

Emerging skills for Circular Sustainable BioEconomy in the Footwear and Apparel Industry

The transition toward a Circular Sustainable BioEconomy in the footwear and apparel industry is not only a technological and environmental shift, but fundamentally a transformation of skills, knowledge systems, and workforce dynamics. As global pressures reshape production and consumption patterns, the Textile, Clothing, Leather, and Footwear (TCLF) sectors are entering a decisive decade in which adaptability and innovation will determine long-term resilience and competitiveness.

Drawing on insights from the Summary of the Annual Report on Skills Intelligence (2025) developed within the Metaskills4TCLF project, a comprehensive picture emerges of an industry in transition. This transformation is driven by interconnected forces: demographic changes that challenge knowledge continuity, rapid digitalisation redefining production processes, increasingly stringent sustainability regulations, and evolving consumer expectations centred on transparency and environmental responsibility.

At the same time, significant skills gaps threaten to slow this transition. The demand for advanced digital capabilities, sustainability-oriented competences, and new hybrid professional profiles is growing faster than the current education and training systems can supply. These challenges are further nuanced by regional differences across Europe and by sector-specific dynamics within textiles, clothing, leather and footwear.

Looking ahead, the TCLF ecosystem faces both uncertainty and opportunity. External pressures such as geopolitical instability and rising costs intersect with an accelerated pace of industrial transformation, requiring a proactive and coordinated response from stakeholders. In this context, strategic action in education, industry collaboration, and policy support becomes essential to ensure a just and effective transition.

The following sections outline the key dimensions of this transformation—ranging from the main drivers of change and existing skills gaps to regional insights, future risks, and strategic recommendations—providing a structured overview of the emerging skills landscape shaping the Circular Sustainable BioEconomy in the footwear and apparel industry, based on the [Annual Report on Skills Intelligence \(2025\)](#) regarding the Textile, Clothing, Leather, and Footwear (TCLF) sectors developed and presented in Metaskills4TCLF project

Therefore, the Annual Report on Skills Intelligence (2025) from the Metaskills4TCLF project is covering all five topics:

1. Core Drivers of Change

The TCLF sectors are being transformed by several powerful forces:

- Demographic Shifts: A "very high" impact from an aging workforce and insufficient generational renewal is a primary driver.
- Digitalisation: The rapid adoption of AI, additive manufacturing (3D printing), and digital design tools is essential for staying competitive.

- **Sustainability & Regulation:** New EU frameworks, such as the Ecodesign for Sustainable Products Regulation (ESPR), Anti-Deforestation Regulation (EUDR), and the implementation of Digital Product Passports, are forcing a shift toward circular models.
- **Consumer Demand:** Increasing eco-awareness, particularly among youth, is driving the need for transparent, high-quality, and traceable products.

2. The Skills Gap

The workforce currently faces critical shortages in key areas:

- **Digital Skills:** Many organisations report a moderate to significant gap, with up to 50% of the workforce requiring advanced digital training.
- **Sustainability Competencies:** There is a widespread need for training in waste management and sustainable material selection, yet these are currently only "moderately integrated" into most educational programmes.
- **Generational Knowledge Loss:** The sector faces a critical lack of specialised technical skills as experienced workers retire without sufficient new talent entering the field.
- **Niche Roles:** There is a notable shortage of specialised figures like Supply Chain Auditors capable of monitoring compliance with new environmental standards.

3. Sector and Regional Insights

- **Southern Europe (Spain, Italy, Portugal):** These regions report higher concern regarding the ageing workforce and express a stronger need for future skills to protect prestigious "Made in" labels.
- **Northern Europe (Sweden, Germany):** These countries benefit from robust vocational education (VET) systems and better collaboration between industry and academia.
- **Clothing & Textiles:** Focus is heavily on luxury niche markets, product longevity, and digital traceability to combat fast fashion.
- **Footwear & Leather:** These sectors are most affected by the retirement wave and are focusing on circularity and repositioning leather as a sustainable, food-industry by-product.

4. Key Threats and Future Outlook

- **Geopolitical & Economic Instability:** Rising energy and raw material costs, coupled with trade barriers (e.g., U.S. tariffs) and market uncertainty, threaten stability.
- **Rapid Transformation:** Over 50% of jobs in the sector are expected to require entirely new digital or sustainability-related skills within just five years.
- **Long-term Outlook:** Stakeholders anticipate a significant or complete transformation of the TCLF industry over the next 5-10 years.

5. Strategic Recommendations

To ensure future resilience, the report recommends:

- **Modernise Curricula:** Embed AI, automation, and circular economy practices into VET and Higher Education programs.
- **Rebrand the Sector:** Launch targeted campaigns to showcase the industry as modern, tech-driven, and sustainable to attract younger talent.

- **Support SMEs:** Provide financial incentives and technical assistance to help smaller firms adopt Digital Product Passports and digital tools.
- **Foster Alliances:** Create closer cooperation between industry, education providers, and public authorities to co-develop curricula that align with real-world needs.

The emerging skills landscape within the footwear and apparel sectors clearly reflects a profound paradigm shift toward circularity, sustainability, and systemic innovation. As highlighted in the Metaskills4TCLF Skills Intelligence Report (2025), the future competitiveness of the industry will depend not only on adopting new technologies, but on embedding sustainability principles across the entire product lifecycle—from design and material selection to production, supply chain management, and regulatory compliance. At the core of this transformation lies a redefinition of design practices, where eco-design approaches such as durability, zero-waste construction, and design for disassembly become essential rather than optional. In parallel, the transition toward bio-based and recycled materials signals a decisive move away from resource-intensive and fossil-based inputs, requiring new technical knowledge and material literacy across the workforce.

Equally important is the evolution of production and supply chain practices, where eco-efficiency, waste valorisation, and transparent auditing mechanisms are becoming standard requirements. The growing integration of digital tools—particularly in traceability systems such as Digital Product Passports and methodologies like Life Cycle Analysis—further demonstrates how digitalisation and sustainability are increasingly intertwined. These shifts are not uniform across the sectors. Footwear, apparel, and leather each face distinct challenges and opportunities, shaped by their material complexity, production processes, and market positioning. However, they converge on a common need: to develop a workforce equipped with hybrid skillsets that combine technical expertise, environmental awareness, and regulatory understanding.

Ultimately, the emergence of these competencies signals more than a skills upgrade—it represents a structural transformation of the TCLF ecosystem. Ensuring that education, training systems, and industry practices evolve in alignment with these needs will be critical to enabling a resilient, competitive, and truly circular sustainable bioeconomy in the years ahead.

According to the same report, the emerging skills and competencies identified across the sectors are then categorised into design, material management, and regulatory compliance as follow:

1. Sustainable and Circular Design (Eco-Design)

Design is highlighted as the most critical stage for enabling product "life extension" and recyclability.

- **Durability and Longevity:** Developing products that maximise durability and reliability to counteract the "fast fashion" model.
- **Zero-Waste Construction:** Using creative pattern-making and tailoring techniques that eliminate resource waste during production.

- **Design for Disassembly:** Creating products that allow for the easy separation of components (e.g., separating mixed fibres or shoe soles) to facilitate repair or recycling at the end of their life cycle.
- **Upcycling:** The ability to treat mountains of clothing waste as "islands of treasures" by repurposing existing materials into high-value products.

2. Bio-Based and Sustainable Materials

The industry is shifting away from synthetic, plastic-based materials toward natural and renewable alternatives.

- **Selection of Sustainable Raw Materials:** Knowledge of certified, sustainably sourced materials (e.g., organic fibres, technical hemp) to reduce the risk of deforestation and soil contamination.
- **Bio-based Alternatives:** Expertise in using and developing biological origin products and "biodegradable leather" alternatives.
- **Recycled Material Integration:** Managing the inclusion of recycled content in new products while maintaining quality standards.

3. Eco-Efficient Production and Supply Chain

Companies are pressured to adopt "green manufacturing" methods that reduce their carbon and water footprints.

- **Resource Management:** Skills in minimising water consumption and greenhouse gas emissions, particularly in energy-intensive processes like tanning and textile finishing.
- **Waste Valorisation:** Implementing "closed-loop" models where production by-products are reused rather than discarded.
- **Sustainable Supply Chain Auditing:** A growing need for "Supply Chain Auditors" capable of monitoring compliance with environmental and labour standards across global production networks.

4. Traceability, Compliance, and Management

Digital tools are becoming inseparable from circularity to ensure radical transparency.

- **Digital Product Passports (DPP):** Skill in implementing and managing DPPs to guarantee a product's traceability, sustainability, and origin for consumers and regulators.
- **Life Cycle Analysis (LCA):** The ability to use specialised tools and methodologies to assess the total environmental impact of a product from "cradle to grave".
- **Regulatory Risk Management:** Understanding and navigating evolving EU legislation, such as the Ecodesign for Sustainable Products Regulation (ESPR) and Anti-Deforestation Regulations.

Sector-Specific Insights

- **Footwear:** The complexity of shoe materials makes circularity challenging. Emerging skills focus on recycling, reparability, and rental/resale business models to extend product life.
- **Apparel:** There is a strong emphasis on slow-fashion trends and the adoption of "zero waste" techniques in construction.

- Leather: Skills focus on repositioning leather as a high-quality, long-lasting circular material that valorises by-products from the food industry.

To address these gaps, the report recommends that vocational and higher education institutions modernise curricula by embedding these sustainability competencies - specifically eco-design and circular economy practices - into all training programmes. Effectively embedding sustainability competencies into education and training systems requires a shift from isolated modules to a fully integrated, practice-oriented learning approach. Eco-design and circular economy principles should be incorporated across all stages of curricula, combining theoretical knowledge with hands-on, project-based learning that reflects real industry challenges. This includes the use of case studies, digital tools such as Life Cycle Analysis, and collaboration with companies to expose learners to practical applications like sustainable material selection, design for disassembly, and traceability systems.

Equally important is strengthening partnerships between vocational education and training (VET) providers, higher education institutions, and industry stakeholders to ensure that programmes remain aligned with rapidly evolving market and regulatory demands. Continuous upskilling opportunities, micro-credentials, and interdisciplinary learning pathways can further support both new entrants and the existing workforce. By embedding these competencies holistically, education systems can play a decisive role in equipping professionals with the skills needed to drive the transition toward a circular and sustainable bioeconomy in the footwear and apparel sectors.