Text required alongside symbols (Chinese characters)	No text required, but can include text for clarity
Drying Symbols	Includes natural and tumble drying symbols	Tumble drying symbols with specific temperature settings	Tumble and natural drying symbols	Natural and tumble drying symbols	Unique symbols for indoor/outdoor and natural drying	Tumble and line drying symbols	Symbols for tumble drying and line drying, with specific instructions for sunlight exposure	Similar to GINETEX; focuses on export needs

233 Complete information about International Care Labelling System (Ginetex) available here.
234 Complete information about ASTM Care Labelling System available here.
235 Complete information about Canadian Care Labelling System available here.
236 Complete information about British Care Labelling System available here.
237 Complete information about Japanese Care Labelling System available here.
238 Complete information about Australian Care Labelling System available here.
239 Complete information about Chinese Care Labelling System available here.
240 Complete information about ISO Care Labelling System available here.

Characteristic	International Care Labelling System (Ginetex)[233]	ASTM Care Labelling System[234]	Canadian Care Labelling System[235]	British Care Labelling System[236]	Japanese Care Labelling System[237]	Australian Care Labelling System[238]	China Care Labelling System[239]	ISO Care Labelling System[240]
Bleaching Symbols	Basic symbols for chlorine and non-chlorine bleach	Detailed symbols for bleach types	Specific symbols for non-chlorine bleach	Similar to GINETEX	Specific symbols for bleach types, including traditional care	Similar to GINETEX	Specific symbols for chlorine and non-chlorine bleach, with detailed instructions	Basic symbols for chlorine and non-chlorine bleach
Ironing Symbols	Dots indicating heat level	Dots indicating heat level	Dots indicating heat level	Dots indicating heat level	Dots with additional instructions	Dots indicating heat level	Dots indicating heat level, with additional instructions on steam use	Dots indicating heat level
Professional Care Symbols	Basic dry cleaning and wet cleaning symbols	Detailed symbols for professional care	Basic symbols for dry and wet cleaning	Similar to GINETEX	Detailed symbols including specific letters for different cleaning methods	Similar to GINETEX	Detailed symbols including specific letters for different cleaning methods	Basic dry cleaning and wet cleaning symbols
Language and Accessibility	Universal symbols for easy understanding	Text and symbols for detailed instructions	Symbols with bilingual text (English/French)	Universal symbols to minimize language barriers	Uses both symbols and text, considering Japanese consumers	Uses both symbols and text	Symbols with accompanying text in Chinese for clarity	Universal symbols for global understanding
Legal Requirements	Voluntary but widely adopted	Mandatory compliance with FTC regulations	Mandatory under the Canadian Textile Labelling Act	Voluntary but widely followed in Europe	Mandatory for domestic manufacturers	Mandatory compliance with Australian Standards	Mandatory compliance under Chinese standards	Voluntary for global standardization

Source: own production

10.9.5 Supporting information on repairability

This section reports a simple analysis of professional repair prices against the prices of the new items of textile apparel. **Table 130** reports the interval of the relative repair price in EU, which takes into account the price intervals of some repair operations carried out by professional repairers and the price intervals of some new items. The analysis shows that repairing an item of textile apparel could be many times more expensive than buying a new item.

Table 130. Comparison between price of professional repair operations and price of new items of textile apparel

Priority part	Failure type	Repair price (EUR)		Items of textile apparel	New item price (EUR)		Relative repair price (%)	
		Min	Max		Min	Max	Min	Max
Fabric	Fabric breakdown	3	9	T-Shirts	3	22	14	300
	Pilling	8	24	Apparel accessories	2	41	20	1 200
				Dresses, Skirts & Jumpsuits	6	90	9	400
				Jackets & Coats	7	589	1	343
				Leggins, stockings, tights and socks	1	19	42	2 400
				Pants & Shorts	3	66	12	800
				Shirts & Blouses	3	90	9	800
				Sweaters and midlayers	3	85	9	800
				Swimsuits	8	74	11	300
				T-Shirts	3	22	36	800
	Stains	3	51	Apparel accessories	2	41	7	2 550
				Dresses, Skirts & Jumpsuits	6	90	3	850
				Jackets & Coats	7	589	1	729
				Leggins, stockings, tights and socks	1	19	16	5 100
				Pants & Shorts	3	66	5	1 700
				Shirts & Blouses	3	90	3	1 700
				Sweaters and midlayers	3	85	4	1 700
				Swimsuits	8	74	4	638
				T-Shirts	3	22	14	1 700
Seam	Hole(s) in seams	3	32	Apparel accessories	2	41	7	1 600
				Dresses, Skirts & Jumpsuits	6	90	3	533
				Jackets & Coats	7	589	1	457
				Leggins, stockings, tights and socks	1	19	16	3 200
				Pants & Shorts	3	66	5	1 067
				Shirts & Blouses	3	90	3	1 067
				Sweaters and midlayers	3	85	4	1 067
				Swimsuits	8	74	4	400
				T-Shirts	3	22	14	1067
Trim	Buttons	1	8	Apparel accessories	2	41	2	400
				Dresses, Skirts & Jumpsuits	6	90	1	133
				Jackets & Coats	7	589	0	114
				Leggins, stockings, tights and socks	1	19	5	800
				Pants & Shorts	3	66	2	267

Priority part	Failure type	Repair price (EUR)		Items of textile apparel	New item price (EUR)		Relative repair price (%)	
		Min	Max		Min	Max	Min	Max
				Shirts & Blouses	3	90	1	267
				Sweaters and midlayers	3	85	1	267
				Swimsuits	8	74	1	100
				T-Shirts	3	22	5	267
	Zips	6	32	Apparel accessories	2	41	15	1 600
				Dresses, Skirts & Jumpsuits	6	90	7	533
				Jackets & Coats	7	589	1	457
				Leggins, stockings, tights and socks	1	19	32	3 200
				Pants & Shorts	3	66	9	1 067
				Shirts & Blouses	3	90	7	1 067
				Sweaters and midlayers	3	85	7	1 067
				Swimsuits	8	74	8	400
				T-Shirts	3	22	27	1 067

Prices are reported without VAT. Repair price were sourced from websites reported in **Table 131**.

$$Relative\ repair\ price\ (\%) = \frac{price\ of\ repair}{price\ of\ new\ apparel\ textile} * 100$$

Source: own elaboration based on (Cooper and Claxton, 2022c) and Statista ([241]).

Table 131. Repair shops and dry cleaners consulted for the analysis reported in **Table 130**

Type	Country	Link
Repair shop	Spain	https://arreglosderopabarcelona.es/tarifas-precios-arreglos-ropa/ https://www.pepevera.com/lista_precios
	Romania	https://www.croitoriepentrutoti.ro/preturi/ https://www.urbanwash.ro/images/lista-croitorie-arad.pdf https://atelierdecroitorie.ro/servicii-si-preturi https://www.atelier-croitorie.com/lista-preturi-croitorie-retus
	Ireland	https://paulhenrytailoring.ie/alterations-dublin
	Sweden	https://www.masterarnes.se/skr%C3%A4dderi.html https://www.jeansverket.se/en/jeans/repairs/ https://secondsunrise.se/pages/repairs
	Italy	https://endelea.it/pages/wear-again-textile_apparel-restoration-hub
Dry cleaners	Spain	https://tintoreriasronsel.es/tienda/precios-tarifas-y-promociones-de-tintoreria/
	Romania	https://ecoclean.ro/preturi/ https://www.elisse.ro/preturi-spalatorie-haine.html https://www.extraclean.ro/preturi-curatatorie-spalatorie-calcatorie-haine-bucuresti/

Source: reported websites

241 Statista. Available at this link. Last accessed 8 August 2024.

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