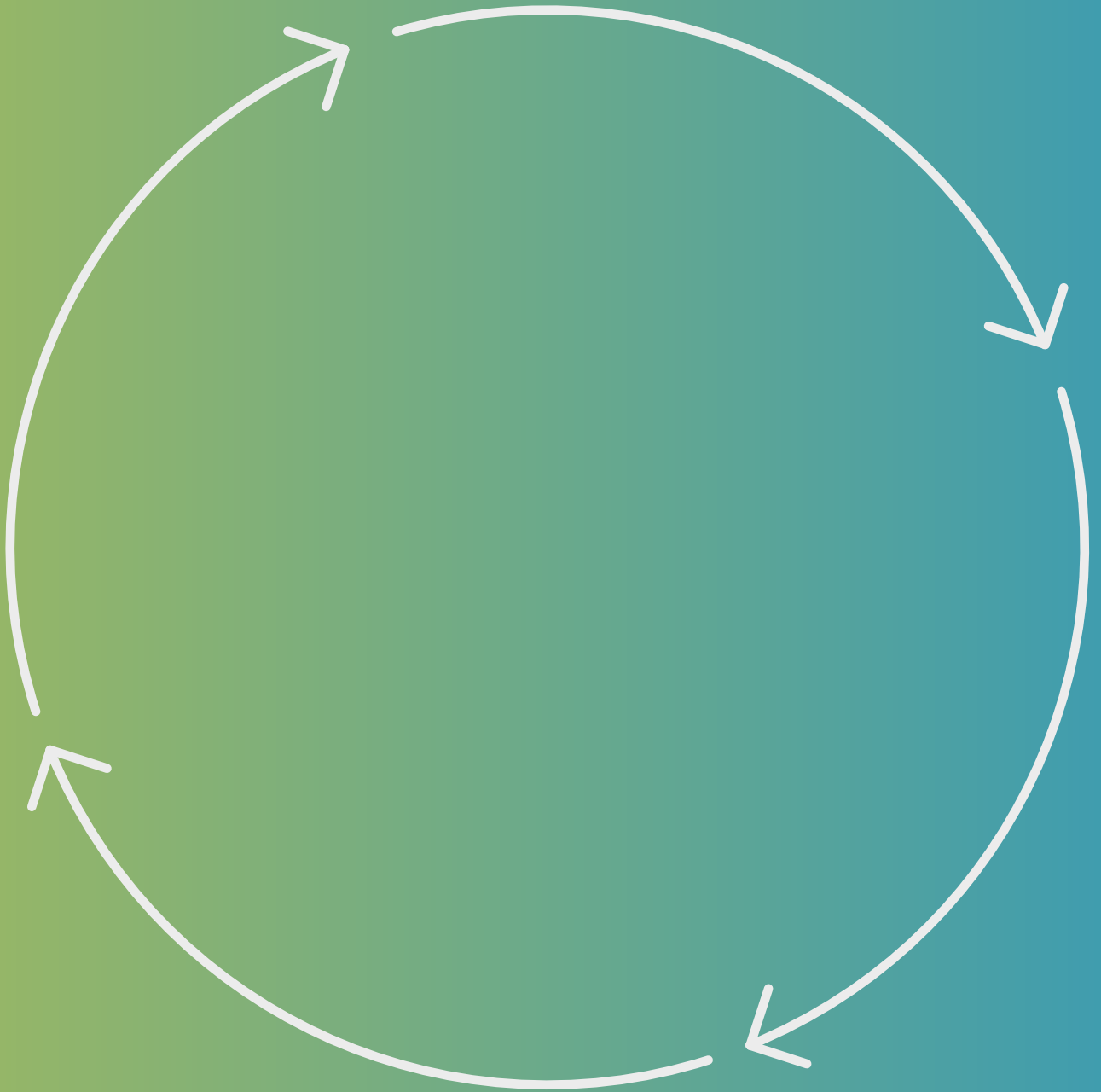


Guide to Best Available Practices in Circular Economy for the textile sector

Resource efficient textile manufacturing and Circular Design guidelines



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Supervision and coordination:

Giorgio Mosangini and Clara Mallart Lacruz, MedWaves, the UNEP/MAP Regional Activity Centre for SCP (former SCP/RAC)

Content prepared by:

Luis Barros Presedo, Sustainability Director FNO PROJECT

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Layout and text edition: Anna Ibañez de Arolas

Design and layout: David Dàmaso Morros
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For further information, please contact:

medwaves.arc@gencat.cat



Table of contents

01. Introduction	07	Strategy 04.	71
02. The importance of this document	09	Increase Resource Utilization Rate	
		Rental, Leasing and Subscription Models	72
03. Main challenges, Trends and Innovations for the Circular Economy	15	Strategy 05.	74
Main challenges to be addressed	17	Shift to Circular Supplies and Renewable Resources	
Trends and Innovations	19	Supply Chain Transparency	75
		Ethical Practices in Raw Materials Procurement	77
04. Standards, Regulations, Norms and Certifications	21	Sustainable Relationships with Suppliers	78
Current and Upcoming European legislations	23	06. Labour conditions in the supply chain	80
Other Legal regulations in the European Union	26	Designing Healthy Workplaces	82
Other relevant legislations around the world	27	Personal Protective Equipment	83
How these legislations affect the companies	29	07. Conclusions	85
Voluntary standards and regulations	30	08. Bibliography	88
05. Strategies for shifting to the circular economy model	32		
Strategy 01.	33		
Prevent Pollution and Save Resources			
Raw material selection	34		
Production processes	41		
Best practices recommendations	49		
Strategy 02.	59		
Recover Resources After Disposal			
Design for Disassembly , Reassembly and Recycling	60		
Collection and Recycling	61		
Upcycling	64		
Strategy 03.	66		
Extend Resource Use and Reduce Disposal			
Design for Durability, Long Lasting and Modularity	67		
Repairing and Upgrading	68		
Reselling	69		



01. Introduction



Today, the textile sector is characterised by dynamism, creativity, functionality and innovation, four essential factors that make it stand out as one of the most competitive sectors in the world economy. At the same time, the textile industry stands as a cornerstone of global commerce, providing an array of fibres, yarns, fabrics and garments among many other goods that define our daily lives.

Yet, beneath the surface of vibrant patterns and fashion trends lies a concerning reality: the profound environmental impact generated by traditional textile production practices. From the cultivation of raw materials to manufacturing processes and eventual disposal, the textile supply chain exacts a toll on natural resources, ecosystems, and communities worldwide.

In recent years, heightened awareness of environmental degradation has prompted a critical reassessment of industry practices. Central to this discourse is the imperative shift from a linear business model, characterized by a "take-make-dispose" approach, to a more sustainable and regenerative circular economy paradigm. Recognizing the urgency of this transition, stakeholders across the textile sector are increasingly embracing innovative techniques and best practices aimed at mitigating environmental harm while fostering economic resilience.

In this This Best Practices Handbook, we explore the imperative for change within the textile industry, examining the far-reaching impacts along the supply chain and underscoring the compelling rationale for embracing a circular economy framework. Through a comprehensive exploration of best techniques and strategies, we aim to empower industry professionals with the knowledge and insights needed to navigate this transformative journey towards a more sustainable and equitable future.

The textile industry, with its rich history and constant evolution, is at a pivotal moment of transformation, where social and environmental responsibility is intertwined with the relentless pursuit of technical excellence. This handbook not only addresses the contemporary challenges facing the industry, but also presents concrete solutions based on the latest innovations and regulations.





Purpose of the Manual

The objective of this manual on best practices for the textile sector is to equip companies with the tools and knowledge necessary to implement sustainable and circular improvement strategies effectively.

By providing comprehensive guidance and insights into the most effective techniques and practices, this guide aims to empower businesses to adopt environmentally responsible and economically viable approaches throughout their operations.

Ultimately, the manual seeks to facilitate the transition towards a more circular, sustainable and social responsible industry by enabling companies to leverage the best available techniques in pursuit of continuous improvement and positive environmental impact.

The main objectives of this manual is to present:

Circular strategies:

Providing a detailed understanding of best practices in all relevant aspects of the textile sector, from raw material selection to manufacturing processes and supply chain management, to help implement best circular practices.

Facilitating Practical Implementation:

Providing tools, advice and case studies that enable companies and professionals to effectively incorporate BAT (Best Available Techniques) into their daily operations, thereby optimising efficiency and quality.

–

Promote Sustainability:

Highlight practices that not only improve competitiveness, but also minimise environmental impact and promote a sustainable approach throughout the textile value chain.

–

Compliance with Regulations and Standards:

To guide readers in complying with legal regulations and standards related to the textile industry, ensuring ethical and responsible operations.

–

Stimulate Innovation:

Inspire the adoption of advanced technologies and innovative methods that drive creativity and differentiation in textile production, thus contributing to the continuous advancement of the industry.

By embracing these objectives, it aims to empower textile stakeholders to not only achieve technical excellence, but also to lead the way towards a future where the textile industry is not only successful, but also sustainable and socially responsible.



02.
**The importance
of this document**



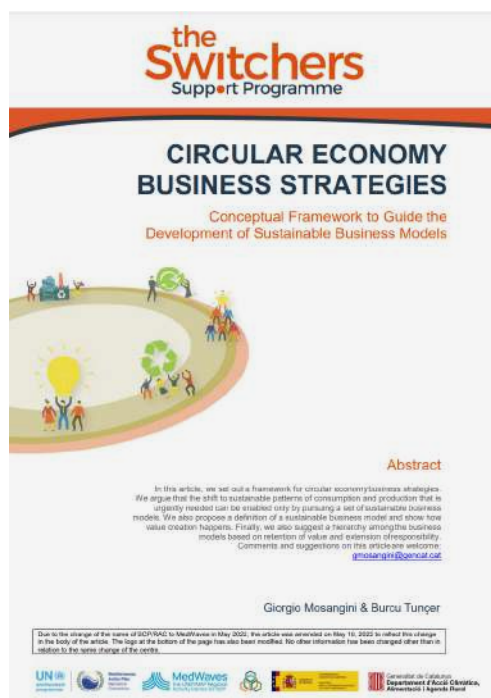
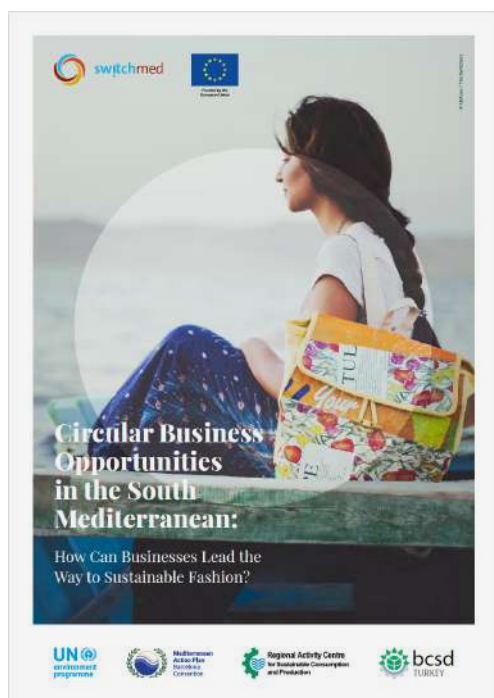
This document has been meticulously crafted as part of a comprehensive initiative aimed at reshaping the textile sector by integrating Best Available Techniques (BATs) into the circular business models and circular best practices indicated in the publication *Circular Business Opportunities in the South Mediterranean*, (2020) developed by Medwaves, the UNEP/MAP Regional Activity Centre for SCP (former SCP/RAC). By merging these valuable resources, our objective is to facilitate continuous improvement within the industry while ensuring alignment with the demands of today's globalized economic landscape.

Structured with a strategic focus, each section of the document addresses key challenges encountered throughout the textile supply and production chains. It begins by outlining sustainable strategies and then delves into specific BATs that can be employed to operationalize these strategies effectively.

Presented in a clear and concise format, each section offers practical guidance followed by a recommended practices summary and resources. This format empowers decision-makers to directly assess which practices their facilities can readily implement and which should be integrated into long-term strategic planning.

It's important to note that the recommendations provided here in are intended as guidance, and the economic implications of implementation should be evaluated by individual companies. Each organization bears the responsibility of assessing the economic viability of implementing these practices within their unique operational contexts.





Circular Strategies and Business Models for the circular economy

In the pursuit of a sustainable and circular economic model, businesses are increasingly turning towards circular strategies and innovative business models. The Circular Economy, in contrast to the traditional linear model of take-make-dispose, aims to minimize waste, maximize resource efficiency, and create long-term value while implementing methodologies to preserve the environment and the social responsibility. This paradigm shift has given rise to a new era of business thinking where environmental responsibility aligns seamlessly with economic prosperity.

The Circular Economy is rooted in the principles of reduce, reuse, and recycle. It envisions a closed-loop system where products, materials, and resources circulate in a sustainable manner, minimizing environmental impact. This holistic approach encourages businesses to rethink traditional practices and embrace strategies that prioritize longevity, efficiency, and environmental stewardship.

Circular strategies encompass a spectrum of practices that extend product lifecycles, reduce waste, and re-

generate natural systems. From designing products for disassembly and recycling to implementing sustainable sourcing and manufacturing processes, businesses are redefining their operations. Circular strategies also involve the recovery and repurposing of materials, contributing to a more resource-efficient and resilient supply chain.

Embracing circular strategies and business models isn't just an ethical choice; it's a strategic imperative. Businesses stand to gain from reduced resource dependency, cost savings through efficient use of materials, enhanced brand reputation, and increased customer loyalty. Simultaneously, the circular economy contributes significantly to environmental conservation by minimizing waste, conserving natural resources, and mitigating the ecological footprint of industrial activities.

The circular strategies advocated in this manual stem from two seminal publications developed by Medwaves, the UNEP/MAP Regional Activity Centre for SCP (former SCP/RAC): *Circular Business Opportunities in the South Mediterranean (2020)* and *Circular Economy Business Strategies (2022)*. These publications serve as beacons of innovation, providing invaluable insights into the principles and practices of circular economy that are essential for transforming the textile industry into a more sustainable and resilient ecosystem.

Based on the *Circular Business Opportunities in the South Mediterranean (2020)* and *Circular Economy Business Strategies (2022)* publication, several practical ways for textile companies to reduce waste had been identified, use resources efficiently, and adopt a more sustainable approach throughout the production and use of their products. By implementing these strategies, businesses can embrace a circular economy, which benefits both the environment and the industry's long-term success. The strategies are classified by:

01.

Prevent pollution & save resources:

This strategy focuses on adopting more efficient production processes to reduce resource and energy use, as well as minimizing waste and emissions.

–

02.

Recover resources after disposal:

This strategy involves reintegrating by-products and waste as inputs in production processes, aiming for closed-loop management of resources.

–

03.

Extend resource use & reduce disposal:

This strategy promotes the production of long-lasting

products through new processes and technologies, aiming to minimize disposal and maximize resource utilization.

–

04.

Increase resource utilization rate:

This strategy emphasizes maximizing the efficiency and productivity of resources throughout the entire product life-cycle.

–

05.

Shift to circular supplies and renewable resource:

This strategy involves adopting CE principles in product development and design, such as using renewable raw materials, promoting reuse and recycling, and designing for durability and modularity.

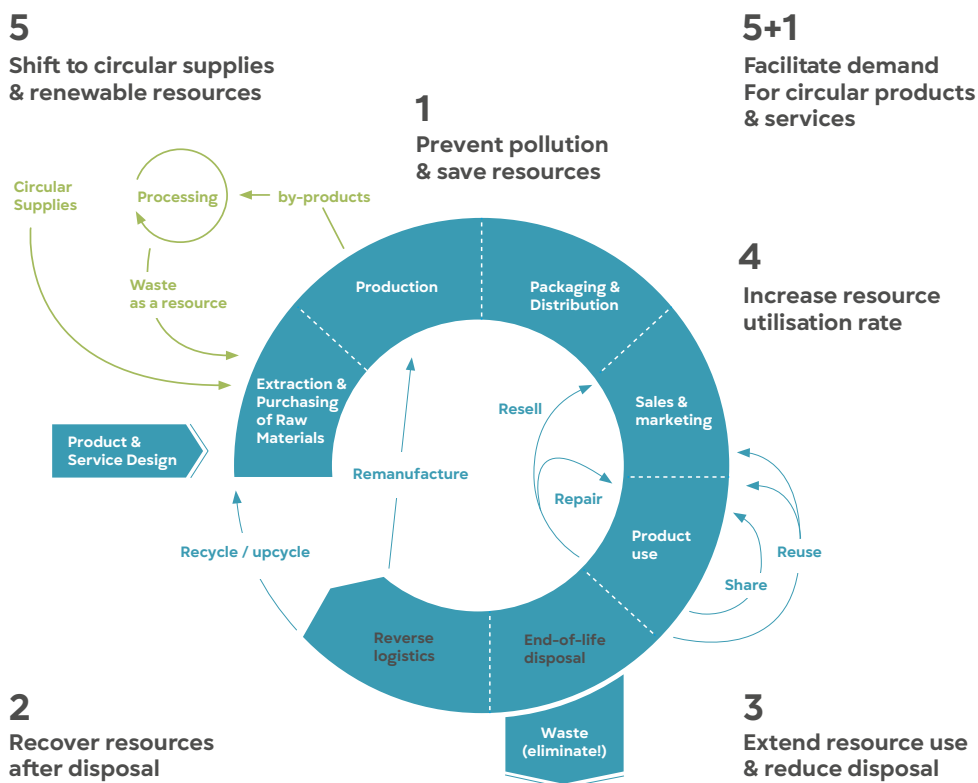
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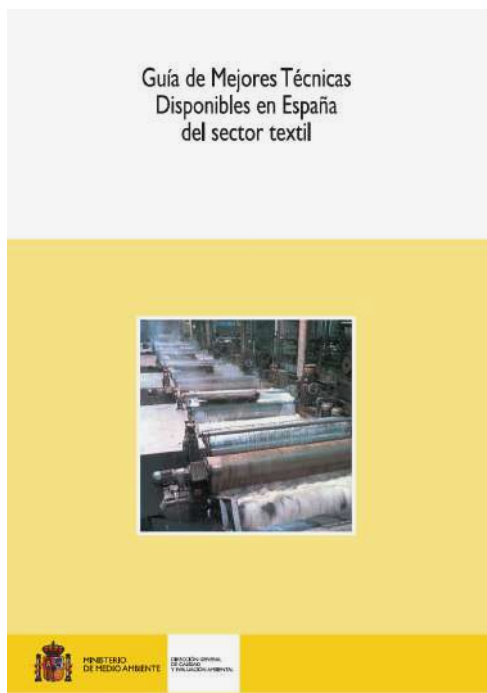
05+1.

Facilitate demand for circular products and services.

The strategies are numbered one through five in order of resource value retention as well as difficulty of implementation and coordination within value chains, with five being the greatest retention value and effort required for implementation and coordination, and one being the lowest.

Strategies





Best Available Techniques (BAT) in the Textile Industry

In the dynamic landscape of the textile industry, the pursuit of sustainability and environmental responsibility has become a focal point. Best Available Techniques (BAT) play a pivotal role in guiding this sector toward practices that balance economic viability with environmental stewardship. BAT represents a set of innovative, efficient, and economically feasible techniques that enable textile manufacturers to achieve optimal performance while minimizing their environmental impact.

Best Available Techniques refer to the most effective methods and processes for achieving a high level of environmental protection in the textile industry. These techniques embody a holistic approach that considers not only the end product but also the entire lifecycle of textile manufacturing. BAT emphasizes resource efficiency, pollution prevention, and the adoption of cutting-edge technologies to align industrial practices with environmental sustainability.

BATs encourage the efficient use of raw materials, energy, and water throughout the production process. This includes optimizing production layouts, implementing closed-loop systems, and minimizing waste generation.

Additionally, BATs focus on preventing or, where that is not practicable, minimizing emissions and releases of pollutants. This involves adopting advanced technologies for air and water treatment, as well as implementing measures to control noise and odor pollution.

While the adoption of BATs presents challenges, such as initial investment costs and the need for skilled personnel, the long-term benefits are compelling. Businesses embracing BAT gain a competitive edge by demonstrating their commitment to sustainable practices, meeting regulatory requirements, and appealing to an increasingly environmentally conscious consumer base.

Importance of Best Available Techniques (BAT) in the Textile Industry

The adoption of Best Available Techniques (BAT) in the textile sector represents a crucial step towards the evolution and sustainable prosperity of the industry. The importance of incorporating these techniques lies in several aspects that have an impact at both a business and global level:

Operational efficiency through process optimisation:

BAT enables the review and improvement of production processes, increasing operational efficiency and reducing waste and unnecessary costs.

Implementation of Product Quality Standardisation:

By implementing BATs, higher standards are set for the quality of textile products, which strengthens the company's reputation and market position.

Environmental Sustainability and Environmental Impact Reduction:

BAT inherently includes practices and technologies that minimise the environmental impact of textile production, thus promoting sustainability and environmental responsibility.

Regulatory Compliance:

The application of BATs ensures compliance with environmental and labour regulations, avoiding legal sanctions and improving corporate image.

Global Competitiveness through Market Differentiation:

Companies that adopt BAT can positively differentiate themselves in the market by highlighting innovative, sustainable and socially responsible practices.

Fostering Technological Innovation:

BAT drives the adoption of advanced technologies in the textile sector, stimulating innovation and adaptation to changing market demands.

Corporate Social Responsibility:

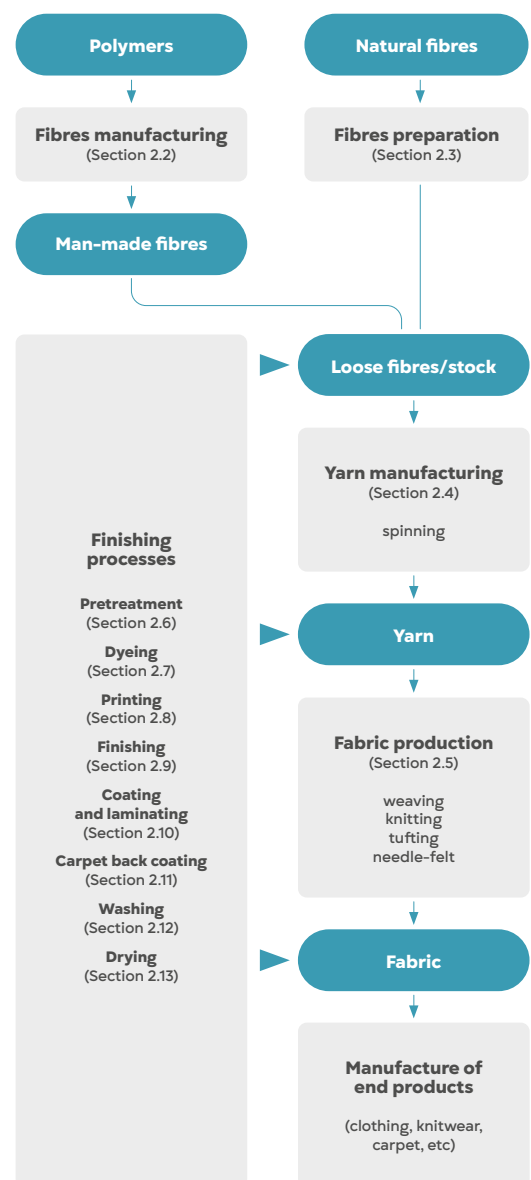
The implementation of BAT reinforces corporate social responsibility by prioritising ethical and sustainable practices, which can generate consumer loyalty and attract ethical investments.

Adapting to Consumer Trends by Meeting Consumer Demands:

Modern consumers increasingly value sustainability and transparency in the supply chain, making the adoption of BAT a smart strategy to meet these demands.

In summary, the importance of Best Available Techniques in the textile sector goes beyond the internal improvement of processes; it is a strategic response to the demands of the environment, guaranteeing the long-term viability of companies and contributing to the construction of a more responsible and resilient textile sector.

Textile chain



Source: Best Available Techniques (BAT) Reference Document for the Textiles Industry, (2023) Roth, J., Zerger, B., De Geeter, D., Gómez Benavides, J., Roudier, S.



03.
**Main challenges,
Trends and Innovations
for the Circular
Economy**



In today's textile and fashion industry, embracing the circular economy paradigm has become paramount for sustainable development and resource efficiency. This section delves into the primary challenges faced, emerging trends, and innovative solutions driving the circularity agenda within the textile sector. From redefining production processes to enhancing material recovery systems, this manual explores the intricate landscape of circularity in textiles. By addressing these challenges head-on and leveraging the latest innovations, stakeholders can pave the way towards a more sustainable and resilient future for the industry.

Contents of the section

Main challenges to be addressed
–
Trends and Innovations

Main challenges to be addressed

Throughout this document, the main challenges faced by the textile industry in transitioning to a circular economy will be explored, along with potential technical solutions to address them. This will enable manufacturers and producers to implement the best available techniques to tackle these challenges, which are expected to arise in the near future.

Complexity of Material Composition:

The intricate blend of materials in textiles, including synthetic fibres, dyes, and finishes, poses a challenge for recycling processes. Implementing advanced sorting technologies that utilize spectroscopy, artificial intelligence (AI), and robotics for precise material identification and separation are some of the solutions to be explored. Digital tagging and block chain can assist in tracking material composition throughout the supply chain.

–

Textile Recycling Technologies:

Existing textile recycling technologies face limitations in effectively processing mixed fibres and producing high-quality recycled materials. Investing in and developing advanced recycling technologies such as enzymatic recycling, mechanical recycling with improved sorting, and chemical recycling methods is one of the main challenges that multiple companies across the world are trying to confront via their R+D+I departments. Collaboration with research institutions and technology companies can drive innovation in this area.

–

Lack of Closed-Loop Systems:

Establishing closed-loop systems where products are designed for disassembly and reassembly is challenging due to the linear nature of current supply chains and the difficulties and economic costs of implementing reverse logistics systems. Utilize digital design tools and technologies for designing products with disassembly in mind, implement tracking systems for products and materials to facilitate their return to the manufacturing process after use are some of the solutions in this field that the companies will have to explore.

Consumer Behaviour and Awareness:

Lack of awareness and understanding among consumers regarding the benefits and methods of circular fashion is one of the main problems in our society. By using digital communication strategies, and peer to peer communications in the area of action of the companies to educate consumers about circular practices this current issue can be mitigated.

–

Fast Fashion Culture:

The fast fashion culture encourages rapid consumption and disposal of clothing items, hindering circularity efforts. To develop block chain-based platforms for garment leasing and subscription models, promoting extended product lifecycles are some of the solutions that will be explored in this document.

Even though the previously cited challenges are the most well known and addressed, suppliers will also have to explore the implementation of chemical management to minimise contaminations, pollution minimisation through environmental friendly manufacturing ecosystems, reduction the cost of sustainable materials through the implementation of technologies that reduce the cost of their extraction and many others.

–

Environmental impact:

The environmental impact caused by the activities developed in the textile sector are mainly derived from the following aspects, making it a critical topic to take into account:

Natural Resource Consumption: The constant demand for textile fibres and the intensive consumption of natural resources, such as water, various energy sources

Main challenges to be addressed



and arable land, pose challenges for long-term sustainability.

Water and Soil Pollution: Dyeing and finishing processes can contribute to water and soil pollution if not properly managed, negatively affecting local ecosystems.

Waste management: The generation of textile waste, as well as the inappropriate disposal of unwanted garments, contribute to the accumulation of waste and represent a challenge for sustainable management. In addition, the large volume of both hazardous and inert waste generated during the garment manufacturing process must be taken into account.

–

Social Responsibility:

In some regions, working conditions in textile production can be precarious, posing challenges in terms of labour rights and business ethics.

The fast fashion cycle and mass production of disposable garments creates pressures on workers, promoting unfair working conditions and contributing to waste.

–

Technological Innovation and Sustainability:

The effective integration of sustainable technologies in textile production, such as digital manufacturing and the use of recycled materials, is a challenge in itself.

Development of Sustainable Materials: The search for sustainable alternatives to conventional fibres, as well as the development of more eco-friendly manufacturing processes, are key challenges for innovation in the sector.

Regulatory Compliance:

Environmental and labour regulations: Complying with ever-changing environmental and labour regulations can be a challenge, especially for companies operating in multiple jurisdictions.

–

Change in Consumer Preferences:

Growing consumer awareness of sustainability and ethics in fashion has changed purchasing preferences, requiring companies to adapt to these changing demands.

Challenges in educating consumers about product quality, traceability and the environmental impact of purchasing decisions.

–

Supply Chain Instabilities:

Global Events: Crises such as the COVID-19 pandemic have highlighted the vulnerability of textile supply chains on a global scale, posing challenges in terms of business continuity and risk management.

–

Emerging Markets Development:

Competition with emerging markets, where production costs may be lower, is a challenge for established textile companies.

Addressing these challenges requires a combination of innovation, industry collaboration, effective regulation and a change in business practices to drive sustainability and responsibility throughout the textile value chain.

Trends and Innovations

The textile sector is constantly evolving, driven by creativity, technology and changing consumer demand. Some of the most prominent trends and innovations in the textile industry include:

Sustainable Fibres:

Interest in organic fibres, such as organic cotton, has grown due to its cultivation without the use of pesticides and toxic chemicals, making it more environmentally friendly.

At the same time the use of recycled fibres, obtained from plastic bottles or other waste, is on the rise. This trend addresses the problem of plastic pollution and reduces dependence on virgin raw materials. Additionally, with new technological and legislative advances, the race to obtain recycled fabrics from discarded fabrics that meet quality and durability standards is emerging as a new need to be met.

–

Technological Fabrics:

The integration of electronic technologies into textiles to create smart clothing with capabilities such as health monitoring, device charging and temperature adjustment, etc.

On the other hand, the development of fabrics that respond to environmental conditions, adapting to body temperature or changing colour according to light.

–



Textile 3D Printing:

Design Customisation: 3D printing enables the customisation of garments at the design level, allowing consumers to create unique clothing tailored to their preferences.

Waste Reduction: 3D printing also contributes to waste reduction, as it enables on-demand production and optimisation of cutting patterns.

–

Sustainable Manufacturing Processes:

Development of dyeing techniques that require less water or, in some cases, dispense with this resource altogether, significantly reducing environmental impact.

Also, the development and application of new printing technologies that make it possible to create higher quality designs by minimising water and chemical consumption, while drastically reducing the hazardous waste and pollutants derived from these operations.



Trends and Innovations



Development of techniques that allow the application of the most demanded finishing techniques, reducing consumption and the generation of waste and emissions.

For last, manufacturing approaches that minimise textile waste, either through more efficient cutting techniques or through the reuse of offcuts and leftovers.

–

Circular Fashion:

The rise of fashion rental platforms and second-hand shopping are helping to reduce the demand for new clothes and encourage a more circular and sustainable approach.

Also, brands are designing products with materials that facilitate end-of-life recycling, promoting a more sustainable life cycle.

–

Traceability and Transparency:

Block chain technology is used to provide transparency in the supply chain, allowing consumers to trace the origin and production of their garments.

Increased emphasis on transparent labelling that provides information on the environmental and social impact of textile products

–

Sustainable Partnerships:

Partnerships between Brands and Environmental Organisations: Collaborations between fashion brands and environmental organisations to address common challenges and work towards sustainability goals.

Open Innovation: Companies adopting open innovation models, collaborating with start-ups and external organisations to drive research and sustainable development.

These trends reflect the shift towards a more conscious, innovative and sustainable textile industry, responding to consumer demands and addressing the environmental and social challenges facing the sector.



04. Standards, Regulations, Norms and Certifications



Navigating the complex regulatory landscape of the textile industry is essential for ensuring compliance, upholding quality standards, and fostering sustainability. This section of the manual is dedicated to elucidating the myriad standards, regulations, norms, and certifications pertinent to the textile sector and fashion industry.

From international standards governing environmental impact to local regulations on worker safety, understanding and adhering to these frameworks is critical for industry stakeholders. By providing insights into the latest updates, best practices, and certification requirements.

This section aims to empower textile professionals to navigate regulatory challenges effectively while embracing responsible and sustainable practices.

Contents of the section

- **Current and Upcoming European legislations**
- **Other Legal regulations in the European Union**
- **Other relevant legislations around the world**
- **How these legislations affect the companies**
- **Voluntary standards and regulations**

Current and Upcoming European legislations

The European Union (EU) stands at the forefront of regulatory initiatives aimed at fostering sustainable and responsible practices across industries. The textile sector, a vital component of the global economy, is subject to a comprehensive framework of EU legislation designed to address environmental concerns, uphold consumer rights, and promote ethical practices within the industry.

The European Green Deal

In addition, and with the aim of establishing a business roadmap aligned with sustainability, the European Union (EU) creates the European Green Deal, marking a comprehensive commitment to sustainability, emissions reduction and the transition to a cleaner and more circular economy.

Announced in December 2019 as the guiding light for the decade ahead, this strategic plan addresses environmental, economic and social challenges in an integrated way, aiming to transform Europe into the first climate-neutral continent by 2050.

Its main components are:

- Climate Neutrality by 2050
- Energy Transformation
- Circular Economy and Sustainability
- Sustainable Mobility
- Biodiversity and Sustainable Agriculture
- Nature Protection
- Sustainable Digitalisation

The European Strategy for the Textile Sector

In addition, and in line with its comprehensive commitment to sustainability, the European Union (EU) has drawn up an ambitious roadmap towards 2030 that focuses specifically on the textile sector after identifying it as one of the four most polluting industrial sectors, outlining a legislative horizon that seeks to radically reshape it.

This approach, framed within the broader vision of the European Green Deal, aims to consolidate the textile industry as a key pillar in the construction of a circular and climate-neutral economy.

The main pillars of the legislative horizon are:

I. Sustainable product design:

The European Commission, as the main legislative body of the European Union, is creating regulations and a series of directives focused on defining the criteria that a product must meet to be considered sustainable, with the aim that all products put on sale on the market from 2030 onwards will be considered as such:

Eco-design for Sustainable Product Regulation (ESPR):

Regulation focused on regulating the use of certified sustainable raw materials will focus on boosting the design of textile products for circularity, promoting durability, reparability and ease of recycling while emphasising the calculation of environmental and social impacts of products and the need to maintain a strict traceability record.

Green Claims Directive:

Directive aimed at establishing control criteria for compliance with the ESPR and the prevention of malpractice linked to dishonest communication of sustainable attributes or Greenwashing.

Digital Product Passport Directive:

Directive aimed at establishing a digital service that allows consumers to access the information considered essential about the product purchased.

Current and Upcoming European legislations



II. Transparency:

The veracity of the information is the second fundamental pillar within the European strategy of the textile sector, being the main object of a series of directives created specifically to avoid Greenwashing, this time centred on the reporting of information by companies located within the European Economic Community, but for which the collaboration of the foreign industrial fabric will be indispensable when seeking its collaboration in the compilation of the information:

Corporate Sustainability Reporting Directive:

This directive seeks to standardise and improve the disclosure of non-financial information by companies. It focuses on environmental, social and corporate governance (ESG) aspects to provide stakeholders with a more comprehensive view of a company's sustainability.

Taxonomy Directive:

The Taxonomy Directive aims to establish a common framework for classifying economic activities that contribute substantially to the EU's environmental objectives. It has a particular focus on environmental sustainability.

Corporate Sustainability

Due Diligence:

This initiative seeks to integrate sustainability due diligence into companies' operations and supply chains. The aim is to prevent and address the negative impacts of business activities on people and the planet.

Green Public Procurement Directive:

This directive focuses on promoting the adoption of public procurement practices that favour sustainability. It seeks to encourage the procurement of goods and services with a lower environmental impact.

III. Waste minimisation:

As a third differentiating factor within the strategy, the European Commission is developing a series of directives related to waste management and extended producer responsibility, all of which are aimed at improving current waste management systems and minimising waste generation:

Waste Framework Directive:

This directive establishes a general framework for waste management in the EU. Its main objective is to prevent or reduce the negative impact of waste generation and management on the environment and human health.

End of Waste Criteria Directive:

This directive seeks to establish clear criteria for determining when certain materials cease to be considered waste and are transformed into a resource. The aim is to encourage recycling and reuse.

Extended Producer Responsibility Directive:

This directive establishes the principle of Extended Producer Responsibility (EPR), which implies that producers must assume additional responsibilities throughout the life cycle of their products, especially in terms of waste management.

Current and Upcoming European legislations



Waste Shipment Regulation Directive:
This directive regulates the transport of waste within and outside the EU, with the aim of preventing the export and import of hazardous waste and ensuring its proper management.

IV. Environmental and Carbon Footprint Directives:

Unintentional Micro plastics Directive:
This directive aims to identify and measure micro plastics unintentionally generated by textile products with the objective of minimising their generation.

Industrial Emissions Directive:
This directive aims to integrate and simplify existing regulations on industrial emissions in the EU. Its main purpose is to prevent or reduce emissions of air and water pollutants from various industrial installations.

Regulation (EU) 2023/1115 on deforestation-free products:
This regulation aims to control the origin of products related to possible uncontrolled deforestation.



Other Legal regulations in the European Union

Legal compliance in the textile sector is imperative to ensure sustainability and accountability at all stages of the production chain. Legal regulations set standards that aim to mitigate the environmental and social impacts associated with the textile industry. By adhering to these regulations, companies in the sector not only avoid potential legal sanctions, but also actively contribute to the preservation of the environment and the respect of labour rights. A proactive approach to legal compliance in the textile sector is not only essential for the reputation and integrity of companies, but also reflects a genuine commitment to adopting sustainable best practices.

This document on Sustainable Best Practices aims to guide companies through the relevant legal requirements, providing a solid framework for the implementation of environmentally friendly and socially responsible practices in the textile industry.

A. Chemicals Regulations:

REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation):

Applicable in the European Union, REACH aims to improve the protection of human health and the environment through the management of chemicals used in industry.

California Proposition 65:

Although specific to California, this law requires companies to warn about exposure to chemicals known to cause cancer, birth defects or other reproductive harm.

CPSIA (Consumer Product Safety Improvement Act):

A US regulation that sets limits on the amount of hazardous chemicals in products intended for children, including children's clothing.

B. European Energy Efficiency Directives:

EU Energy Efficiency Directive (EED):

Affects textile companies in the European Union and sets energy efficiency targets and actions to reduce energy consumption.

These regulations and standards reflect the growing importance of sustainability and environmental responsibility in the global textile sector. It is essential that textile companies keep up to date on relevant regulations in their regions and adopt practices that promote sustainability throughout their value chain.



Other relevant legislations around the world

In addition to the European Union's environmental regulations, other countries and regions have introduced policies and standards that directly impact textile manufacturers. From mandatory to voluntary standards, companies should comply with these regulations to ensure better market entry. This section introduces the main environmental regulations affecting textile manufacturers of China and US.

Chinese standards:

In the realm of Chinese standards, the term "GB" holds significant importance, standing for "Guo Biao" in Pinyin, which translates to "Chinese national standard." It has become a common shorthand for various references, encompassing GB standards, GB tests, GB requirements, GB capacity tests, and more.

Chinese standards feature different prefixes in their codes, such as GB, GB/T, FZ/T, QB/T, each indicating specific characteristics:

GB - Chinese National Standard - Mandatory

–

GB/T - Chinese National Standard - Recommended
("T" denotes "recommended")

Mandatory standards related to textiles or garments

GB 18401 - 2010	National general technical safety code for textile products	Applicable to textile clothing, textile accessories and household textiles
GB 31701 - 2015	Technical Safety Code for Baby and Children's Textile Products	Applicable to textile clothing, textile accessories and household textiles
GB 5296.4 - 2012	Instructions for the use of products of consumer interest - Part 4: Textiles and clothing	Applicable to textile clothing, textile accessories and household textiles
GB 20400 - 2006	Leather and fur - Limit of hazardous substances	Applicable to leather garments and leather accessories
GB 21550 - 2008	Restriction of hazardous materials in artificial leather made of polyvinyl chloride	Applicable to garments containing PVC and PVC accessories

Other relevant legislations around the world

Apart from GB, the prefixes in standard codes often originate from the abbreviations of related companies:

FZ/T - Abbreviation for “Fang Zhi”, meaning textile industry standard - Recommended

-

QB/T - Abbreviation for “Qingong Biaozhun”, meaning Light Industry Standard (applicable to some leather products, footwear, hard goods, etc.) - Recommended.

I. A crucial consideration for those engaged in the Chinese market is whether products must adhere to mandatory standards. In general, mandatory standards focus on health, safety, hygiene, or high-risk product categories. All products manufactured, sold, or imported into China must comply with the requirements of mandatory standards.

II. Regarding voluntary standards, they outline performance requirements for different product types and technical details of testing methods. While there are several voluntary standards to choose from, it is essential to select one of these “voluntary” standards. If a product carries a specific voluntary standard as an “executive standard” on its label, all the requirements of the voluntary standard must be met.

III. In essence, navigating the landscape of Chinese textile regulations requires a nuanced understanding of mandatory and voluntary standards, with compliance being imperative for market entry and ensuring the well-being of consumers.

United States regulations:

The Textile Manufacturing Sector, classified in USA under NAICS 313 in the broader manufacturing sector (NAICS 31 – 33), encompasses establishments involved in the transformation of natural and manmade fibers into yarns and threads. These materials are further woven or knitted into fabrics, with subsequent processes involving dyeing and finishing.

The Environmental Protection Agency has created several legal restrictions based on this classification that involves national productions and therefore, brands will seek to extrapolate these requirements to foreign productions:

Air Regulations:

The textile manufacturing sector is subject to several air quality regulations enforced by the United States Environmental Protection Agency (EPA). Notable programs and standards include:

Greenhouse Gas Reporting Program:

Monitoring and reporting emissions data related to greenhouse gases, ensuring transparency and accountability.

-

National Emissions Standards for Hazardous Air Pollutants (NESHAP).

-

Fabric Printing, Coating & Dyeing: Imposing standards to control hazardous air pollutants released during fabric printing, coating, and dyeing processes.

-

Industrial Cooling Towers:

Establishing regulations to manage air emissions from industrial cooling towers within the textile industry.

-

Leather Tanning and Finishing Operations:

Enforcing standards specific to air emissions from leather tanning and finishing operations.

Water Regulations:

Water quality regulations are crucial for the textile manufacturing sector. EPA guidelines ensure responsible water management practices, including:

Leather Tanning and Finishing Effluent Guidelines:

Imposing standards for the discharge of pollutants from leather tanning and finishing operations into water bodies, safeguarding water quality.

Compliance Measures:

Ensuring compliance with environmental regulations is paramount for textile manufacturers. The Resource Conservation and Recovery Act (RCRA) plays a significant role, and the EPA provides industry-specific guidance to assist businesses, including small enterprises.

The Hazardous Waste Generator Guidance for Industry, a component of RCRA, offers a detailed guide that includes a hazardous waste table outlining specific requirements.

How these legislations affect the companies

01. USA and Mexico

02. Europe

03. Asia

01. Environmental Protection Agency restrictions for NAICS 31-33

02. European Green Deal The European Strategy for the Textile Sector Chemical Regularions European Energy Efficiency Directives

03. GB, GB/T, FZ/T and QB/T



Manufacturers within the textile industry are urged to cultivate collaborative and cooperative relationships with the brands they work with. Such partnerships enable manufacturers to stay informed about the diverse regulations their products must adhere to.

It's a common assumption within the industrial textile sector that compliance is solely tied to the regulations of the countries hosting their manufacturing facilities and partners. However, this belief overlooks a crucial aspect. The reality is far more intricate, as manufacturers must also align with the regulations of the countries where the brands distribute their products. This comprehensive approach ensures full legal compliance and mitigates the risk of non-compliance issues.

By fostering open lines of communication and cooperation with brands, manufacturers can stay updated on evolving regulatory landscapes and proactively adapt their practices to meet the diverse compliance requirements. This proactive engagement not only safeguards against legal risks but also enhances trust and transparency throughout the supply chain.



Voluntary standards and regulations

In the intricate fabric of the textile sector, legal compliance emerges as an essential thread that underpins ethical and sustainable business practices. Beyond creativity and innovation, respect for legal rules and regulations is fundamental to forging a lasting path to success in the contemporary textile industry.

The legal environment in which textile companies operate has become increasingly complex and demanding. From environmental regulations that seek to reduce ecological impact to labour regulations that safeguard workers' rights, compliance with laws is essential not only to avoid legal sanctions, but also to boost consumer confidence and strengthen corporate reputation.

International Agreements

Although not specific to the textile sector, the Paris Agreement seeks to limit global warming and can influence the environmental policies and practices of textile companies in relation to greenhouse gas emissions.

ZDHC and Aqueous Effluent Chemicals Standard

The Zero Discharge of Hazardous Chemicals Coalition (ZDHC) is a global initiative that seeks to phase out the use and release of hazardous chemicals in the textile supply chain. One of the key focus areas of the ZDHC is the safe management of chemicals in aqueous effluents, vital to reducing the environmental impact of the textile industry.

The ZDHC's Aqueous Effluent Chemicals Standard sets specific guidelines for the discharge of wastewater from textile processing facilities. This standard aims to limit the presence of hazardous chemicals in effluents, thus ensuring that the water released meets environmental and human health criteria.

In this way, the ZDHC maintains an updated list of restricted chemicals that must not be present in aqueous effluents. This list is revised periodically to reflect advances in chemical research and regulation.

The standard also sets strict limits for the amount of certain chemicals allowed in effluents. These limits are designed to protect receiving water bodies and prevent pollution.

In order to promote the principles of its standard, the ZDHC provides assessment and certification processes for facilities seeking to comply with the standard. These processes include audits, laboratory analysis and the implementation of best practices.

Quality and Safety Standards

In the textile sector, quality and safety are fundamental aspects that affect both manufacturers and consumers. Various standards and certifications ensure that textile products meet certain quality, safety and sustainability criteria. Some of the most internationally recognised standards include:

Voluntary standards and regulations

OEKO-TEX Standard 100:

This standard guarantees that textile products have been tested for harmful substances and meet safety criteria in terms of human health.

Bluesign:

This standard focuses on sustainability in the textile supply chain, addressing aspects such as chemical management, resource efficiency and worker safety.

ISO 9001 (Quality Management System):

Although not specifically designed for the textile sector, ISO 9001 sets standards for quality management systems, including processes such as textile production. It ensures continuous improvement and customer satisfaction.

Social Accountability Standards

SA8000 (Social Accountability):

This standard establishes requirements for social accountability in the supply chain, including safe and ethical working conditions.

WRAP (Worldwide Responsible Accredited Production):

WRAP is a certification that focuses on social responsibility in manufacturing, covering areas such as labour rights, working conditions and legal compliance.

Fair Trade Certification:

Fair Trade certification in textile products ensures that ethical trading practices have been followed and that workers have been treated fairly and are paid an adequate wage.

AMFORI BSCI (Business Social Compliance Initiative):

BSCI is an initiative that seeks to improve labour conditions in the global supply chain. It provides a framework for assessing and improving labour conditions by promoting social responsibility throughout the supply chain.

Environmental Standards:

Implementing environmental standards in the textile sector is of paramount importance due to its significant ecological footprint throughout the production chain. From the cultivation of raw materials to manufacturing processes and eventual disposal, the textile industry has historically been associated with substantial resource consumption, pollution, and waste generation. By adhering to stringent environmental standards, textile companies can mitigate their environmental impact, reduce energy and water usage, minimize emissions of harmful chemicals, and optimize waste management practices.

ISO 14001 (Environmental Management System):

The ISO 14000 series comprises international standards related to environmental management, developed by the International Organization for Standardization (ISO). These standards provide a framework for organizations to establish and improve their environmental management systems, aiming to minimize the environmental impact of their operations and activities.

EMAS (Environmental Management and Audit Scheme):

EMAS is a voluntary environmental management system developed by the European Union (EU). EMAS goes beyond ISO 14000 standards by requiring organizations to conduct detailed environmental assessments, publish environmental reports, and undergo periodic verifications conducted by accredited external auditors.

EU Ecolabel:

Also known as the European Union Ecolabel, is a voluntary eco-labeling system applied to products and services within the European Union. To obtain the EU Ecolabel, products and services must comply with strict environmental performance criteria set by the EU in areas such as resource efficiency, emission reduction, and waste minimization. This label provides consumers with a reliable indication that a product or service has been produced and/or supplied in an environmentally friendly manner.





05.
**Strategies for
shifting to the circular
economy model**



Prevent Pollution and Save Resources

In the textile industry, achieving sustainability and resource efficiency hinges on meticulous material management. Our manual section, "Prevent Pollution and Save Resources," delves into this intricate relationship between material choices and environmental impact. Key practices like Raw material selection, where companies evaluate materials' environmental footprint to minimize resource depletion and emissions, serve as the foundation of sustainable manufacturing.

Monitoring, control, and tracking of consumption ensure transparency in resource use, helping to identify inefficiencies and optimize utilization. Embracing Advanced Manufacturing Process Technologies enables efficiency gains, reducing water and energy consumption while lowering emissions. Additionally, Promoting

Zero Waste practices shifts the industry towards a circular economy model, maximizing resource recovery and minimizing landfill contributions.

Contents of the section

- Raw material selection**
- Production processes**
- Best practices recommendations**

In the textile sector, the pursuit of sustainability has become a paramount concern as industries worldwide strive to minimize their environmental footprint.

A critical aspect of achieving sustainability in textile manufacturing is the careful selection of raw materials. This manual aims to elucidate the pivotal role raw material selection plays in sustainable manufacturing within the textile industry and how it contributes to minimizing environmental impact and promoting responsible production practices.

In order to achieve this goal the following aspects will have to be taken into consideration:

Environmental Impact Assessment:

The selection of raw materials serves as the foundational step in assessing and mitigating the environmental impact of textile manufacturing. By scrutinizing the life cycle of various raw materials, manufacturers can make informed decisions that align with sustainable practices. Factors such as water and energy consumption, greenhouse gas emissions, and chemical usage should be considered during the evaluation process.

Renewable and Biodegradable Resources:

Prioritizing renewable and biodegradable raw materials is integral to sustainable textile manufacturing. Natural fibers like organic cotton, hemp, and bamboo possess characteristics that make them eco-friendly alternatives to traditional materials. These fibers decompose naturally, reducing the environmental burden associated with non-biodegradable counterparts.

Reduced Carbon Footprint:

Opting for raw materials with a lower carbon footprint contributes significantly to sustainable manufacturing. Materials that require less energy-intensive processing, transportation, and extraction play a crucial role in mitigating greenhouse gas emissions. Additionally, utilizing locally sourced materials can further reduce the overall carbon footprint associated with transportation.



Closed-Loop Systems and Recycling:

Incorporating closed-loop systems and recycling mechanisms into the production process can dramatically enhance sustainability. Choosing materials that can be recycled or repurposed at the end of their life cycle promotes a circular economy. This minimizes waste generation and fosters a more sustainable approach to resource utilization.

Social Responsibility:

Raw material selection is not only about environmental impact but also about ensuring ethical and socially responsible sourcing practices. Sustainable manufacturing in the textile sector should prioritize raw materials that adhere to fair labor standards, support local communities, and avoid exploitative practices.

Longevity and Durability:

Selecting raw materials based on their durability and longevity contributes to the creation of long-lasting textile products. Products that withstand the test of time reduce the need for frequent replacements, ultimately minimizing resource consumption and waste generation.

Fiber classification

Fiber classification is an essential aspect of textile manufacturing, influencing the properties, performance, and sustainability of the final product. Below, a classification of the various types of fibers can be found differentiating among natural, artificial, cellulosic, biobased, and animal origin fibers, to assist stakeholders in making informed decisions for sustainable and efficient textile production.



Natural fibres

Natural fibres are derived from plants. Common examples include cotton, linen and hemp. These fibers are characterized by their inherent properties, such as breathability, comfort, and moisture absorption. Understanding the unique characteristics of each natural fibre is essential for optimizing their application in textile processes.



Artificial fibres

Artificial fibres, also known as synthetic or man-made fibres, are produced through chemical processes using polymers derived from petrochemicals. Examples include polyester, nylon, and acrylic. These fibres offer versatility in terms of strength, durability, and resistance to environmental factors, making them integral to various textile applications.



Cellulosic fibres

Cellulosic fibres, derived primarily from plant cell walls, include natural fibres like viscose and lyocell. The unique properties of cellulosic fibres, such as moisture absorption, breathability, and biodegradability, make them highly desirable for sustainable textile manufacturing.



Biobased synthetic fibres

Biobased synthetic fibres are manmade materials intended to substitute artificial fibres created from polymers derived from petrochemicals. These fibres contribute to sustainability by reducing reliance on finite resources. Examples of biobased fibres include soybean fibre and corn fibre among many others.



Animal origin fibres

Animal origin fibres are sourced from animals and include wool, silk, leather and down. These fibres offer unique characteristics such as warmth, softness, and luxurious texture, making them suitable for a range of high-quality textile products.

Strategies for the prevention and resource saving related to raw materials

The choice of sustainable raw materials emerges as a central element in the transformation towards more responsible and efficient practices in the textile sector. This best practices report explores the importance of adopting raw materials that not only meet the quality standards required by the industry, but also respect the principles of environmental and social sustainability.

Sustainable raw materials encompass a diverse range of options, from organic raw materials and recycled fibres to innovative biomaterial-based alternatives. These strategic choices directly impact the environmental footprint of the textile sector, reducing pressure on natural resources and minimising waste generation. In addition, the adoption of sustainable raw materials contributes to the mitigation of social impacts by promoting ethical agricultural practices and fair labour conditions.

The section on sustainable raw materials delves into the key defining characteristics of these raw materials, highlighting their environmental and social benefits. It also explores emerging trends in the research and development of new materials, highlighting the importance of innovation in the constant search for alternatives that drive sustainability.

By incorporating these Best Available Techniques, we are not only improving the sustainability of the textile supply chain, but also laying the foundation for a production model that responds to today's demands without compromising the well-being of the planet and global communities.



Preferred Raw Materials



Organic raw materials

Organic raw materials, such as organic cotton, organic flax and organic hemp, are grown without the use of synthetic chemical pesticides and fertilisers. This holistic approach based on the organic farming model seeks to maintain soil health, biodiversity and water quality, thus contributing to the reduction of the environmental footprint associated with textile production. Among the advantages of using such materials is the reduction of chemical waste: by eliminating the use of synthetic chemicals, soil and water pollution is significantly reduced. Similarly, organic agriculture promotes healthier habitats and the conservation of biodiversity, preserving the variety of species in agricultural ecosystems.

On a social level, it was characterised by a model of improved working conditions: The production of organic raw materials often involves more ethical labour practices and fair working conditions for farmers. Another core principle of organic commodity standards focuses on community health: the elimination of toxic chemicals improves the health of local communities surrounding the growing areas.

Organic Content Standard



Global Organic Textile Standard



Recycled raw materials

Recycled textile raw materials represent a key innovation in the textile sector, responding to the growing demand for sustainable and circular practices. These raw materials are obtained from the re-use of pre-existing textiles both pre-and post-consumer, thus avoiding exclusive reliance on natural resources and minimising waste generation. Within the category of recycled textile raw materials, two main types can be distinguished: those of natural origin and those of artificial origin.

Both types of recycled textile raw materials contribute to the reduction of waste and the conservation of natural resources while minimising the need to produce new fibres from scratch, resulting in lower greenhouse gas emissions.

These raw materials can be used in a wide variety of textile applications, from clothing to household products, providing designers and manufacturers with sustainable options without compromising quality or performance.

In short, recycled textile raw materials represent a promising approach to move towards a more sustainable and circular textile industry. The distinction between those of natural and artificial origin offers industry players options tailored to their specific needs, enabling a significant shift towards more responsible and environmentally friendly practices.

Recycled Claim Standard



Global Recycled Standard



Preferred Raw Materials



Biomaterial-based feedstocks

Biomaterial-based textile raw materials represent a revolutionary frontier in the search for sustainable solutions for textile production. These biomaterials, derived from biological sources such as plants, microorganisms or organic waste, offer a promising alternative to traditional textile fibres, reducing dependence on non-renewable resources and mitigating the environmental impact associated with conventional textile production.

While the adoption of textile biomaterials opens up new opportunities for sustainability in the textile industry, it also presents challenges, such as the scalability of production and the need to develop efficient processes. However, continuous research and investment in innovative technologies are paving the way for a successful transition towards more sustainable and resource-conscious textile production. The integration of textile biomaterials in the supply chain can be a fundamental pillar in the evolution towards a more eco-friendly and ethical textile industry.

Repreve



Sorona



Econyl



Responsible raw materials

The selection of responsible raw materials plays a fundamental role in the transformation towards more ethical and environmentally friendly practices. However, it has not yet reached the status of organic or recycled raw materials in some cases, due to the lack of certain criteria that are increasingly considered essential, such as traceability through mass balance. Additionally, some approaches focus on very specific aspects without considering sustainability holistically, such as those that prioritize only the social aspects of production or those that focus exclusively on fair trade practices.

In spite of this, this type of raw material currently accounts for a high percentage of the total raw materials used in textile production, as it is a more economically viable alternative to organic and recycled materials, while at the same time offering certain environmental attributes.

Responsible Wool Standard



Cotton Made in Africa



Responsible Down Standard



Fairtrade Labelling Organizations



Better Cotton Initiative



European Flax



Preferred Raw Materials



Sustainable raw materials certified under trademark

The adoption of certified sustainable raw materials under registered trademarks has become an essential pillar in the quest for responsible practices in the textile sector. These certifications not only validate the industry's commitment to sustainability, but also provide consumers with the confidence that the products they purchase meet rigorous environmental and social standards.

The main characteristics offered by Trademark Certified Sustainable Raw Materials are very diverse, as it will depend on the criteria that the company owning the trademark has chosen to promote sustainability under its marketing. However, the most common characteristics are responsible sourcing, sustainable management, fair labour conditions.

Lenzing group



Aditya Birla Group



Recommended practices:

Certifications:

The use of raw materials with globally recognised organic or recycled certifications is recommended to guarantee the authenticity of the products.

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Trademark:

The use of raw materials under trademark with a globally recognised reputation and with recognised certifications from verifying bodies outside the trading company is recommended to guarantee the authenticity of the products.

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Traceability and Certification of responsible raw materials:

Effective implementation of responsible raw materials requires robust traceability and certification systems from production to marketing.

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Crop Rotation:

The implementation of crop rotation practices is recommended to improve soil health and reduce pressure on specific resources.

–

It is highly recommended to prioritize **sourcing** certified natural materials from suppliers who have regenerative agricultural practices implemented.

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Prioritisation of post-consumer recycling:

It is recommended to encourage the use of post-consumer raw materials due to the imminent European directive that will re-qualify pre-consumer fibres as reused fibres, thus eliminating the interest of brands in this type of material.

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Development of Transparent Supply Chains:

It is recommended to promote transparency in supply chains, from cultivation to manufacturing, to ensure traceability and authenticity of certified raw materials.

In the dynamic landscape of the textile sector, optimizing the production process in each step is a key strategy for achieving efficiency, reducing costs and enhancing overall competitiveness. The key areas where optimization can lead to improved productivity, resource utilization and ultimately, the delivery of high-quality garments to the market are:

Efficiency and Time Management

- Resource Utilization
- Technology Integration
- Quality Control
- Cost Reduction
- Flexibility and Adaptability



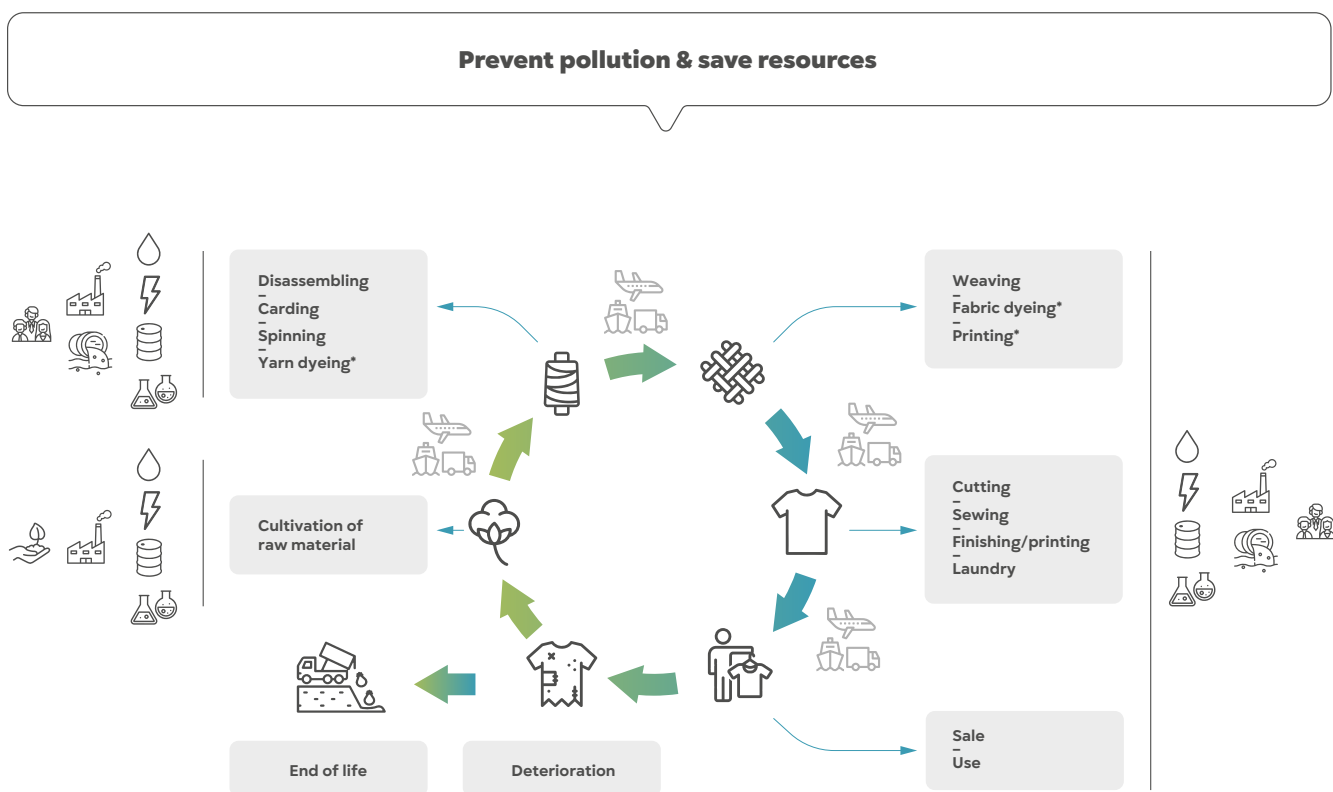
Common steps of an industrial garment manufacturing process



Understanding the life cycle of a garment is indispensable for navigating the complexities of textile manufacturing sustainably. Adopting this methodology, brands and producers can detect in what areas both environmental and social impact are more likely to be caused.

By assessing each and every step of the manufacturing process of a garment and the future steps in its life cycle, a deeper comprehension of where the raw material and resource depletion as well as the generation of waste and gaseous and water emissions are more likely to be an issue to be approached.

By embracing best practices at each stage, the industry can not only mitigate its environmental impact but also thrive in a market increasingly driven by sustainability. This manual serves as a guide to empower textile manufacturers to make informed decisions, contribute to a circular economy, and foster a more sustainable future for the textile sector.



This way, the benefits of optimization extend across various facets of the textile sector. This manual serves as a guide for stakeholders, emphasizing the strategic significance of continuous improvement in production processes to ensure the delivery of high-quality garments in a sustainable, cost-effective, and timely manner.

Efficient use of water

The efficient use of water in textile production has become a critical imperative in the framework of sustainability and environmental responsibility.

The textile industry, historically water-intensive, faces the challenge of balancing growing product demand with the need to conserve this vital resource and preserve aquatic ecosystems. Growing global water scarcity underscores the urgency of rethinking the way the textile industry uses this resource. Key textile production regions often face water stress, highlighting the need to implement measures that minimise abstraction and maximise water use efficiency.

From the cultivation of raw materials to the dyeing and finishing processes, textile production involves several phases with significant water requirements. Farming for textile fibres and associated chemical processes, such as dyeing and finishing, are critical areas where water plays a central role.

Responsible water management is not only an environmental necessity, but also aligns with consumer expectations and regulatory demands. Companies that prioritise efficient water use reinforce their commitment to sustainability and contribute to the development of a more ethical and environmentally conscious textile industry.

Recommended practices:

It is recommended that **flow meters** be installed at all water source catchments in order to control the total consumption of the process.

–

It is recommended to keep a **record** at least on a monthly basis of the aqueous consumptions of the manufacturing plant.

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The installation of flow meters at all wastewater emission points is recommended in order to control that all water consumed (excluding evaporation losses and



product occlusion) is emitted for proper treatment and early detection of leaks.

–

The installation of flow meters or water measurement systems in all individual production processes is recommended for proper process optimisation, water balance calculation and early detection of losses.

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The use of **dope dyeing techniques** for artificial fibres is recommended in order to avoid subsequent water consumption during the different textile production processes.

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The use of exhaustion dyeing machinery that allows dyeing operations to be carried out at a low liquor ratio is recommended.

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The use of **continuous dyeing** machinery with sensors is recommended for a greater optimisation of the use of water resources.

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The application of **Cold Pad Batch techniques** is recommended when applicable for the drastic reduction of water in dyeing processes.



The use of continuous **washing machines** equipped with sensors is recommended for the reduction of water consumption.

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The use of garment washing machines optimised for low liquor ratio processes is recommended.

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The purchase and use of high efficiency chemicals is recommended in order to optimise processes and reduce water consumption.

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The use of **boiler condensate** is recommended as a water saving measure.

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The reuse of non-contact cooling water is recommended.

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The use of digital printing is recommended as an alternative to positional or web printing in order to minimise water consumption in production.

–

The reuse of wastewater after purification is recommended in order to minimise the amount of fresh water collected.

Waste water management

Efficient water management in the textile industry is essential to meet environmental standards, reduce the water footprint and ensure the sustainability of operations. The existence of a wastewater treatment system suited to the specific needs of textile mills is essential to achieve these objectives. Different wastewater treatment configurations and their applications in the textile sector are discussed below:

Recommended practices:

It is recommended that a wastewater treatment system is available according to the chemical load and discharge requirements that can treat 100% of the water from the factory (excluding evaporation loss and occlusion in the product).

–

Periodic wastewater analysis is recommended to ensure compliance with environmental legislation or the requirements of external subcontracted wastewater treatment plants.

–

The adoption of a List of Restricted Substances in Manufacturing is recommended to control the chemical content of the discharges made.

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It is recommended that a strategy is established to control and minimise the use of restricted and banned chemicals in order to achieve excellence in production processes.





Energy Efficiency

The continuous growth of this industry has led to a significant increase in energy consumption, posing environmental and economic challenges. In this context, energy efficiency emerges as an unavoidable priority for textile mills, driving the search for Best Available Techniques (BAT) to optimise processes and minimise environmental impact.

Improving energy efficiency not only responds to environmental imperatives, but also translates directly into economic benefits for factories. Implementing efficient practices not only reduces operating costs associated with energy, but also strengthens the resilience of facilities in the face of fluctuating energy prices and evolving government regulations.

Recommended practices:

It is recommended to implement a certified Energy Management System (EMS) in order to monitor, analyse and continuously improve the energy performance of the plant.

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It is recommended to implement a system to record the energy consumption of the factory, at least on a monthly basis.

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It is recommended to implement automatic control systems to automatically adjust operating conditions according to needs, avoiding unnecessary operation of equipment.

–

It is recommended that conventional lighting be replaced by LED technology, which offers greater light efficiency and a longer useful life.

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It is recommended that heat recovery systems be implemented in drying machines, chimneys, pipes and boiler systems and in the plant's wastewater outlet.

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The implementation of condensate recovery systems in steam pipes is recommended in order to implement their reuse and minimise energy consumption derived from steam production or water heating systems.

–

It is recommended that thermal insulation be applied to equipment and piping to reduce heat losses and improve energy efficiency.

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It is recommended to establish a monitoring system for insulation systems and include them in the preventive maintenance plan of the manufacturing plant.

–

The integration of renewable energies such as solar or wind power is recommended to supply at least part of the plant's electricity demand.

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It is recommended that a system of regular staff training be implemented to raise awareness of the importance of energy efficiency and to promote practices that contribute to the optimisation of resources.

Chemical management

One of the most pressing challenges within the textile industry is chemical management, an essential dimension of textile manufacturing.

Effective chemicals management in the textile industry is a technical and ethical imperative that encompasses two fundamental spheres: safeguarding human health and preserving the environment. In this context, the implementation of advanced chemical management practices is not only a corporate responsibility, but also ensures the long-term sustainability of the textile sector.

Exposure to hazardous chemicals during textile processes can have a direct impact on the health of workers and, by extension, on public health. Poor chemical management can result in occupational illnesses, skin and respiratory allergies, and potentially contribute to the spread of harmful substances in final products. The implementation of good practices, such as the substitution of toxic chemicals with safer alternatives and the adoption of personal protective measures, makes a crucial contribution to the health and well-being of workers in the textile industry.

The textile industry, by using a variety of chemicals throughout its production chain, can generate significant environmental impacts. From water pollution to the emission of harmful gases, improper chemical management can trigger devastating consequences for the surrounding ecosystems. Taking proactive measures, such as implementing wastewater treatment technologies, minimising chemical waste and finding more sustainable alternatives, is essential to mitigate the environmental impact of the textile industry.

Recommended practices:

Responsible chemical selection is recommended to ensure compliance of final products with REACH, other applicable legislation and customer requirements.

It is recommended to establish a procedure for the substitution of hazardous substances with the aim of

working with less toxic chemicals or seeking alternatives that are less harmful to human health and the environment.

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It is recommended to implement real-time monitoring and control systems that allow precise control of chemical processes, helping to prevent spills and reduce the need for costly corrections.

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It is recommended that a clear and precise labelling system be established with the aim of detailing and clearly informing about the risks associated with each chemical used, facilitating identification and safe handling.

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It is recommended to establish a real-time updated chemical inventory in order to establish a better management of chemicals.

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It is recommended that safety data sheets be compiled for each chemical stored in the manufacturing plant and that these be available for consultation by workers.

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It is recommended to establish a control system to prevent leaks and drips in the chemical stores in order to reduce the risk to workers.

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It is recommended that criteria be established so that only trained and qualified workers have access to warehouses.

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It is recommended that a continuous staff training programme be established to regulate the safe handling of chemicals, including emergency protocols and safe working practices.



Waste Management

Efficient waste management in the textile industry has become an unavoidable technical imperative and is key to achieving comprehensive sustainability from production to final disposal of textile products. The importance of effective waste management is reflected in multiple technical and environmental dimensions.

The implementation of advanced waste management systems in the textile industry allows for optimal recovery and reuse of materials. Efficient sorting of textile waste, such as fabric offcuts or defective products, facilitates the identification of opportunities for recycling and reintegration into manufacturing processes. This not only reduces dependency on virgin resources, but also minimises waste generation and associated disposal costs.

Promoting zero waste begins with the design phase. Textile manufacturers are adopting sustainable design principles that prioritize efficiency and waste reduction. This involves designing products with the end of

life in mind, using materials that are recyclable, biodegradable, or sourced responsibly.

Embracing the circular economy model is also fundamental to zero waste practices. This involves creating closed-loop systems where materials are continuously reused, recycled, or repurposed. Textile businesses are exploring ways to extend product life, encouraging repair, refurbishment, and recycling to minimize the disposal of textile waste.

Finally, it is important to bear in mind that promoting zero waste practices requires collaboration across the entire textile supply chain. This involves engaging with suppliers, manufacturers, retailers, and consumers to collectively work towards waste reduction goals. Partnerships and alliances are formed to share best practices, innovations, and sustainable solutions, such as pattern making and cutting and 3D Software prototyping for minimizing textile waste.

On the other hand, poor waste management can lead to soil and water pollution as well as greenhouse gas emissions. Implementing practices that encourage



waste reduction, reuse and recycling contributes directly to mitigating the environmental impact of the textile industry. This not only complies with environmental regulations, but also responds to the growing expectations of consumers who are looking for products with a smaller ecological footprint.

Robust waste management is essential to comply with local and international regulations. Obtaining sustainable certifications, which are increasingly valued in the market, requires not only the implementation of eco-efficient practices in production, but also the responsible management of waste generated throughout the product life cycle.

Recommended practices:

It is recommended to establish a detailed inventory of the waste generated in the manufacturing plant.

It is recommended to contract an authorised waste manager for the correct management of both hazar-

dous and non-hazardous waste.

It is recommended to establish a system for the storage of waste collection receipts by the authorised waste manager.

It is recommended to have a safe waste storage place in the factory so that the waste is ventilated, covered against atmospheric conditions, labelled, segregated and with risk and leakage prevention systems.

It is recommended to implement computer-aided design systems.

It is recommended to implement automated cutting machines.

It is recommended to implement laser cutting technology.

It is recommended to implement digital printing for pattern application.

It is recommended to implement 3D Software prototyping for minimizing textile waste.



Preventing waste during the industrial processes

01. Pattern making and cutting

In the ever-evolving landscape of the textile industry, pattern making and cutting play pivotal roles in shaping the efficiency, precision, and sustainability of manufacturing processes. Innovations in this area are not only enhancing traditional methods but also contributing to a more resource-efficient and technologically advanced future for textile production.

Computer-Aided Design (CAD) Systems:

Modern pattern making often begins with sophisticated Computer-Aided Design (CAD) systems. These digital tools allow designers and pattern makers to create, modify, and visualize patterns with precision. CAD systems streamline the design process, enabling faster iterations and minimizing material waste through accurate digital representations.

Automated Cutting Machines:

Automated cutting machines have revolutionized the cutting phase of textile production. Computer Numerical Control (CNC) cutting systems use advanced algorithms to cut fabric with unparalleled precision. These machines optimize material usage, reduce errors, and enhance production speed, contributing to overall efficiency and cost-effectiveness.

Laser Cutting Technology:

Laser cutting has emerged as a sustainable alternative to traditional cutting methods. Laser cutting machines use focused beams of light to precisely cut through fabrics, providing intricate detailing with minimal waste. This technology is particularly advantageous for delicate materials and complex patterns, offering a high level of accuracy.



Digital Printing for Pattern Application:

As explained in other sections of this document, digital printing technologies allow for intricate and highly detailed patterns to be directly applied to fabrics. When combined with new pattern applications, this eliminates the need for separate pattern cutting and sewing, reducing material waste associated with traditional pattern application methods. Digital printing also offers greater flexibility in design customization.

Preventing waste during the industrial processes

02. 3D Software prototyping for minimizing textile waste

The textile industry, historically known for its resource-intensive processes, is undergoing a transformative shift fuelled by technological innovations. One key advancement making waves in the sector is the implementation of 3D software prototyping. This technology holds tremendous promise in minimizing textile waste, offering a more sustainable and efficient approach to garment design and production.

Precision in Design:

Traditional methods of garment design often involve creating physical prototypes, which can lead to numerous iterations before achieving the desired fit and design. 3D software prototyping, on the other hand, allows designers to create digital representations of garments with unparalleled precision. This precision significantly reduces the need for physical prototypes and the associated material waste that comes with trial and error in traditional processes.

Virtual Try-Ons and Fittings:

One of the key advantages of 3D software prototyping is the ability to conduct virtual try-ons and fittings. Designers can simulate how garments will fit on different body types, identifying potential issues before a single piece of fabric is cut. This not only improves the accuracy of designs but also minimizes the production of ill-fitting garments that may eventually contribute to textile waste.

Iterative Design without Physical Samples:

With 3D software prototyping, designers can make iterative changes to garment designs in the digital realm



without the need for multiple physical samples. This iterative process allows for quicker design adjustments, reducing the time and resources spent on creating and discarding physical prototypes. It streamlines the design phase and minimizes the environmental impact associated with excessive material usage.

Material Optimization:

3D software prototyping enables designers to optimize material usage by simulating how patterns can be arranged on fabric to minimize waste. This includes considerations for fabric width, pattern layout efficiency, and strategic placement to make the most of each material cut. The result is a more sustainable approach to material consumption, contributing to the reduction of textile waste in the production process.

Sustainable Decision-Making:

Beyond the design phase, 3D software prototyping facilitates informed decision-making regarding material choices and production methods. Designers and manufacturers can assess the environmental impact of different design options, enabling them to choose more sustainable materials and processes from the outset. This proactive approach aligns with the industry's growing commitment to sustainability.

Cost and Time Efficiency:

Implementing 3D software prototyping not only aligns with sustainability goals but also offers economic benefits. The reduction in physical prototyping, quicker design iterations, and optimized material usage contribute to overall cost and time efficiency in the garment production process.

Monitoring, control and tracking of consumption

In the fast-paced and resource-intensive landscape of the textile sector, the effective monitoring, control, and tracking of consumption play an essential role in achieving sustainable and efficient manufacturing practices therefor demonstrating the importance of implementing robust systems for monitoring and controlling resource consumption. This approach can lead to significant benefits in terms of cost reduction, environmental impact mitigation, and overall operational excellence.

Monitoring resource consumption is the first step towards achieving sustainable manufacturing. By tracking the usage of raw materials, energy, water, and other resources at each stage of production, manufacturers can identify areas of inefficiency, set benchmarks, and implement targeted strategies for improvement.

Additionally, by implementing real-time control systems enable manufacturers to actively manage and optimize resource consumption during the production process. Automated sensors and control mechanisms can adjust parameters such as temperature, pressure, and machine speed to ensure optimal resource utilization. This not only improves efficiency but also minimizes waste.

Effective monitoring, control, and tracking of consumption contribute directly to cost reduction. By optimizing resource usage, minimizing waste, and enhancing overall efficiency, manufacturers can achieve operational excellence, leading to increased profitability and competitiveness in the market.

For last, many regions and industries have stringent regulations related to resource consumption and environmental impact. Implementing robust monitoring and tracking systems ensures compliance with these regulations and facilitates accurate reporting. This not only avoids legal complications but also enhances the reputation of the company as a responsible and sustainable entity.

Recommended practices:

It is recommended to implement a raw material consumption monitoring process.

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It is recommended to implement a water consumption monitoring process.

–

It is recommended to implement an electricity consumption monitoring process.

–

It is recommended to implement a fuel consumption monitoring process.

–

It is recommended to implement a wastewater generation monitoring process.

–

It is recommended to implement a solid waste genera-

tion monitoring process.

–

It is recommended to implement a gas emissions generation monitoring process.

–

It is recommended to assess the adherence to management systems that involves waste management monitoring, such as EMAS, ISO 14001 or others such as the OEKOTEX Green Passport, etc.



Advanced Manufacturing Process Technologies

In the ever-evolving landscape of the textile sector, staying at the forefront of technological advancements is essential for maintaining competitiveness and achieving operational excellence. By adopting to the newest technologies, the producers will not only provide a modern production option to their client, but they will achieve a more optimise production processes where resource consumption is optimised to the maximum level and therefore reducing costs and improving the sustainability of their process.

01. Automation and Robotics

02. Digital printing

03. Best practices regarding dyeing and finishing



Advanced Manufacturing Process Technologies

01. Automation and Robotics

The integration of automation and robotics has emerged as a transformative force, reshaping the way we conceptualize and execute manufacturing processes. As demands for efficiency, quality, and sustainability continue to drive innovation, automation and robotics have become integral components of the modern textile manufacturing ecosystem. From the precision cutting of fabrics to the seamless assembly of intricate designs, and from intelligent material handling to the optimization of quality control, the impact of automation is pervasive and revolutionary.

Automated Robotic Systems:

Robotics has become a cornerstone of advanced manufacturing in textiles. Automated robotic systems are employed for tasks such as material handling, fabric spreading, cutting (e.g. laser cutting), sewing, fabric and garment inspection, pressing and packaging. These systems enhance precision, reduce labor costs, and significantly increase production speed while maintaining consistent quality.

3D Printing in Textile Manufacturing:

3D printing is making inroads into textile production. This technology enables the creation of intricate and customized textile structures, offering new possibilities in design and functionality. From prototyping to on-demand production, 3D printing transforms traditional manufacturing approaches.

Advanced Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM):

The integration of advanced CAD, also known as AutoCAD, and CAM systems streamlines the design-to-pro-



duction workflow. These tools facilitate intricate pattern design, prototyping, and precision cutting. Automation in the design and cutting phases enhances accuracy, reduces waste, and accelerates time-to-market.

Sustainable Dyeing and Finishing Technologies:

Advanced manufacturing extends to sustainable dyeing and finishing processes. Technologies such as waterless dyeing, digital printing, and plasma treatments minimize environmental impact. These processes reduce water usage, eliminate harmful chemicals, and offer greater control over color variations.

Block chain for Supply Chain Transparency:

Block chain technology is being employed to enhance transparency and traceability in the textile supply chain. From raw material sourcing to final product delivery, block chain ensures accountability and authenticity, addressing concerns related to ethical sourcing and sustainable practices.

Advanced Manufacturing Process Technologies

01. Automation and Robotics

Recommended practices:

It is recommended to implement robotics in fabric handling.

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It is recommended to implement automation systems in fabric spreading.

–

It is recommended to implement robotics in cutting.

–

It is recommended to implement robotics in sewing.

–

It is recommended to implement robotics in folding and packing.

–

It is recommended to implement robotics in fabric and garment inspection.

–

It is recommended to implement automation systems in pressing.

–

It is recommended to implement robotics in 3d structures for protective apparels.

–

It is recommended to implement auto cad and cam.

–

It is recommended to implement sustainable dyeing and finishing technologies.

–

It is recommended to implement blockchain systems for supply chain transparency.



Photo: www.kuka.com

Advanced Manufacturing Process Technologies

02. Digital printing

Digital printing has emerged as a revolutionary technology in the textile sector, offering unprecedented flexibility, precision, and sustainability in the creation of vibrant and intricate designs that allow designers to expand their creativeness and industrial to adjust to the needs of the brands, developing products that adjust perfectly to their requirements. Digital printing involves the direct application of designs onto fabrics using inkjet technology. Unlike traditional methods, such as screen printing, digital printing eliminates the need for intermediate steps like screens or cylinders. The process allows for high-resolution printing with intricate details and a wide range of colors. Even though it is seen as a simple technology, there are multiple aspects that need to be taken into consideration:

Textile Pre-treatment:

Proper pre-treatment of textiles is essential to ensure optimal ink absorption and colourfastness. The various pre-treatment methods, include chemical processes and surface modifications, to prepare textiles for digital printing. Effective pre-treatment is key to achieving vibrant and durable prints.

Inkjet Technology in Textile Printing:

Inkjet technology is at the core of digital textile printing. This way, prior to the start of the process, the understanding of the functioning of inkjet print heads is essential to optimize ink formulations and achieving optimal colour reproduction. Understanding the intricacies of inkjet technology is also crucial for maximizing print quality and longevity.

Colour Management and Calibration:

Achieving accurate and consistent colour reproduction is paramount in digital textile printing. This section explores colour management techniques, colour calibration, and the use of colour profiles to ensure that printed textiles match the intended design. Consistent colour accuracy is critical for meeting client expectations and quality standards.

Printed Textile Finishing:

Post-printing processes are explored, including fixation methods to set the ink into the fabric, washing procedures for colourfastness, and finishing techniques to achieve desired textures or properties. Understanding these processes is crucial for delivering high-quality printed textiles that meet industry standards.

Sustainability in Digital Printing:

Digital printing offers sustainability advantages over traditional methods, such as reduced water usage, minimal chemical waste, and energy efficiency. The manual delves into sustainable practices within digital printing, including the use of eco-friendly inks, recycling initiatives, and the overall environmental impact of the technology.

Recommended practices:

It is recommended to implement textile Pre-treatment optimisation processes.

–

It is recommended to provide training regarding Inkjet Technology in Textile Printing to the operators in order to optimise the whole process.

–

It is recommended to implement Colour Management and Calibration process.

–

It is recommended to implement Printed Textile Finishing optimized processes.

Advanced Manufacturing Process Technologies

03. Best practices regarding dyeing and finishing

Dyeing and finishing are critical stages in the textile manufacturing process, influencing the aesthetic appeal, durability, and overall quality of the final product. The application and implementation of the best available practices in dyeing and finishing, cover key aspects that contribute to achieving superior colour fastness, sustainability, and operational efficiency.

Dye Selection and Formulation:

Choosing the right dye is foundational to achieving vibrant and long-lasting colours. Currently, colour selection has multiple restrictions depending on the area where the manufactured good will be sold. In order to implement the best available practices in the formulation of dye recipes with precision and obtaining consistency in colour reproduction while ensuring legal compliance, the manufacturers will have to work alongside their chemical suppliers so they can assess what brands can offer a better quality and better sustainable attributes to the production.

The use of colorants and chemicals with sustainable certificates, such as Blue-Sign, can make this task easier to implement taking into account all the information that is available to the user.

Preparation and Pre-treatment:

Proper preparation and pre-treatment of textiles set the stage for successful dyeing. Best practices include thorough cleaning to remove impurities, desizing, scouring, and ensuring optimal moisture content. Adequate pre-treatment contributes to even dye penetration and enhances colour retention.

Water and Chemical Management:

Water and chemical usage in dyeing processes are significant environmental considerations. Implementing best practices involves optimizing water consumption, recycling, and utilizing eco-friendly chemicals. Minimizing the environmental impact through efficient chemical management contributes to sustainable textile production.

Additionally, the implementation of optimised technologies such as Cold Pad Batch dyeing or Low Liquor Ratio Dyeing in jet dyeing machines or garment dyeing machines can help reducing costs while enhancing a sustainable production process.

Dyeing Machinery and Equipment:

Selecting appropriate dyeing machinery is crucial for achieving uniform colour distribution and minimizing waste. This section explores best practices related to the use of dyeing machines, dyeing temperature control, and agitation techniques. Understanding the machinery's capabilities ensures optimal dyeing outcomes.

Energy-Efficient Dyeing:

Energy consumption is a significant factor in dyeing operations.

Best practices involve adopting energy-efficient dyeing technologies, optimizing process parameters, and implementing heat recovery systems. Reducing energy consumption not only lowers operational costs but also aligns with sustainable production practices.

Waste Management and Recycling:

Effectively managing waste generated during dyeing and finishing processes is integral to sustainability. Best practices include the recycling of water, proper disposal of chemicals, and exploring innovative approaches for repurposing waste materials. Implementing robust waste management strategies aligns with environmental stewardship.

Advanced Manufacturing Process Technologies

03. Best practices regarding dyeing and finishing

Recommended practices:

It is recommended to implement dye selection and formulation internal procedures.

–

It is recommended to implement best available technologies in preparation and pretreatment processes.

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It is recommended to implement water and chemical management processes.

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It is recommended to implement best available dyeing machinery and equipment or optimise the processes developed in the existing ones.

It is recommended to implement energy-efficient dyeing machinery or optimise the processes developed in the existing ones.

–

It is recommended to implement waste management and recycling processes.



Resources:

EMAS:

<https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/sistema-comunitario-de-ecogestion-y-ecoauditoria-emas.html>

EMAS:

https://green-business.ec.europa.eu/eco-management-and-audit-scheme-emas_en

ISO 9001:

<https://www.iso.org/standards/popular/iso-9000-family>

ISO 14001 (Environmental Management System):

<https://www.iso.org/iso-14001-environmental-management.html>

EU Ecolabel:

https://europa.eu/youreurope/business/product-requirements/labels-markings/ecolabel/index_en.htm

REACH:

<https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX%3A32006R1907&qid=1604582377617>

Green passport OEKOTEX:

<https://www.oeko-tex.com/en/our-standards/oeko-tex-eco-passport>

OEKOTEX RSL:

<https://www.oeko-tex.com/en/downloads>

AFIRM RSL:

<https://afirm-group.com/afirm-rsl/>

ZDHC MRSL:

<https://mrsl-30.roadmaptozero.com/>

SA8000:

<https://sa-intl.org/programs/sa8000/>

GB STANDARDS:

<https://www.gbstandards.org/>

CPSIA:

<https://www.cpsc.gov/Regulations-Laws--Standards/Statutes/The-Consumer-Product-Safety-Improvement-Act>

BSCI:

<https://www.amfori.org/en/solutions/social/about-bsci>

SEDEX SMETA:

<https://www.sedex.com/solutions/smeta-audit/>

TEXTILE EXCHANGE:

<https://textileexchange.org/>

OCS:

<https://textileexchange.org/knowledge>

RCS:

<https://textileexchange.org/knowledge-center/documents/recycled-claim-standard-rcs/>

GRS:

<https://textileexchange.org/knowledge-center/documents/grs-implementation-manual/>

RWS:

<https://textileexchange.org/responsible-wool-standard/>

RDS:

<https://textileexchange.org/knowledge-center/documents/responsible-down-standard-rds/>

LENZING:

<https://www.lenzing.com/>

LENZING TM:

<https://www.lenzing.com/products/lenzingtm>

TENCEL:

<https://www.lenzing.com/products/tenceltm>

ECOVERO:

<https://www.lenzing.com/products/lenzingtm-ecoverotm>

VEOCEL:

<https://www.lenzing.com/products/veoceltm>

ADITA BIRLA GROUP:

<https://www.adityabirla.com/about-us>

REPREVE:

<https://repreve.com/>

SORONA:

<https://sorona.com/>

ECONYL:

<https://www.econyl.com/>

BCI:

<https://bettercotton.org/>

EPA (TEXTILE MANUFACTURING):

<https://www.epa.gov/regulatory-information-sector>

EUROPEAN FLAX:

<https://allianceflaxlinenhemp.eu/en/certification-traceability>

COTTON MADE IN ÁFRICA:

<https://cottonmadeinafrica.org>

FAIRTRADE LABELLING ORGANIZATIONS:

<https://www.fairtrade.net>

Recover Resources After Disposal

As the textile industry embraces sustainability and circular economy principles, the focus on resource recovery after disposal has become increasingly crucial. This section will serve as a comprehensive guide for textile professionals, outlining strategies and best practices for recovering resources from disposed materials, fostering a more sustainable and responsible approach to textile production. The implementation of the best available technologies regarding resource recovery implies understanding End-of-Life Textiles. To effectively recover resources, a comprehensive understanding of end-of-life textiles is essential, considering the various types of textile waste generated throughout the product lifecycle, including post-consumer waste and manufacturing offcuts.

In the same way, to explore advanced textile recycling technologies that facilitate the recovery of fibers, polymers, and other valuable components from discarded textiles will be essential. Mechanical, chemical, and thermal recycling processes must be implemented and assessed in order to adopt the best approach for each composition.

Contents of the section

Design for Disassembly, Reassembly and Recycling
– **Collection and Recycling**
– **Upcycling**

Resource recovery after disposal is a pivotal component of sustainable textile manufacturing. In order to optimise the process, it is essential that the industrials acquire the knowledge needed to implement effective resource recovery strategies, fostering a circular economy within the industry and work as partners for the brands they collaborate with so the whole process can be properly implemented.

By embracing these practices, manufacturers care for the environment, reduce waste, and position themselves as leaders in responsible textile production.

The correct use of the Ecodesign notions, coupled with principles of Design for Disassembly (DfD), Reassembly, and Recycling, has emerged as a critical approach in the textile sector, guiding the industry toward sustainable and circular practices.



Monomaterial compositions

In the pursuit of a circular economy, the textile sector is increasingly turning to innovative solutions, with monomaterial compositions standing out as a transformative approach due to its effectiveness at the time of recycling.

Monomaterial compositions refer to textile products made from a single type of material or fiber. Unlike traditional textiles with complex blends, monomaterials offer a streamlined and homogeneous composition, facilitating easier recycling and recovery.

The paramount advantage of monomaterial compositions lies in the ease of recycling, enabling straightforward separation and processing. Monomaterials can be recycled without the challenges posed by mixed-fiber textiles, contributing to a more efficient circular economy.

Monomaterial compositions align seamlessly with closed-loop recycling systems. Closed-loop systems

involve the continual recycling of materials into new products of similar quality.

Additionally, it has to be taken into account that mixed-fiber textiles often pose challenges in recycling facilities, leading to contamination and compromised material quality. Monomaterial compositions alleviate these issues, as the consistent composition allows for uncontaminated recycling streams.

Recyclability potential

As the textile industry strives towards sustainable and circular practices, understanding the recyclability potential of textiles becomes paramount.

This way, it'll be essential for producers to examine the key factors that influence the process and to explore innovative technologies that will shape the future of recycling in the textile sector. The recyclability of textiles is inherently linked to material complexity. As explained in the previous section, the composition of textiles, including fiber types, blends, and finishes, influences the ease with which materials can be separated and processed during recycling, making it easier for mono-material garments with fewer rivets, seams and accessories to be recycled, while garments made of mixed materials and featuring many accessories and prints are still a challenge for recyclers today.

In the pursuit of a sustainable and circular textile industry, the correct collection and recycling of both pre-consumer and post-consumer textiles stand as an essential axis in a company's strategy. The significance of the adoption of precise methodologies in the collection and recycling processes, addressing the unique challenges and opportunities associated with each stage of the textile life cycle will be essential to develop a well optimised process that will provide solutions to the brands that the industrial sector works for.

Understanding the distinction between pre-consumer and post-consumer textiles is foundational. Pre-consumer textiles encompass manufacturing waste, offcuts, and unsold inventory and in the near future will be considered as reutilisation of materials for the European authorities, while post-consumer textiles include used garments and textiles discarded by consumers. Both streams offer distinct opportunities for recycling.

Textile waste collection

Effective textile waste collection is an essential component of sustainable and circular practices within the textile industry. In order to implement a well organised system, producers will have to explore the different methodologies, challenges, and opportunities associated with collecting these diverse textile waste streams.

As mentioned previously, pre-consumer textile waste originates within manufacturing processes and encompasses manufacturing scraps, offcuts, and unsold inventory. By implementing an organised and optimised waste management systems within manufacturing facilities, optimizing collection processes, and fostering a closed-loop approach to minimize pre-consumer waste up to an 80% of the original material used can be recovered and reinserted in the manufacturing chain.

Efficient collection of pre-consumer textile waste begins at the source within manufacturing facilities. Implementing systems for the segregation and collection of manufacturing offcuts ensures the highest possible yield for recycling.

On the other hand, post-consumer textiles encompass used garments and textiles discarded by consumers. Collecting post-consumer textiles involves navigating diverse materials, contamination issues, and decentralized disposal. Incorporating public awareness



campaigns in the area of action of the facilities and collaboration with retailers will be to main actions that will help the implementation of this techniques.

The challenges in post-consumer textile waste collection require the establishment of robust infrastructure.

This includes strategically placed collection points, efficient transportation networks, and collaboration with municipalities. Developing collection systems that incentivize consumers to participate is crucial for successful post-consumer textile waste collection.

Technological advancements, including smart bins, RFID tracking, and data analytics, are playing an increasingly significant role in optimizing textile waste collection.

Sorting technologies

Once retrieved, it will be observed that both types of textile waste may consist of diverse materials, including different fibers, fabrics, and finishes. Effective sorting and categorization are a key aspects for maximizing material recovery as these technologies contribute to the optimization of recycling processes, enhancing resource recovery and minimizing environmental impact.

Traditional manual sorting has been a longstanding method in textile recycling facilities. Although sometimes considered as a more accurate process, the limitations that it presents in terms of time consumption and when speaking about accurately categorisation of textiles based on material type, colour, and condition is still considered a critical issue due to the economic costs and the delay on the obtention of raw material for production.

Automated sorting systems, on the other hand, have revolutionized the efficiency of textile waste sorting with the implementation of conveyor belt sorting machines equipped with any additional technology.

NIR spectroscopy is a powerful tool in textile waste sorting. This technology relies on the absorption of infrared light by materials, providing information about their composition.

X-ray and magnetic sorting technologies offer specialized solutions for certain types of textiles. X-ray systems can identify different materials within a textile, while magnetic sorting is effective for separating ferrous and non-ferrous materials.

AI-driven sorting systems are at the forefront of technological innovation. Machine learning algorithms can analyse vast datasets to improve sorting accuracy and adapt to variations in textile waste streams.

Robotics is increasingly integrated into sorting processes to automate tasks that were traditionally performed manually. These systems are generally equipped with sensors and grippers that can handle and sort textiles with precision, improving efficiency and reducing labour-intensive tasks.



Recycling waste textile material

The textile industry is undergoing a transformative shift toward sustainable practices, and recycling technologies play a key role in shaping this evolution. The advances on this field has brought us multiple technologies that can be used in order to obtain recycled materials that offer the desired quality that both brands and consumer request nowadays.

Mechanical recycling is a cornerstone in textile waste management. The procedure involves shredding, carding, and mechanical sorting that breaks down textile waste into fibers for reuse in new textile products. The main advantage of this method is its simplicity, making it accessible to most of the industrial manufacturers, whereas its main disadvantage resides in the fact that during the processing of this textiles, the length of the fiber is considerably shortened, making it essential the use of virgin materials to be mixed with the recycled ones in order to maintain a certain quality in the final product.

Chemical recycling has emerged as a promising solution to address challenges associated with mixed-fiber or artificial fiber garment to garment recycling process. Technologies like depolymerization and solvolysis specially indicated in this case showcasing their ability to break down complex textile structures into chemical constituents for the production of new fibers. Although the effectiveness of this technology has been proved, it has to be highlighted that the costs of implementing it might not be reachable for every company.

Also, hydrothermal and enzymatic processes are innovative techniques in textile recycling. These processes involve the use of water, heat, and enzymatic reactions to selectively break down fibres into their molecular components. The advantages of these environmentally friendly processes are implied as it can be used over a wide range of materials whereas its main disadvantage remains to be the economic costs and difficulty to its implementation due to the technical knowledge that it requires.

Many other methodologies are currently being developed, such as the use of nano-technology, and although they are in their primal steps of optimisation will result in a breaking option for the future of the circular economy.

Understanding Pre-consumer and Post-consumer Recycled Textile Materials

Understanding the distinctions between pre-consumer and post-consumer recycled materials is essential for the future of the textile production sector. Each category presents unique sourcing methods, advantages, and challenges.

However, with upcoming European directives, the classification of pre-consumer recycling is set to undergo a significant transformation, emphasizing its role as a resource recovery process.

Pre-consumer Recycled Textile Materials:

Pre-consumer recycled textiles originate from manufacturing waste, encompassing unused materials, trimmings, and offcuts generated during production processes. These materials are diverted from landfills and reintroduced into the manufacturing cycle.

The main advantage that this type of materials present is that as they are sourced from controlled production environments, they can ensure consistent quality standards.



Post-consumer Recycled Textile Materials:

Post-consumer recycled textiles are derived from discarded consumer goods, such as apparel, upholstery, and household textiles, collected through recycling programs or waste management systems.

The main advantage that this type of materials present is the waste diversion. By repurposing post-consumer textiles, significant volumes of waste are diverted from landfills, mitigating environmental impact.

On the other hand, they present a supply chain complexity. Sourcing post-consumer materials involves coordination with multiple stakeholders, including recycling facilities, municipalities, and consumers, adding logistical challenges.

As a conclusion, understanding the distinctions between pre-consumer and post-consumer recycled textile materials is essential for informed decision-making in sustainable textile production. As regulatory landscapes evolve, the reclassification of pre-consumer recycling underscores its significance in advancing circular economy objectives and reducing environmental impact across the textile industry.

In the pursuit of more sustainable and environmentally conscious practices, the textile sector has turned to upcycling as a powerful strategy to reduce waste and breathe new life into discarded materials. Upcycling represents a creative and innovative approach that goes beyond traditional recycling, transforming textile waste into unique, high-quality products. Here's a closer look at the significance of upcycling in the textile industry:

Upcycling involves the process of repurposing discarded textiles or clothing items to create new, higher-value products. Unlike recycling, which often breaks down materials to their basic components, upcycling seeks to elevate the original materials into something of greater utility or aesthetic value.

The textile industry is notorious for its significant contribution to global waste. Upcycling directly addresses this issue by diverting materials from landfills and incineration. By giving a second life to discarded textiles, upcycling reduces the demand for new raw materials and minimizes the environmental impact associated with the extraction, production, and disposal of textiles.

Additionally, upcycling fosters a culture of creativity and innovation within the textile sector. Designers and manufacturers are challenged to think outside traditional production methods, encouraging the exploration of unconventional materials and techniques. This creative process not only results in unique, one-of-a-

kind products but also pushes the boundaries of what is possible within sustainable fashion.

Successful upcycling initiatives often involve collaboration across the supply chain. Partnerships between brands, manufacturers, and recycling facilities facilitate the collection and repurposing of textile waste. These collaborations strengthen the overall impact of upcycling efforts.



Photo: Joshua Simualis ©

Recommended practices:

It is recommended to use mono-material fabrics in the development of new products in order to optimize circular economy processes.

–

It is recommended to implement eco-design concepts in order to ease the disassembly and sorting processes.

–

It is recommended to study all different approaches to recyclability in order to implement the most suitable process for each type of raw material recycling.

–

It is recommended to differentiate between pre-consumer and post-consumer recycled product in order to adapt to the upcoming European legislations.

–

It is recommended to establish robust waste recuperation processes in order to easy recycling synergies.

–

It is recommended to optimize sorting procedures and assess the viability of implementing new technologies in order to maximize the efficiency and accuracy of the process.

–

It is recommended to assess the collaboration with companies that are creating new methodologies for recycling in order to be able to adapt to the new trends and needs of the sector.

–

It is recommended to implement upcycling procedures in order to minimize waste generation.

–

It is recommended to establish collaborations in order to bring innovation into the upcycling process.

Resources:

Disassembled technologies:

<https://www.centexbel.be/en/projects/deseptex>

R-Two ISKO:

<https://iskodenim.com/r-two>

ReFashion, design for recyclability:

<https://refashion.fr/eco-design/sites/default/files/fichiers/Textile%20design%20for%20recycling%20guidelines%20%28WP4%29.pdf>

SuperCircle:

<https://textileexchange.org/textile-to-textile-recycling-supercircle/>

Circular Design Toolkit for Fashion and Textiles:

<https://wrap.org.uk/resources/guide/circular-design-toolkit>

How to collect, sort, and reuse textile waste locally?:

https://zerowastecities.eu/wp-content/uploads/2023/12/zwe_Dec23_guidance_textilecollectionandsorting.pdf

White paper on textile waste management:

<https://acte.net/wp-content/uploads/2022/03/WHITE-PAPER-ACTE-DG-002.pdf>

Trash-2-cash EU project:

<https://cordis.europa.eu/project/id/646226/es>

PYRATEX®:

<https://www.pyratex.com/upcycled>

UNE 40700 for the reuse and recycling of used textiles:

<https://en.tienda.aenor.com/norma-une-40700-2023-n0072309>

Extend Resource Use and Reduce Disposal

The textile and fashion industry faces pressing challenges concerning resource depletion and waste management, necessitating innovative approaches to extend resource utilization and minimize disposal. This section delves into strategies and best practices aimed at maximizing the lifespan of textile materials, optimizing resource efficiency, and minimizing environmental impact throughout the product lifecycle.

From adopting circular design principles to implementing efficient recycling and repurposing techniques, this manual explores a spectrum of strategies tailored to promote sustainable resource management within the textile sector. By prioritizing the extension of resource use and minimizing disposal, stakeholders can not only

reduce environmental footprint but also unlock economic opportunities and enhance overall resilience in the industry.

Contents of the section

- Design for Durability, Long Lasting and Modularity**
- **Repairing and Upgrading**
- **Reselling**

Design for Durability, Long Lasting and Modularity

Strategy 03

Sustainability in the textile industry extends beyond materials and production processes; it encompasses the design phase as a critical factor. This subject affects the principles of Design for Durability, Longevity, and Modularity in textiles, emphasizing how thoughtful design choices can significantly contribute to a more sustainable and circular textile economy.

Durability is the foundation of sustainable textiles. In order to provide long-lasting product, the design of strategies that prioritize the selection of high-quality materials, robust construction methods, and reinforcement techniques shall be implemented. By focusing on durability, designers can extend the lifespan of textiles, reducing the frequency of replacements and minimizing environmental impact.

The choice of materials plays a pivotal role in designing durable textiles. Therefore a good assessment on the characteristics of resilient fibers, finishes, and coatings that enhance the resistance of textiles to wear, tear, and environmental stressors has to be performed.

Reinforcement strategies, including the use of additional layers, patches, or integrated reinforcements, contribute to the longevity of textiles and are also a key aspect of the durability of a product. The techniques include, among others, the application of anti-pilling treatments and abrasion-resistant coatings, that protect textiles from deterioration over time, especially in high-stress areas.

On the other hand, modularity is a sustainable design concept that promotes adaptability and flexibility. By designing textiles with modular elements, an easy disassembly, repair, or reconfiguration will be possible. Modularity does not only extend the lifespan of textiles but also facilitates the incorporation of new features or updates, reducing the need for complete replacements.



anti-pilling treatment





In the pursuit of a circular economy, the repairing and upgrading of textiles and garments play an important role in extending product life cycles and minimizing waste.

Repairability begins with thoughtful design prioritizing accessible seams, modular components, and clear repair instructions. By designing garments with repair in mind, manufacturers facilitate the process of mending, reducing the likelihood of premature disposal and encouraging a culture of sustainability.

The durability of stitching and fastening techniques is paramount for effective repairs. Some advanced stit-

ching methods such as reinforced seams, and durable fastenings enhance the longevity of repaired textiles. Employing robust techniques ensures that repaired items maintain their structural integrity over time.

Additionally, beyond repairs, upgrading garments is a proactive strategy to enhance functionality and aesthetic appeal. With the inclusion of detachable elements or adaptable features, the manufacturer will allow users to modify their garments to meet changing preferences or needs.

Currently, the reselling of textile has become a strategic element within the circular economy of the textile industry. Reselling textiles has emerged as a powerful tool to extend a product life's cycles, reduce waste, and contribute to a more sustainable industry.

Although more extended in the post-consumer side of life of a garment, several projects have already been created in order to also resell pre-consumer goods such as fabric and yarn dead stocks that producers can't put to a good use.

Reselling begins with the initial production of textiles due to the fact that the quality assurance measures, including stringent manufacturing standards and durable material choices, are essential for producing textiles that maintain their integrity and desirability through multiple life cycles.

Effective reselling hinges on clear labeling and traceability. With the implementation of a comprehensive labeling systems that provides information on materials, care instructions, and the origin of textiles the usability of the product will be enhanced and serve as a guide to what options the new buyer has with its acquisition.

By implementing a digital platform or a physical catalog of products, the manufacturers will be able to extend their offer and create a market opportunity for products that otherwise are condemned to end up as waste.



Recommended practices:

It is recommended to prioritize the use of high-quality materials that will enhance the durability of the product.

–

It is recommended to implement techniques that reinforce the durability of the product.

–

It is recommended to assess the viability of incorporating modularity notions in order to expand the life expectancy of a product, its durability, reparability and recyclability of a product.

–

It is recommended to prioritize reparability notions into the design of a product.

–

It is recommended to implement the upgrading concept into the design of a product.

–

It is recommended for producers to create a digital platform or a physical catalog in order to resell their dead stocks.

Resources:

REFASHION – Clothing Longevity Protocol:

<https://refashion.fr/eco-design/sites/default/files/fichiers/How%20to%20use%20the%20Clothing%20Longevity%20Protocol.pdf>

WRAP – Design for Longevity:

<https://refashion.fr/eco-design/sites/default/files/fichiers/Design%20for%20Longevity.pdf>

REFASHION – Guide to Ecomodulation:

https://refashion.fr/pro/sites/default/files/fichiers/2023_GUIDE_ECO_MODULATIONS_EN_201123.pdf

WRAP – Sustainable Clothing Action Plan:

<https://wrap.org.uk/resources/guide/textiles/sustainable-clothing-action-plan>

Redress Award:

<https://www.redressdesignaward.com/>

PLATE Conference:

<https://www.plateconference.org/>

Increase Resource Utilization Rate

In the dynamic landscape of the fashion industry, the traditional linear model of production and consumption is being increasingly challenged by innovative approaches aimed at maximizing resource utilization.

By shifting from ownership to access-based models, textile businesses can optimize resource utilization rates, reduce waste generation, and mitigate environmental impact. Through rental, leasing, and subscription arrangements, products are utilized over multiple cycles, extending their lifespan and maximizing value extraction from finite resources.

By embracing these alternative business models, textile enterprises can not only enhance sustainability but also unlock new revenue streams and foster customer loyalty in an evolving market landscape.

Contents of the section

Rental, Leasing and Subscription Models

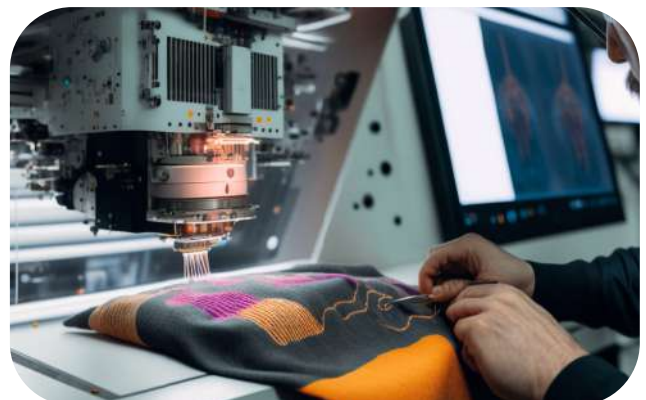


Maximizing the resource utilization rate of textiles is currently considered a critical point in order to achieve sustainability goals in the fashion industry. On this matter the technical intricacies of implementing rental or leasing systems and subscription models will become crucial as part of the innovative approaches to textile consumption.

Understanding the entire lifecycle of textile and garment production is a fundamental step when assessing the possibility of implementing Best Available Technologies aimed for this phase of life of the product. The importance of conducting a comprehensive Textile Lifecycle Assessment (TLCA) to quantify the environmental impact of textile production, use, and disposal serves as a foundation for identifying areas where rental/leasing and subscription models can optimize resource utilization.

The success of rental/leasing and subscription models hinges on the durability and quality of garments. Therefore, material selection, cut and sewing methods, and finishes that enhance the lifespan of the garments will be considered as essential. Rigorous quality assurance procedures will be also crucial to ensure garments withstand multiple cycles of use.

Automated inspection and maintenance processes are essential for ensuring garments to meet quality standards throughout their lifecycle. These possibilities expand the services that producers and manufacturers can offer to the brands they work with creating new market opportunities. This way, as this side of the business develops, the implementation of new technologies such as computer vision and machine learning algorithms that automate the inspection of garments and textiles, detecting wear and tear, and triggering maintenance actions, could simplify the process and increase accuracy and rentability.



Recommended practices:

It is recommended to perform a Garment Life Cycle Analysis (TLCA) of products in order to assess the most suitable materials for creating product to be rented, leased or subscription models.

–

It is recommended to evaluate the best cut and sewing methods and finishes in order to guarantee a longer durability of the products.

–

It is recommended to expand the services and offer reparation and maintenance of products to brands.

Resources:

TEXTILE EXCHANGE-LCA:

<http://textileexchange.org/lca-faq/>

SAC-Higg index tools:

<https://cascale.org/tools-programs/higg-index-tools/>

ISO 14040:2006(en)-Environmental management- Life cycle assessment-Principles and framework:

<https://www.iso.org/obp/ui#iso:std:iso:14040:ed-2:-v1:en>

REFASHION- Clothing Longevity Protocol:

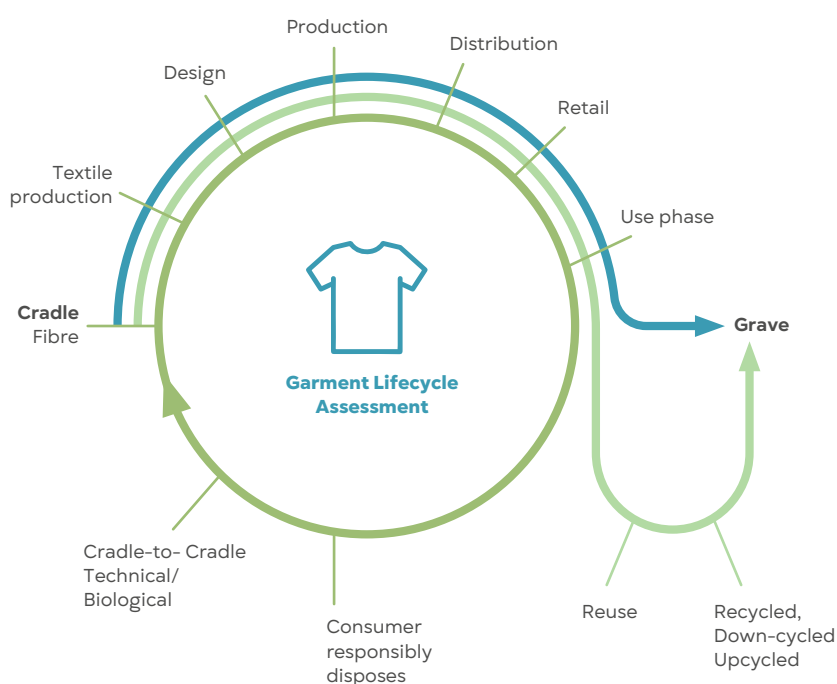
<https://refashion.fr/eco-design/sites/default/files/fichiers/How%20to%20use%20the%20Clothing%20Longevity%20Protocol.pdf>

Rent the runway:

<https://www.renttherunway.com/>

Thred Up:

<https://www.thredup.com/>



Shift to Circular Supplies and Renewable Resources

The textile and fashion industry is undergoing a paradigm shift towards sustainability by embracing circular supplies and renewable resources. With these implications in mind, suppliers must explore the intricate technical considerations involved in transitioning to collaborating with sub-suppliers that are currently incorporating renewable resources, highlighting the methodologies and technologies driving this transformative journey and assessing the implementation of such technologies alongside the existing ones.

The most common a principal consideration will have to be directly related to those suppliers capable to offer source materials that include the principles of the circular economy.

Circular supplies in the textile sector revolve around adopting a circular economy framework. This includes sourcing materials through closed-loop systems, emphasizing strategies such as recycling post-consumer textiles, remanufacturing, and implementing take-back programs to recover and reuse materials as well as other implications

Contents of the section

Supply Chain Transparency

- Ethical Practices in Raw Materials Procurement
- Sustainable Relationships with Suppliers

Supply chain transparency is a critical component of sustainable and responsible practices in the textile sector. Achieving and demonstrating transparency throughout the textile supply chain, emphasizing the technologies and methodologies that enable traceability, accountability, and ethical sourcing is, currently the first requirement that brands request for a company to be sustainable.

Additionally, in the near future, brands from all over the world will have to include the complete traceability of their products within the labels due to the upcoming legislations transforming this transparency exercise that up until now was just considered as volunteer into a mandatory one.

In terms of best available technologies, there are several considerations that a manufacturer or producer can implement in order to be considered as a pioneer in this matter:

Blockchain Technology for Traceability:

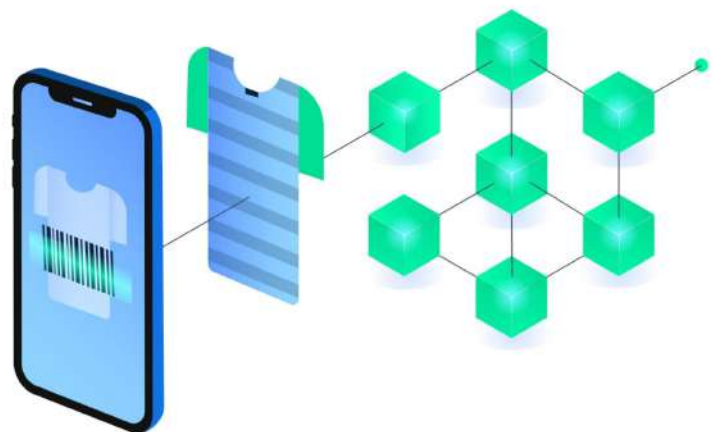
Blockchain technology stands out as a powerful tool for achieving end-to-end traceability in textile supply chains, where each transaction is recorded in an immutable, decentralized ledger. This ensures transparency by providing a secure and unalterable record of every step in the supply chain, from raw material sourcing to manufacturing and distribution.

RFID and NFC Tagging Systems:

RFID (Radio-Frequency Identification) and NFC (Near Field Communication) tagging systems offer technical solutions for real-time tracking of textile products, enabling individual items to be tagged, allowing for precise tracking and monitoring at each stage of the supply chain. RFID and NFC enhance transparency by providing instant access to product information and movement data.

QR Code Integration:

Integrating QR codes into product labelling is a technical strategy to enhance supply chain transparency. These QR codes, when scanned by consumers or stakeholders, can provide detailed information about the product's origin, materials, and manufacturing





processes. This straightforward technology contributes to increased transparency and consumer engagement.

Geolocalisation Technologies for Raw Material Tracking:

Geolocalisation technologies, including satellite imaging and GIS (Geographic Information System), enable precise tracking of raw material origins, providing accurate geographical information about farms, mines, and forests, ensuring visibility into the exact sources of raw materials and contributing to transparency in the supply chain.

Digital Platforms for Supplier Communication:

Implementing digital platforms for supplier communication is crucial for real-time information exchange. Cloud-based systems and secure communication channels allow suppliers, manufacturers, and other stakeholders to share data seamlessly. These platforms enhance collaboration, reducing delays and improving overall transparency.

Data Analytics for Risk Assessment:

Data analytics plays a key role in identifying and miti-

gating risks within the supply chain allowing the utilization of big data analytics to assess supplier performance, identify potential ethical issues, and predict disruptions. Advanced analytics enable textile companies to proactively address challenges, ensuring a transparent and resilient supply chain.

Supplier Auditing Technologies:

Supplier auditing is a vital element of ensuring compliance with ethical and sustainability standards. Among the many existing supplier auditing technologies, the most relevant nowadays might be remote auditing tools, risk assessments, and mobile applications that facilitate comprehensive and efficient audits, contributing to transparency and accountability.

Contracts for Ethical Compliance:

Contracts, powered by blockchain technology, automate and enforce ethical compliance within the supply chain and can be programmed to execute specific actions when predetermined conditions are met. This ensures that ethical standards are embedded in the supply chain process, contributing to transparency and accountability.

Ethical practices within supply chain acquisition are paramount for fostering sustainability, social responsibility, and environmental stewardship in the textile industry. The intricacies of implementing a comprehensive framework generally includes a code of conduct, certification of raw materials, adherence to social and environmental standards, the establishment of Restricted Substances Lists (RSL) and Manufacturing Restricted Substances Lists (MRSL), along with other relevant measures.

Code of Conduct Implementation:

A robust code of conduct serves as the foundation for ethical supply chain practices. The technical aspects of developing and implementing a code of conduct outlines clear guidelines for suppliers. This code should cover minimum ethical labour practices, environmental responsibilities, and adherence to legal standards.

Certification of Raw Materials:

Implementing certifications for raw materials is a technical approach to guarantee ethical and sustainable sourcing. The integration of certifications such as Fair Trade, GOTS, and FSC among many others ensure that raw materials meet established ethical and sustainability standards.

Social Standards Compliance:

Ethical practices demand adherence to social standards, and ensuring compliance requires technical solutions. The monitorisation and evaluation of supplier's practices related to labour conditions, worker safety, and fair wages among many other matters is a clear sign of commitment to the best practices in this area. Environmental Standards Adherence:

Meeting environmental standards is a technical challenge that involves monitoring and reducing the environmental impact of the supply chain. The implementation of environmental management systems show the commitment of a company and its suppliers towards offering more sustainable solutions as well as a continuous improvement trend.

Restricted Substances List (RSL) Implementation:

Establishing a Restricted Substances List (RSL) is cru-

cial for preventing the use of harmful chemicals in textiles as a final product. Creating or adhering to an existing one and enforcing an RSL, utilizing analytical chemistry techniques and material testing technologies provides the level of security that textile brands need in order to be able to offer the health and safety measures required by law.

Implementation of Manufacturing Restricted Substances List (MRSL):

Expanding the focus to the manufacturing stage by implementing a Manufacturing Restricted Substances List (MRSL) ensures that the production processes adhere to ethical chemical usage. The integration of a waste water analysis system in the supply chain that demonstrate the compliance and improvement of the facilities is currently considered as one of the best practices available in the field of chemical management.



Supplier Relationship Management is a strategic business initiative focusing on cultivating mutually beneficial relationships with suppliers. While every supplier holds value, some are crucial and strategic, making this strategy a fundamental technique a tool that can provide additional value to manufacturers and producers.

With the implementation of a good Supplier Relationship Management strategy, manufacturers and producers can benefit from the implementation of sustainable procurement, and finding and offering solutions to their clients, and therefor becoming partners of innovation.

Supplier Segmentation:

Supplier segmentation involves categorizing suppliers into different groups based on their business impact. Common segmentation groups include key suppliers, volume suppliers, bottleneck suppliers, and routine suppliers. This allows organizations to manage internal and external resources more efficiently.

Governance Model:

A Governance Model is the structured organization of people, controls, and mechanisms that describe processes and escalations related to relationship development and problem-solving. Governance models include accountable individuals at various levels, from top management to account management and operations.

Steering Group:

A steering group provides a structured approach to managing relationships, making decisions, and steering the work undertaken by others. This group normally comprises of individuals with expertise in specific topics to aid decisions that align with the success of both companies and clients.



Recommended practices:

It is recommended to implement a system to prioritise circular or sustainable suppliers or establish a systematic plan to transform the business models of the existing ones.

–

It is recommended to implement blockchain technology, RFID or NFC tagging systems or integration of QR codes to enhance traceability within the supply chain.

–

It is recommended to implement the use of Digital Platforms for supplier communication as a way to enhance traceability and transparency.

–

It is recommended to implement data analytics in order to identify potential issues and protect disruptions in the supply chain.

–

It is recommended to implement auditing systems to enhance the sustainability and transparency of the supply chain.

–

It is recommended to implement geolocalisation technologies to increase the transparency on raw material obtention.

–

It is recommended to implement contracts for ethical compliance.

–

It is recommended the establishment and signing of a code of conduct.

–

It is recommended to be certified for the use of sustainable raw materials.

–

It is recommended to adhere to a social standard compliance system.

–

It is recommended to adhere to an environmental standard compliance system.

–

It is recommended to create or adopt a Restricted Substances List (RSL).

–

It is recommended to test the manufactured products according to a RSL.

It is recommended to adopt a Manufacturing Restricted Substances List (MRSL).

–

It is recommended to perform wastewater analysis in order to demonstrate compliance regarding the adopted MRSL.

–

It is recommended to implement supplier segmentation system to improve internal management.

–

It is recommended to implement a governance model to increase the efficiency of the organisation.

–

It is recommended to create a steering group to improve decision making.

Resources:

Restricted Substances List (RSL):

<https://www.oeko-tex.com/en/downloads>

–

<https://afirm-group.com/afirm-rsl/>

Manufacturing Restricted Substances List (MRSL):

<https://mrsl-30.roadmaptozero.com/>

Blockchain technology, RFID or NFC tagging systems or integration of QR codes to enhance traceability within the supply chain:

<https://sistemas-rfid.es/etiquetas-rfid-activas>

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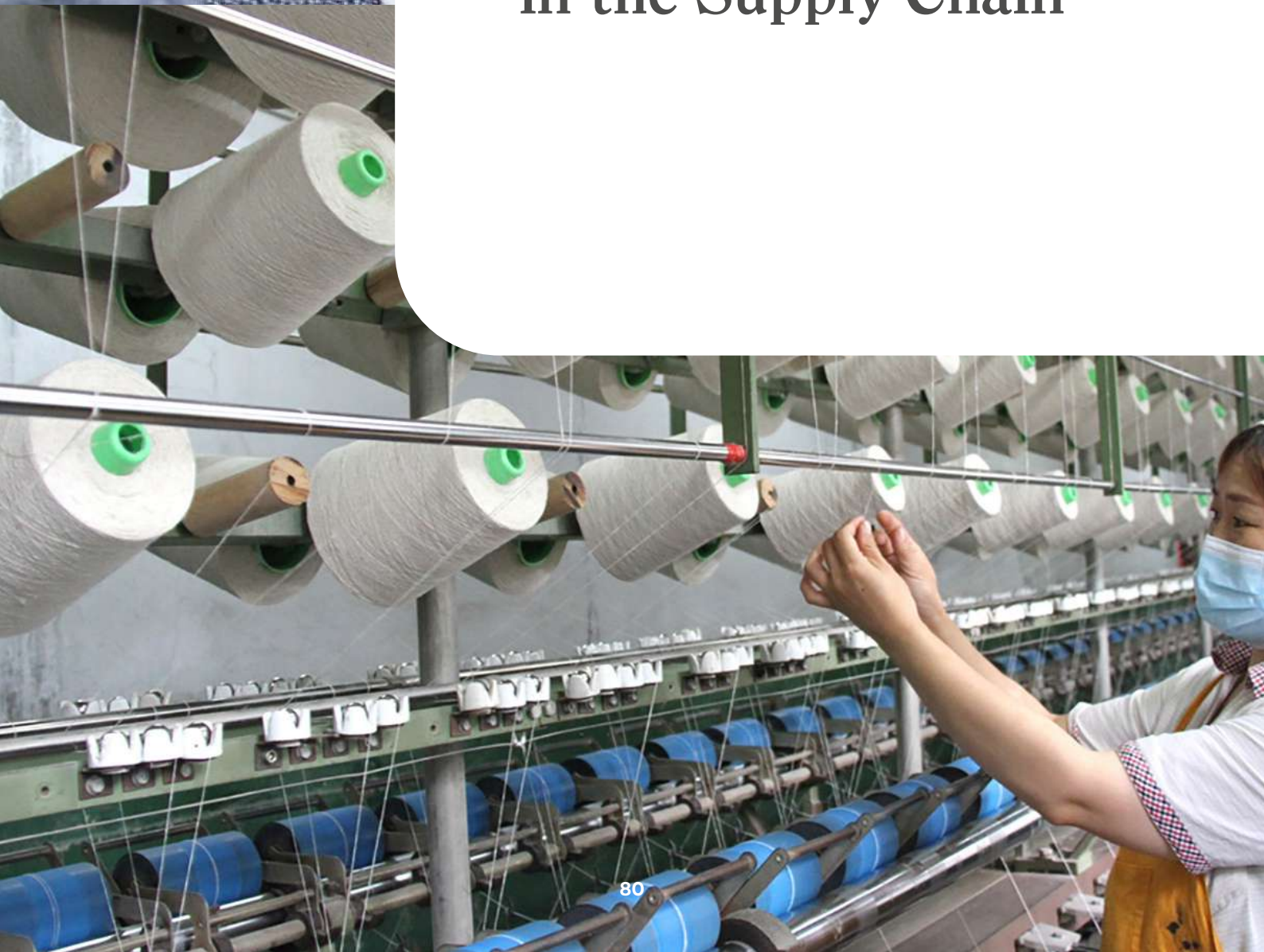
<https://www.investopedia.com/terms/r/radio-frequency-identification-rfid.asp>

Digital Platforms for supplier communication:

<https://www.cooperatextil.com/en>



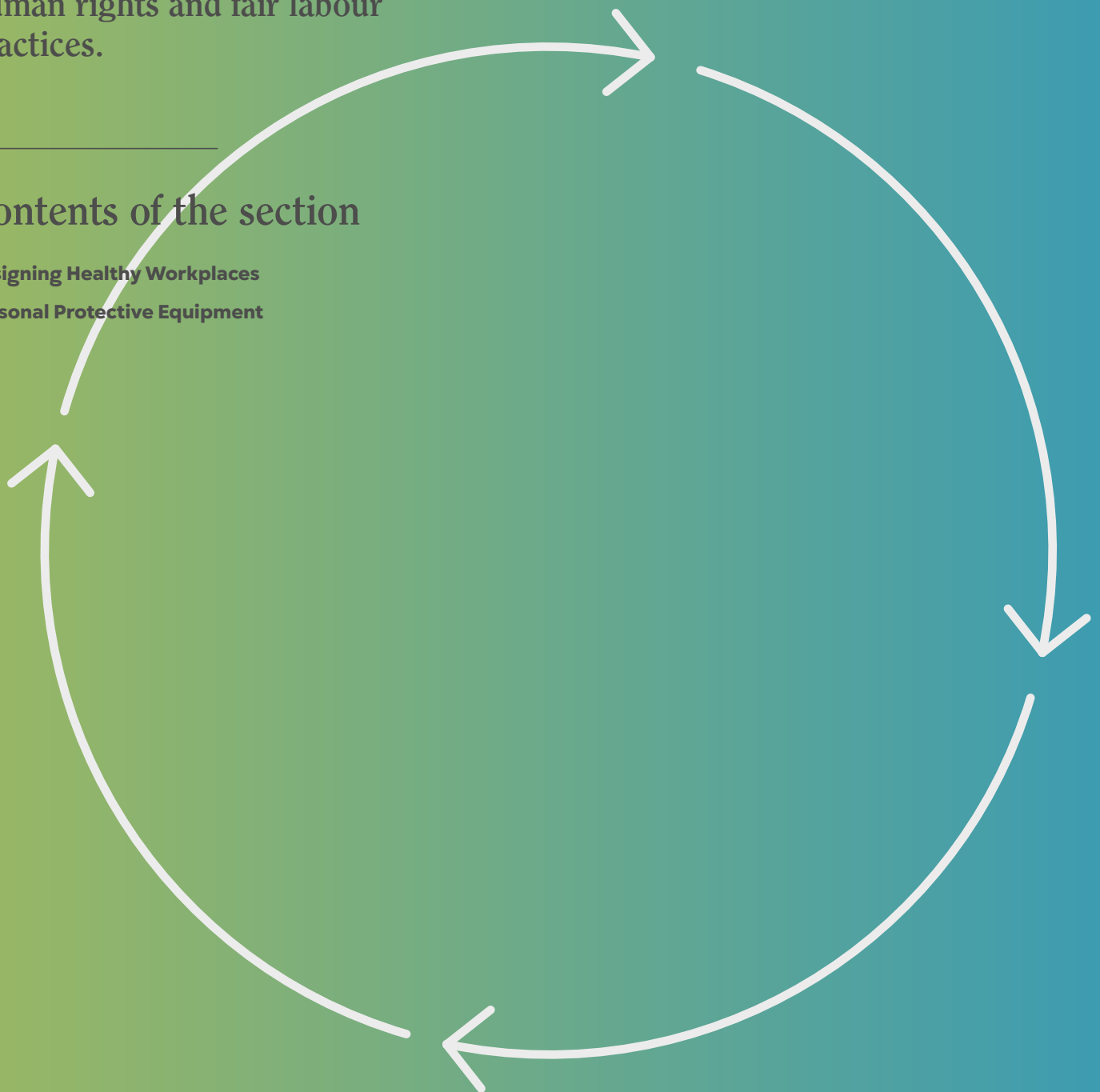
06. Labour conditions in the Supply Chain



Ensuring ethical labour conditions within the textile supply chain is an imperative responsibility for the industry including labour conditions, human rights, freedom of association and health and safety while exploring key challenges, methodologies for improvement, and the adoption of advanced technologies to uphold human rights and fair labour practices.

Contents of the section

Designing Healthy Workplaces
–
Personal Protective Equipment



Designing Healthy Workplaces

Creating healthy workplaces in the textile industry is a technical challenge that demands a comprehensive approach. Manufacturers and producers will have to explore innovative methodologies and technologies aimed at designing environments that prioritize the physical and mental well-being of workers, enhance productivity, and foster a sustainable and thriving textile industry.

Ergonomic Workstations:

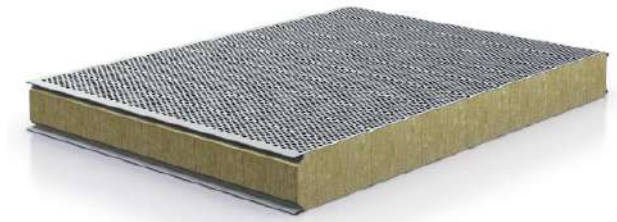
Designing ergonomic workstations is a fundamental technical aspect of creating a healthy workplace. This involves engineering workstations to accommodate the physical needs of workers, considering factors such as proper lighting, adjustable seating, and equipment positioning. Utilizing ergonomic design principles enhances worker comfort, reduces the risk of musculoskeletal disorders, and improves overall productivity.

Ventilation Systems:

Implementing advanced ventilation systems is crucial for maintaining air quality in textile facilities. Technical solutions, such as high-efficiency particulate air (HEPA) filters and air exchange systems, mitigate exposure to airborne particles and ensure a healthy indoor environment. Monitoring air quality in real-time through IoT sensors contributes to a safer workplace.

Natural Lighting Optimization:

Optimizing natural lighting in textile workplaces is a technical strategy that positively impacts both physical and mental well-being. Utilizing smart sensors and automated shading systems ensures that workspaces receive optimal natural light, reducing eye strain and enhancing the overall mood and productivity of workers.



Noise Reduction Technologies:

Noise reduction technologies play a technical role in mitigating the impact of noise in textile facilities. Implementing sound-absorbing materials, noise barriers, and utilizing noise-cancelling technologies contribute to a quieter and healthier work environment.

Health Monitoring:

Health monitoring involves the implementation of systems to assist workers in the early detection of health issues. By implementing health monitoring systems, the facilities will also be able to minimize work absenteeism and improve efficiency due to the workers being in their complete capability of developing their jobs.

Occupational Health and Safety:

Occupational health and safety provide a technical platform for workers to access relevant information and report concerns. This system can include guidance on proper lifting techniques, reminders for breaks, and reporting mechanisms for unsafe conditions. The technical integration of such systems ensures that workers have immediate access to resources that support their well-being.

Temperature Control Systems:

Maintaining optimal temperatures in the workplace is a technical necessity for worker comfort and safety. Advanced temperature control systems, including smart thermostats and climate monitoring, contribute to creating a conducive work environment. Ensuring temperature regulation is particularly crucial in textile facilities with varying manufacturing processes.

Training programs:

Training programs provide a technical solution for educating workers on proper ergonomics and workplace safety. These programs allow workers to experience and address potential ergonomic challenges in a controlled environment, enhancing their understanding and reducing the risk of injuries.

Personal Protective Equipment

In the textile sector, the safety and well-being of workers are paramount. Personal Protective Equipment (PPE) plays a crucial role in ensuring that employees are adequately protected from potential hazards in the workplace.



Respiratory Protection:

The textile sector often involves processes that generate dust, fibres, or particulate matter, posing respiratory hazards. Technical advancements in respiratory protection include the use of N95 respirators or higher-grade masks with efficient filtration capabilities. Powered air-purifying respirators (PAPRs) provide an additional layer of protection, ensuring that workers breathe clean air in environments with airborne contaminants.

Eye and Face Protection:

Eye and face protection are critical in textile facilities where workers may be exposed to flying particles, chemicals, or intense light. Safety goggles with anti-fog coatings, face shields, and welding helmets equipped with auto-darkening features are technical solutions that enhance visibility and protect workers' eyes and faces during various textile processes.

Hearing Protection:

Noise is a common occupational hazard in textile manufacturing. Technical advancements in hearing protection include earmuffs and earplugs designed to attenuate specific frequencies while allowing workers to communicate effectively. Noise-canceling technologies integrated into earmuffs further contribute to a safer and more comfortable work environment.

Hand Protection:

Textile workers often handle machinery, fabrics, and chemicals, necessitating effective hand protection. Technical innovations in gloves include cut-resistant materials, chemical-resistant coatings, and touchscreen-compatible designs. Tailoring gloves to specific tasks ensures that workers have the dexterity required for their roles while mitigating potential risks.

Body Protection:

Textile processes may involve exposure to chemicals, heat, or flames. Technical advancements in body protection include flame-resistant clothing, chemical-resistant suits, and heat-reflective materials. These garments are designed to provide a barrier against specific hazards while maintaining comfort and allowing for ease of movement.

Foot Protection:

The textile industry often involves heavy machinery and materials handling, making foot protection crucial. Technical considerations for footwear include steel-toe boots, puncture-resistant soles, and slip-resistant features. Innovations in materials and design ensure that workers' feet are protected from various workplace hazards.

Fall Protection:

In facilities where working at heights is common, fall protection is imperative. Technical solutions include harness systems, self-retracting lifelines, and shock-absorbing lanyards.

Heat Stress Management:

In environments with elevated temperatures, heat stress becomes a concern. Technical advancements in cooling vests, moisture-wicking fabrics, and personal cooling systems help manage heat stress. These innovations enhance worker comfort and reduce the risk of heat-related illnesses.

Chemical Hazard Management:

Textile processes often involve the use of various chemicals. Technical considerations for chemical hazard management include chemical-resistant PPE, such as aprons, suits, and gloves made from specialized materials. Implementing color-coded systems for PPE helps easily identify the level of protection required for specific chemicals.

Best practices recommendations

Recommended practices:

It is recommended to implement ergonomic workstations.

–

It is recommended to implement ventilation systems in facilities.

–

It is recommended to implement natural light optimization systems.

–

It is recommended to implement noise reduction technologies.

–

It is recommended to implement health monitoring systems.

–

It is recommended to implement occupational health and safety programmes.

–

It is recommended to implement temperature control systems.

–

It is recommended to implement training programs.

–

It is recommended to implement the use of respiratory protection.

–

It is recommended to implement the use of eye and face protection.

–

It is recommended to implement hearing protection.

–

It is recommended to implement hand protection.

–

It is recommended to implement body protection.

–

It is recommended to implement foot protection.

–

It is recommended to implement fall protection in high areas.

–

It is recommended to implement heat stress management systems y high temperature areas.

–

It is recommended to implement chemical hazard management systems.

It is recommended for the facilities to be audited according to an official standard of international reputation.

Resources:

SA8000:

<https://sa-intl.org/programs/sa8000/>

GB STANDARDS:

<https://www.gbstandards.org/>

AMFORI- BSCI;

<https://www.amfori.org/en/solutions/social/amfori-bsci>

SEDEX SMETA:

<https://www.sedex.com/solutions/smeta-audit>

WRAP:

<https://wrapcompliance.org/>

Higg FEM & FSLM:

<https://cascale.org/tools-programs/higg-index-tools/facility-tools/>

Ethical Trading initiative;

<https://www.ethicaltrade.org/i>

Fair Wear Foundation;

<https://www.fairwear.org/>

The Common Framework

for Responsible Purchasing Practices;

<https://www.cfrpp.org/the-common-framework>



07. Conclusions



Main Conclusions

Taking into consideration all that has been included in this manual on Best practices in circular economy the textile industry, it is evident that the pursuit of sustainability and circular economy principles is crucial for the sector's long-term viability. The purpose of this manual was to provide comprehensive insights into BAT, addressing the challenges, regulations, and strategies essential for fostering a more sustainable textile industry.

The manual began by highlighting the significance of BAT in the textile industry related with the Circular Economy strategies. Recognizing the current challenges, including environmental impact and resource depletion, underscored the urgency for adopting BAT and Circular Economy strategies to drive positive change. The industry's commitment to circular strategies and innovative business models was identified as a transformative approach.

The document's structure was designed to guide stakeholders through critical aspects, including circular economy strategies, regulatory considerations, and practical techniques for minimizing environmental impact. Strategies for transitioning to a circular economy model were outlined, with a particular emphasis on preventing pollution, resource recovery, extending resource use, and increasing resource utilization rate.

In embracing best practices, recommendations and adopting circular economy strategies, the textile industry has the potential to redefine its role in sustainability. By implementing the outlined techniques and strategies, stakeholders can contribute to a circular and responsible future. The manual serves as a valuable resource for navigating the complexities of sustainable textile production, fostering collaboration, and guiding the industry toward a more environmentally conscious and economically viable path.

Future Perspectives in the Textile Sector

The textile sector is standing at the cusp of transformative change, driven by a growing awareness of environmental concerns, changing consumer preferences, and technological advancements. As we look ahead, several key perspectives shape the future of the textile industry, pointing towards sustainability, innovation, and a more circular approach.

The future of the textile sector is undeniably linked to sustainability. The industry is witnessing a paradigm shift where sustainable practices are no longer viewed as a volunteer matter but are becoming standard operating procedures. From raw material selection to production processes, an increasing number of businesses are integrating sustainable practices, driven by both regulatory pressures and a genuine commitment to environmental stewardship.

Circular economy principles are set to play a pivotal role in the future of textiles. Strategies such as zero waste practices, upcycling, and closed-loop systems are gaining traction. The focus is not only on producing garments but on designing products with the end of life in mind, ensuring materials can be continuously reused, recycled, or repurposed. This approach aligns with broader global efforts to reduce waste and promote resource efficiency.

On the other hand, it has to be taken into account that the textile sector is embracing Industry 4.0, incorporating advanced technologies such as artificial intelligence and automation. Smart manufacturing processes are enhancing efficiency, reducing waste, and enabling more precise control over production. Digitalization is not only optimizing supply chains but also facilitating customization, allowing for more personalized and sustainable products.

For last, consumers are becoming increasingly mindful of the environmental impact of their choices. The future textile sector will witness a more informed and eco-conscious consumer base, demanding transparency, ethical practices, and sustainable products, especially after the implementation of the digital product passport that will be required by law in the European Union. Brands that successfully align with these values will likely gain a competitive edge in the market.

In conclusion, the future perspectives in the textile sector are shaped by a dynamic interplay of sustainability, technology, and consumer-driven values. By embracing innovation, circular economy principles, and ethical practices, the textile industry has the potential to not only survive but thrive in an era where environmental consciousness and social responsibility are integral to success. The future promises a more sustainable, innovative, and resilient textile sector.

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