CONSOLIDATED CROSS-NATIONAL ASSESSMENT OF AI IMPLEMENTATION IN THE FASHION AND TEXTILE SECTOR

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Chapter 1 – Introduction

The fashion and textile sector is undergoing a profound transformation driven by the combined pressures of digitalisation, environmental sustainability, and regulatory reform. As one of the most resource-intensive and globalised industries, fashion faces persistent challenges related to overproduction, waste generation, opaque supply chains, labour conditions, and environmental degradation (European Commission, 2022a). In response, the European Union has increasingly positioned circular economy principles and digital innovation—particularly Artificial Intelligence (AI)—as key enablers of a more sustainable, resilient, and competitive textile and clothing ecosystem (European Commission, 2020; Ellen MacArthur Foundation, 2019).

Against this backdrop, the TechStyle project (AI-Driven Circular and Regenerative Fashion in VET Education) has been developed under the Erasmus+ KA220-VET – Cooperation Partnerships in Vocational Education and Training framework. The project addresses a critical skills and knowledge gap at the intersection of AI technologies, circular fashion practices, and vocational education and training (VET). While AI is rapidly being adopted across the fashion value chain—from design and trend forecasting to logistics, resale platforms, and recycling—its integration remains uneven, particularly among small and medium-sized enterprises (SMEs) and within VET systems (OECD, 2021; European Commission, 2023a). At the same time, new EU digital regulations are

reshaping the conditions under which AI-driven solutions can be developed and deployed responsibly.

This report constitutes Work Package 2 (WP2) of the TechStyle project and focuses on the assessment of national existing practices and industry advancements related to AI-driven circular and regenerative fashion. Its primary objective is to provide an evidence-based overview of the policy, regulatory, technological, and educational landscape shaping AI adoption in the fashion and textile sector across the participating countries: France, Sweden, Greece, Italy, Spain, and Türkiye. By mapping existing frameworks and practices, the report establishes the analytical foundation for subsequent project outputs, including curriculum development, skills frameworks, and pilot VET interventions.

The scope of the report is intentionally multidisciplinary. It integrates legal analysis, policy review, technological mapping, and skills-oriented insights, reflecting the complexity of the ecosystem in which AI-enabled circular fashion operates. Particular emphasis is placed on regulatory literacy, as compliance with EU digital legislation increasingly constitutes a prerequisite for innovation, market access, and workforce readiness. In this sense, regulation is approached not as a constraint but as a structuring force guiding trustworthy, transparent, and human-centric AI adoption (European Union, 2024a).

Chapter 2 examines the EU AI regulatory framework relevant to the fashion and textile sector, focusing on horizontal legislation that directly or indirectly governs AI deployment. This includes the General Data Protection Regulation (GDPR), the Digital Markets Act (DMA), the Digital Services Act (DSA), the Cyber Resilience Act (CRA), and the Artificial Intelligence Act (AI Act). Together, these instruments define obligations related to data governance, algorithmic transparency, cybersecurity, platform accountability, and risk-based AI management (European Union, 2016; European Union, 2022a; European Union, 2022b; European Union, 2024a; European Union, 2024b). The chapter also considers the proposed AI Liability Directive (AILD) and its relevance for accountability and redress in AI-enabled systems (European Commission, 2022b).

Chapter 3 provides a comparative overview of national AI policies, strategies, and legal adaptations in the partner countries. While aligned with EU-level frameworks, national approaches reflect differing governance traditions, industrial priorities, and levels of digital maturity (European Commission AI Watch, 2024). The chapter highlights how AI policy is embedded within broader strategies for innovation, sustainability, and industrial transformation, and how these strategies shape AI adoption in the fashion and textile sector.

Chapter 4 maps EU platforms and research and innovation initiatives supporting AI applications for circular fashion, including data spaces, digital twin infrastructures, AI excellence networks, and textile-specific innovation projects. These initiatives illustrate

how EU-level ecosystems enable experimentation, interoperability, and cross-sector collaboration in support of circular economy objectives (European Commission, 2023b).

Chapter 5 focuses on practical AI tools relevant to circular fashion skills development, identifying representative technologies used across the value chain. Rather than offering an exhaustive inventory, the chapter highlights tools that demonstrate concrete applications of AI in circular design, production optimisation, traceability, and consumer engagement, with direct relevance for VET learners and SMEs (OECD, 2021).

Chapter 6 presents national case studies illustrating real-world industry applications of AI-driven circular fashion. These examples demonstrate how AI is operationalised within different regulatory and market contexts, highlighting both opportunities and challenges related to compliance, data governance, and workforce capacity (European Commission, 2023a).

Chapter 7 reviews existing VET and higher education programmes addressing AI, circular fashion, and sustainable textiles. The analysis identifies gaps between current educational provision and emerging industry needs, reinforcing the rationale for targeted VET-oriented curriculum development within the TechStyle project (Cedefop, 2020).

Finally, Chapter 8 synthesises the main findings and outlines key conclusions, linking the analytical insights of WP2 to the next implementation phases of the project.

Methodologically, the report is based on desk research, analysis of EU and national policy documents, review of legal frameworks, and mapping of existing tools, platforms, and educational programmes. While not intended as a legal opinion or market forecast, it provides a structured reference for VET providers, trainers, SMEs, policymakers, and other stakeholders involved in the digital and circular transformation of the fashion and textile sector.

By situating AI-driven circular fashion within a coherent regulatory, technological, and educational framework, this report supports the overarching ambition of TechStyle: to equip the VET ecosystem with the knowledge and competences required for responsible, compliant, and sustainable AI adoption in one of Europe's most strategically significant industries.

Chapter 2 – EU AI Regulatory Framework for the Fashion & Textile Sector

The rapid integration of Artificial Intelligence (AI) into the fashion and textile sector takes place within an increasingly dense and interconnected EU regulatory environment. Although most EU digital regulations are horizontal in nature and not sector-specific, they collectively shape the legal conditions under which AI systems can be designed, deployed, and scaled across textile and fashion value chains. This chapter provides an

overview of the key EU legislative instruments governing data protection, digital markets, digital services, cybersecurity, and artificial intelligence, and examines their relevance for AI-driven applications in the fashion and textile sector. By outlining the scope and implications of these frameworks, the chapter establishes the regulatory foundation necessary for understanding compliant, responsible, and sustainable AI adoption in the context of circular and regenerative fashion (European Union, 2016; European Union, 2022a; European Union, 2024a).

Regulation (EU) 2016/679 – General Data Protection Regulation (GDPR)

The General Data Protection Regulation (GDPR) constitutes the core legal framework governing the processing of personal data of natural persons within the European Union. Its primary objective is to safeguard the fundamental right to privacy while simultaneously ensuring the free movement of personal data across the EU internal market (Regulation (EU) 2016/679). The regulation establishes a harmonised set of rules applicable across all Member States and sectors, creating a common standard for data protection and accountability.

At the heart of the GDPR lies a set of fundamental principles that must guide all personal data processing activities. These include lawfulness, fairness, and transparency, as well as purpose limitation, data minimisation, accuracy, storage limitation, and integrity and confidentiality. In parallel, the regulation grants individuals strong and enforceable rights

over their personal data, such as the right to be informed about data processing activities, the right of access and rectification, and the right to erasure, commonly referred to as the “right to be forgotten” (Regulation (EU) 2016/679). To ensure effective implementation, the GDPR imposes strict obligations on data controllers and processors, including the adoption of appropriate technical and organisational security measures, the application of data protection by design and by default, and the ability to demonstrate compliance through robust accountability mechanisms.

As a horizontal regulation, the GDPR applies fully to the fashion and textile sector whenever companies process personal data relating to individuals residing in the EU, regardless of where the company itself is established. This is particularly relevant for the sector, which relies extensively on consumer data across multiple business functions. Personal data such as customer names, contact details, browsing behaviour, purchase history, and size or fit preferences are commonly used for personalised marketing, demand forecasting, and trend analysis. Under the GDPR, each of these processing activities must be grounded in a lawful basis, such as explicit consent or legitimate interest, and communicated clearly to data subjects (Regulation (EU) 2016/679).

The global nature of the fashion industry further increases the relevance of GDPR compliance, particularly regarding cross-border data processing. International fashion brands must ensure that any transfer of personal data outside the EU is subject to appropriate safeguards, such as adequacy decisions or standard contractual clauses, to guarantee an equivalent level of data protection (Regulation (EU) 2016/679). In

addition, the sector's transition towards more sustainable and circular business models—such as rental, resale, repair, and take-back schemes—has led to the generation of new and more complex data streams. When product tracking data, including information collected through digital product passports or reverse logistics systems, can be linked to identifiable individuals, the GDPR requires the application of privacy-by-design principles and the collection of clear and informed consent (European Commission, 2020).

The regulation also has significant implications for the adoption of advanced digital technologies, particularly Artificial Intelligence (AI), which is increasingly used in the fashion sector across design processes, as well as marketing and sales funnel management. The GDPR explicitly addresses profiling and automated decision-making, granting individuals the right to object to profiling activities and the right not to be subject to decisions based solely on automated processing when such decisions produce legal or similarly significant effects. In practice, this means that AI-driven systems used for customer segmentation, pricing, creditworthiness, or personalised offers cannot operate in a fully autonomous manner without appropriate safeguards, transparency, and meaningful human oversight (Regulation (EU) 2016/679).

AI-driven tools frequently used in fashion retail, such as virtual fitting rooms and augmented reality try-on solutions, often rely on biometric data, including facial features and body measurements. Under the GDPR, biometric data is classified as a special category of personal data and therefore requires explicit consent and enhanced

safeguards. Furthermore, the principle of fairness requires fashion brands to ensure that AI systems trained on personal data do not produce discriminatory or biased outcomes. This necessitates regular auditing of algorithms and training datasets to ensure diversity and representativeness, for example in relation to body types, gender, or skin tones (European Data Protection Board, 2022).

From a data governance perspective, the GDPR introduces strong accountability requirements that directly affect how fashion companies design and manage their digital systems. When introducing high-risk processing activities—such as AI systems that rely on large-scale personal or sensitive data—companies are often required to conduct a Data Protection Impact Assessment (DPIA) to identify and mitigate potential risks to data subjects' rights and freedoms (Regulation (EU) 2016/679). Accuracy and transparency obligations further imply that human oversight remains essential, particularly when generative or predictive AI tools are used, as responsibility for the correctness of outputs ultimately lies with the data controller. Brands must therefore be transparent about how personal data is used to train AI systems and ensure that inaccurate or outdated data does not lead to harmful outcomes.

Finally, the GDPR requires all digital systems, including AI platforms and supply chain digitalisation tools, to be developed and implemented in accordance with the principles of data protection by design and by default. This means that privacy and security considerations must be embedded into the technical architecture of systems from the outset, rather than added retrospectively. For the fashion and textile sector, this

obligation reinforces the need for integrated data governance strategies that support innovation, sustainability, and circularity while maintaining full compliance with EU data protection standards (Regulation (EU) 2016/679).

Regulation (EU) 2022/1925 - Digital Markets Act (DMA)

The primary purpose of the Digital Markets Act, as defined in Article 1 of Regulation (EU) 2022/1925, is to "contribute to the proper functioning of the internal market by laying down harmonised rules ensuring for all businesses, contestable and fair markets in the digital sector across the Union where gatekeepers are present." This proactive, rules-based approach stands in contrast to traditional competition law, such as Articles 101 and 102 of the Treaty on the Functioning of the European Union (TFEU). While competition law acts *ex-post* to penalize established anti-competitive behavior, often after extensive and complex investigations, the DMA imposes upfront obligations to prevent such harmful practices from occurring in the first place. Its objective is not merely to protect undistorted competition but to ensure digital markets remain structurally open and fair.

The DMA's regulations are targeted at a specific category of large digital platforms designated as 'gatekeepers'. A gatekeeper is defined as an undertaking that has a significant impact on the internal market, operates a core platform service that serves as an important gateway for business users to reach end users, and enjoys an entrenched and durable position in its operations.

To ensure objectivity, the DMA establishes clear quantitative thresholds for a company to be presumed a gatekeeper.

Criterion	Threshold
Size & Reach	Annual Union turnover of at least €7.5 billion OR market capitalization of at least €75 billion.
User Base	At least 45 million monthly active end users in the Union.
Business User Base	At least 10,000 yearly active business users in the Union.
Durability	Meeting the user thresholds for at least three consecutive years.

Since the initial designations in September 2023, the European Commission has continuously updated the list of gatekeepers and their specific core platform services. As of 2024, the list includes Alphabet, Amazon, Apple, ByteDance (TikTok), Meta, Microsoft, and Booking.com. It is also important to note that specific operating systems, such as iPadOS, have been added to the list of regulated services to ensure the rules cover the full breadth of these digital ecosystems.

The DMA imposes a set of clearly defined obligations and prohibitions that gatekeepers must follow. These can be categorized into a "blacklist" of prohibited practices and a "whitelist" of mandatory actions.

Prohibited Practices (Blacklist)	Mandatory Obligations (Whitelist)
• Combine personal data from different services without explicit user consent (Article 5.2). • Prevent business users from offering different prices or conditions on other sales channels (Article 5.3). • Restrict business users from promoting offers and concluding contracts with customers acquired via the gatekeeper's platform (Article 5.4). • Require business users or end users to use the gatekeeper's own identification, payment, or web browser engine services (Article 5.7). • Require users to subscribe to or register with other core platform services as a condition of access (a practice known as tying and bundling) (Article 5.8).	• Allow end users to easily uninstall pre-installed software applications, thereby opening up the digital ecosystem to competing applications (Article 6.3). • Allow the installation and use of third-party software applications or app stores, promoting consumer choice and developer competition (Article 6.4). • Provide advertisers and publishers with daily, transparent information on the price and performance of advertisements, enabling them to verify the value of their ad spend (Articles 5.9 & 5.10). • Grant business users effective, real-time access to the data generated by their activities on the platform, providing brands with direct insight

• Use non-public data generated by business users to compete against them (Article 6.2). • Treat their own services and products more favorably in ranking than those of third parties (a practice known as self-preferencing) (Article 6.5).	into sales performance and customer engagement (Article 6.10). • Ensure interoperability for key hardware and software features with third-party providers, enabling third-party accessories and services to function seamlessly within the gatekeeper's ecosystem (Article 6.7).

The European Commission is the sole authority empowered to enforce the DMA. This centralized enforcement model ensures consistent application of the rules across the Union. The penalties for non-compliance are substantial and designed to be a credible deterrent.

For an initial infringement, a gatekeeper can face a fine of up to 10% of its total worldwide turnover in the preceding financial year. For repeated infringements, this can rise to 20% of its total worldwide turnover. In cases of systematic non-compliance, the Commission can impose structural remedies, such as requiring the divestiture of a part of the business.

This robust framework moves beyond abstract principles to establish concrete rules of engagement, with significant consequences for consumer-facing industries like fashion that rely heavily on these digital gateways.

The Digital Markets Act is not merely a technology regulation; it is a significant commercial framework with direct and tangible consequences for the European fashion and textile industry. For years, fashion brands have navigated a digital ecosystem where a few dominant platforms controlled market access, often imposing restrictive terms. Practices such as self-preferencing and prohibitions on pricing freedom have limited brands' strategic autonomy. The DMA's strategic importance lies in its potential to directly address these challenges and rebalance the commercial relationship between fashion brands and the gatekeeper platforms they rely on.

The DMA has profound implications for fashion e-commerce, as several major platforms where brands sell their products fall under its scope. Most notably, Amazon Marketplace has been formally designated as a gatekeeper. This designation fundamentally alters the power dynamic between such dominant online marketplaces and the thousands of fashion brands, retailers, and small and medium-sized enterprises (SMEs) that operate as their business users. The Act provides these businesses with a new set of rights and protections designed to foster a fairer and more competitive digital environment.

The DMA provides specific, actionable advantages to fashion businesses operating on gatekeeper platforms, addressing long-standing challenges related to pricing, visibility, data access, and competition.

• Strategic Pricing Freedom (Article 5.3): The prohibition on so-called "wide parity clauses" is a major victory for brands. Fashion businesses are now free to implement

differentiated pricing strategies across their various sales channels. For instance, a brand can offer a lower price on its own direct-to-consumer website than on a gatekeeper marketplace like Amazon or Meta Marketplace without facing contractual restrictions or penalties from the platform. This empowers brands to manage their pricing and promotional activities more strategically.

• Fairer Digital Shelves (Article 6.5): The anti-self-preferencing rule is critical for a level playing field. It prevents gatekeepers from unfairly promoting their own private-label fashion products over those of third-party sellers in search results and rankings. Gatekeepers must now apply transparent, fair, and non-discriminatory conditions to ranking, ensuring that a brand's products are judged on their merits rather than being systematically disadvantaged against the platform's own competing offerings.

• Unlocking Customer Insights (Article 6.10): Fashion businesses gain the right to access the valuable, real-time data generated through their activities on a gatekeeper's platform. This includes aggregated and non-aggregated data on customer behavior and transactions related to their products. Access to this data enables brands to improve their business intelligence, refine marketing strategies, optimize product development, and build a more direct understanding of their end customers.

• Protecting Brand Innovation (Article 6.2): The DMA explicitly prohibits gatekeepers from using non-public data generated by their business users to compete against them. This means a platform cannot analyze a fashion brand's private sales data—including information on clicks, searches, and purchase history for its products—to inform the

design, launch, and marketing of a competing private-label product. This safeguard protects the innovation and intellectual capital of fashion sellers.

The DMA's regulatory impact is situated within a broader context of technological disruption in the fashion industry. As the sector continues to adopt digital innovations, including Artificial Intelligence, for functions ranging from supply chain management to customer engagement, its reliance on dominant platforms deepens. The DMA provides a crucial regulatory foundation, ensuring that as these technological shifts occur, the market remains open and competitive, preventing gatekeepers from leveraging their position to stifle innovation from emerging e-commerce models and digital-native brands. This connection is particularly relevant as the DMA includes specific rules governing data management, which directly impacts the development of AI. For the textile sector, this regulatory environment is further shaped by the EU AI Act, which introduces a risk-based framework for AI systems. While the DMA ensures textile brands have fair access to the digital marketplace, the AI Act governs the safety and transparency of the AI tools those brands use for design, marketing, and logistics.

The AI Act introduces three critical requirements for the European clothing industry:

• Transparency in Marketing: Fashion brands using generative AI to create marketing imagery or virtual models must clearly disclose that the content is AI-generated to prevent consumer deception.

• High-Risk Operations Control: AI systems used in textile manufacturing for worker management or in retail for automated recruitment are classified as 'High-Risk', requiring strict data governance and human oversight.

• Prohibited Practices: The use of AI-driven emotion recognition in garment factories or retail environments to monitor employee or customer states is strictly prohibited to protect people's fundamental rights.

The Digital Markets Act's market-shaping rules have a critical and direct connection to the development and deployment of Artificial Intelligence. While not an "AI regulation" in itself, the DMA's provisions on data access, user consent, and algorithmic transparency create profound strategic implications for how gatekeepers can build, train, and deploy AI systems, particularly those integrated into their core platform services.

The DMA is empowered to regulate AI even though "Artificial Intelligence" is not explicitly listed as a 'core platform service'. The DMA High-Level Group, an expert body assisting the Commission, has clarified this scope, stating: "To the extent that such AI systems are embedded into designated core platform services, the DMA obligations apply, and compliance has to be assessed taking into account how AI systems determine the behaviours that are covered by the DMA provisions."

This means that if a gatekeeper uses an AI-powered algorithm for search rankings, content moderation, or ad targeting within a designated service like an online marketplace or social network, that AI system is subject to the DMA's rules. Furthermore, it is foreseeable that some large, general-purpose AI models, such as OpenAI's ChatGPT,

could potentially meet the quantitative thresholds for direct gatekeeper designation in the future.

Article 5.2 is a cornerstone of the DMA's approach to data governance and has profound implications for AI. This rule prohibits gatekeepers from combining and cross-using personal data from different services within their ecosystem without obtaining explicit, freely given user consent. Data is fundamental to developing performant AI systems, and this provision directly restricts the massive data accumulation advantage that has historically fuelled the training of gatekeepers' AI models. By disrupting this automatic data aggregation, Article 5.2 directly targets the primary fuel for gatekeeper AI models, aiming to lower barriers to entry for competitors who cannot access data at a similar scale and thus fostering a more contestable market for AI-driven services.

The strict consent requirements of Article 5.2 have triggered a significant regulatory debate around "pay-or-consent" models. In March 2024, the European Commission launched a formal investigation into Meta's subscription model for Facebook and Instagram, which offers users a choice between consenting to data processing for ads or paying a monthly fee for an ad-free experience. The core issue under review is whether requiring users to pay a fee for the non-tracking service constitutes a genuinely "freely given" choice, as required by the DMA. If the alternative to consent is not a truly equivalent service or is made unduly difficult, it could undermine the DMA's objective of providing users with authentic control over their data. Under the AI Act, this data protection is further emphasized; users must be informed if their data is being used

specifically to train the large-scale models that power the advertising algorithms fashion brands rely on for targeted sales.

Beyond data combination rules, several other DMA provisions are designed to promote fairness and competition in the development and deployment of AI systems.

•Data Portability: AI assistants and services derive immense value from accumulated user data and preferences. Strong enforcement of the DMA's rules on continuous, real-time data portability could enable users to switch between competing AI services (e.g., from one AI assistant to another) while maintaining their synchronized data profiles, memories, and preferences, thereby reducing lock-in effects.

• Algorithmic Transparency: The DMA's mandate for transparent, fair, and non-discriminatory conditions for ranking directly curtails a gatekeeper's ability to use opaque, AI-driven algorithms for self-preferencing. This ensures that algorithmic decision-making does not unfairly disadvantage third-party competitors.

• Profiling Audits: Under Article 15, gatekeepers must submit an independently audited description of their consumer profiling techniques. This includes detailing the data used, the processing applied, and the purpose of the profile. This requirement enhances transparency around the data and logic that feed into AI-driven personalization and advertising systems.

The Digital Markets Act is a key pillar within the EU's broader digital governance framework, designed to operate in tandem with other critical legislation, most notably the AI Act. It is essential to understand their distinct but complementary objectives:

• The Digital Markets Act (DMA) focuses on the economic aspects of fairness and contestability in digital markets. Its goal is to prevent gatekeepers from leveraging their market power in anti-competitive ways.

• The AI Act establishes a complementary risk-based framework addressing the societal risks of AI systems, focusing on protecting health, safety, and fundamental rights. For the textile industry, this means ensuring that AI-driven supply chain optimizations do not infringe on labour rights and that consumer-facing AI (like virtual stylists) operates transparently.

Together, these two regulations form a coordinated ecosystem intended to ensure that the development and deployment of AI in Europe is not only economically fair but also safe, transparent, and aligned with fundamental values. The DMA's role in this partnership is to shape the underlying market structure, fostering a more balanced and innovative digital future for Europe.

The following Table provides a side-by-side comparison of the compliance milestones for the Digital Markets Act (DMA) and the EU AI Act, specifically tailored for a business owner in the textile and clothing industry.

As of early 2026, the regulatory landscape has shifted from "preparation" to "active enforcement.

Compliance Timeline: DMA vs. AI Act (2024–2027)

Milestone Date	Digital Markets Act (DMA)	EU AI Act	Industry Relevance (Textiles)
Aug 2024	Regulation fully in force for the first wave of Gatekeepers.	Entry into Force: Framework officially begins.	Brands must audit data-sharing agreements with Amazon/Google.
Feb 2025	—	Prohibitions Apply: Bans on emotion recognition in workplaces and "unacceptable risk" AI.	Action: Ensure factory floor monitoring doesn't use prohibited biometric/emotion AI.
Aug 2025	Designated gatekeepers (e.g., Booking.com) must comply with data portability.	GPAI Rules: Transparency requirements for General Purpose AI (foundational models).	Marketing teams must verify that AI tools (like ChatGPT/Midjourney) are compliant.

Milestone Date	Digital Markets Act (DMA)	EU AI Act	Industry Relevance (Textiles)
Feb 2026	Current Stage: Commission review of DMA effectiveness and gatekeeper compliance.	Guidelines Issued: EU Commission provides practical examples of "High-Risk" use cases.	Review if your automated supply chain or recruitment tools fall under "High-Risk."
Aug 2026	Ongoing enforcement and updates to the Gatekeeper list.	Major Deadline: Most rules apply, including transparency and Annex III High-Risk systems.	Action: Full transparency for AI-generated ads; high-risk audits for AI-driven HR/hiring.
Aug 2027	—	Product Integration: AI embedded in regulated products (toys, PPE, machinery) must comply.	Relevant for textile companies producing "smart clothing" or wearable tech.

Key takeaways for T&C business owners include the following:

• The "Marketing Transparency" Shift (August 2026). By August 2, 2026, you must comply with Article 50 of the AI Act. If your brand uses AI to generate fashion lookbooks, social

media influencers, or digital "try-on" experiences, these must be explicitly labelled. This prevents consumer deception, a major focus for European consumer protection authorities.

• Employment and HR Algorithms. The AI Act classifies AI used for recruitment, promotion, and termination as "High-Risk" (Annex III). If you use third-party software to filter CVs for retail staff or monitor productivity in garment factories, you must ensure these systems undergo a Conformity Assessment and have human-in-the-loop oversight.

• Data Sovereignty via the DMA. For textile brands selling on Amazon or advertising through Meta, the DMA is your "shield". You now have a legal right to access the data generated by your customers on these platforms. Use this window to migrate customer data into your own CRM systems to reduce "platform lock-in".

• Prohibited Workplace Practices. Since February 2025, it has been illegal to use AI systems that "infer emotions" in the workplace. Textile manufacturers should ensure that any "smart" cameras or wearable sensors used for factory safety are not repurposed to monitor worker sentiment or stress levels, as this could lead to significant fines.

Regulation (EU) 2022/2065 - Digital Services Act (DSA)

The Digital Services Act (DSA), Regulation (EU) 2022/2065, is a cornerstone of the European Union’s digital governance framework, establishing harmonised rules for

online intermediary services, including online platforms, hosting services and digital marketplaces. Unlike the EU Artificial Intelligence Act, which constitutes the only binding and AI-specific regulatory instrument, the DSA focuses on digital services, platform governance and algorithmic accountability within online environments (European Union, 2022). Its primary objectives are to enhance transparency, strengthen accountability, protect users' rights and mitigate systemic risks arising from platform-based business models and algorithmically mediated services.

Although the DSA is not sector-specific, it is particularly relevant to the fashion and textile sector due to the industry's strong dependence on digital platforms, e-commerce, online marketing and data-driven consumer engagement. Fashion brands, retailers, second-hand platforms and emerging circular business models increasingly operate through online marketplaces and digital intermediaries. As a result, many actors in the textile and fashion value chain fall within the scope of the DSA either directly, as platform providers, or indirectly, as business users of regulated digital services (European Commission, 2023).

A central element of the DSA concerns the governance and transparency of recommender systems, which are widely used in digital fashion environments to personalise product listings, rank content and influence consumer purchasing behaviour. These recommender systems are typically powered by AI-based algorithms that analyse user data, preferences and behavioural patterns. Under the DSA, online platforms are required to provide meaningful information on the main parameters

determining the functioning of their recommender systems and to offer users at least one option not based on profiling (European Union, 2022). For the fashion and textile sector, this requirement has direct implications for AI-driven digital merchandising, targeted advertising and consumer experience design, as it reinforces the need for explainability, documentation and human oversight of algorithmic decision-making processes.

From a data management perspective, the DSA introduces strengthened obligations related to risk assessment, traceability and accountability of algorithmic systems, particularly for very large online platforms. These obligations require platforms to identify, analyse and mitigate systemic risks linked to the use of algorithms, including risks associated with consumer manipulation, unfair commercial practices and opaque advertising mechanisms (European Union, 2022; OECD, 2023). For fashion and textile companies relying on AI-supported digital tools for marketing, pricing and content optimisation, this regulatory context underscores the importance of responsible data governance, transparency in data use and alignment with platform compliance requirements.

The relevance of the DSA extends to circular digital business models within the fashion and textile sector, such as resale, rental and peer-to-peer platforms. Digital marketplaces facilitating second-hand fashion and circular consumption operate under the same transparency and due diligence obligations as conventional e-commerce platforms. The DSA therefore contributes to increased consumer trust, fair competition and accountability in digital circular markets, which are essential conditions for scaling

circular fashion practices. At the same time, compliance with the DSA often relies on AI-enabled tools for content moderation, fraud detection and monitoring of online transactions, further reinforcing the interaction between AI deployment and platform governance in circular fashion ecosystems.

In the context of the TechStyle project, the Digital Services Act is treated not as a core AI regulation, but as a horizontal framework that defines the digital environment in which AI tools are deployed. For VET learners, entrepreneurs and SME workers, the DSA translates into concrete operational knowledge and skills rather than abstract legal understanding. These include the ability to understand how AI-driven recommender systems function within platform settings, awareness of transparency and accountability obligations, and capacity to manage AI-supported digital tools in compliance with platform governance rules. Such competences are particularly relevant for industry, which represent the vast majority of actors in the textile and clothing sector and often lack dedicated legal or compliance departments.

From a curriculum development perspective, the DSA provides a foundation for defining practical learning outcomes related to responsible digital and AI-supported business practices. Learners must be able to recognise the role of algorithms in shaping consumer experience, assess the implications of data-driven marketing strategies, and apply transparency principles when using AI-supported tools for branding, retail and e-retail activities. By embedding these considerations into the TechStyle curriculum, the project

supports the development of future-oriented skills that enable safe, trustworthy and impactful use of AI within digital fashion environments.

Overall, the Digital Services Act shapes the regulatory conditions under which AI-enabled digital services operate in the fashion and textile sector. By imposing obligations related to transparency, accountability and systemic risk management, the DSA indirectly governs how AI tools are designed, deployed and managed across digital fashion ecosystems. While it does not regulate artificial intelligence as such, its horizontal scope and strong focus on algorithmic governance make it a critical reference framework for understanding the digital context in which AI-supported circular fashion solutions are implemented. In this sense, the DSA complements the EU AI Act by ensuring that AI adoption in the fashion and textile sector occurs within a transparent, accountable and trust-based digital marketplace.

Regulation (EU) 2024/2847 – Cyber Resilience Act (CRA)

The Cyber Resilience Act (CRA), formally adopted as Regulation (EU) 2024/2847, establishes a comprehensive legal framework to ensure the cybersecurity of products with digital elements placed on the European market. It represents one of the central instruments of the European Union's digital strategy, complementing other legislative acts such as the Artificial Intelligence Act, the Digital Services Act, and the Data Act, by addressing the security dimension of connected products and software (European Union, 2024).

Unlike regulations focusing on ethical or transparency aspects of AI, the CRA introduces horizontal and binding cybersecurity requirements applicable to all connected devices and digital products. Its purpose is to strengthen the resilience of Europe's digital ecosystem by ensuring that hardware and software are secure by design, maintained through their lifecycle, and continuously protected against vulnerabilities. The regulation applies to manufacturers, importers, and distributors who are responsible for guaranteeing that their products meet essential cybersecurity standards before and after they are made available on the market (European Union, 2024).

The CRA introduces obligations regarding secure development, vulnerability handling, and product updates, aiming to enhance trust and accountability in digital markets. Manufacturers must conduct conformity assessments, provide documentation proving compliance with security-by-design principles, and ensure that users receive timely security updates. By mandating these procedures, the CRA seeks to reduce the number of insecure digital products circulating in the EU and to mitigate the economic and societal costs of cyber incidents. This regulation therefore complements the Artificial Intelligence Act by safeguarding the operational environment in which AI-based systems are developed and deployed (European Union, 2024).

The fashion and textile industry increasingly depends on digital and AI-enabled infrastructures, making the CRA highly relevant for its transition toward circular and data-driven models. Many stages of the fashion value chain now rely on networked systems—ranging from automated production and material tracking to online retail and

digital product passports. As such, the CRA, even if not mentioned directly, it does affect companies developing or using AI-driven manufacturing systems, digital twins, IoT-enabled garments, and traceability platforms. These systems depend on continuous data exchange across supply chains and therefore must comply with cybersecurity requirements that protect both consumer information and proprietary industrial data (European Union, 2024).

The regulation's emphasis on security-by-design principles also strengthens the reliability of circular and sustainable business models. Circular fashion systems, which rely on data sharing across multiple actors for product repair, reuse, and recycling, depend on secure and interoperable digital environments. Under the CRA, any AI or IoT application facilitating such exchanges must integrate safeguards against unauthorised access, data manipulation, or system breaches. In practice, this means that tools supporting textile lifecycle management or material traceability must meet the CRA's essential cybersecurity requirements throughout their lifecycle—from design and deployment to decommissioning.

From a skills development perspective, the CRA also introduces new knowledge and competence needs for professionals in the fashion and textile sectors. As the digitalisation of production and retail processes accelerates, workers and SMEs must understand how to operate AI tools securely and comply with EU-level cybersecurity obligations. For VET learners, this translates into the ability to identify cybersecurity risks in digital fashion environments, manage AI-based systems responsibly, and maintain

data integrity across networked operations. Embedding CRA-related knowledge into vocational education programmes will help ensure that new entrants to the industry are equipped not only with digital literacy but also with the awareness needed to manage AI systems in accordance with EU resilience and data protection standards (European Union, 2024).

In essence, the Cyber Resilience Act provides the security foundation for Europe's broader AI and digital transformation. By imposing mandatory cybersecurity requirements across all digital products and connected services, it ensures that technological innovation in the fashion and textile sector proceeds within a trustworthy and resilient digital ecosystem. For projects such as TechStyle, which aim to foster the responsible integration of AI into circular fashion education, the CRA offers a crucial legal reference that links technological advancement, user safety, and sustainable digital practices under a unified regulatory vision (European Union, 2024).

Regulation (EU) 2024/1689 – Artificial Intelligence Act (AI Act)

The EU AI Act (2024/1689) is the world's first comprehensive legal framework for regulating AI. It aims to harmonize rules across the EU Single Market, ensuring that AI systems are developed and used in a manner that is trustworthy, human-centric, and safe (European Union, 2024).

The fundamental principle of the Act is the application of a risk-based approach, which imposes obligations on providers (developers) and deployers (users) based on the extent to which an AI system could harm the safety or fundamental rights of individuals and/or society. The EU AI Act defines four levels of risk **(Figure 1)**, with obligations increasing significantly as the risk level rises (European Union, 2024).

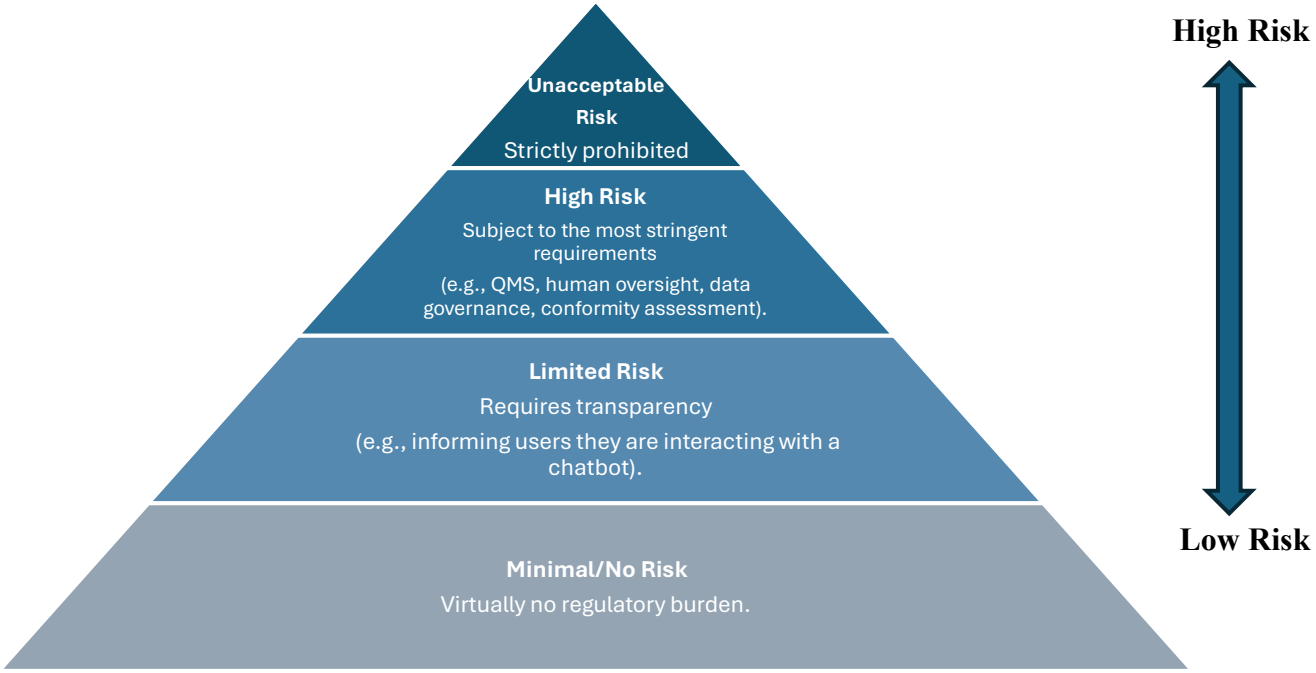

Figure 1. *Risk-based classification system of the EU AI Act (European Commission, 2024).*

Crucially, the Act applies not just within the 27 Member States but also has an **extraterritorial effect** (**Figure 2**), covering all AI systems whose output is used within the EU, regardless of where the systems are developed (European Union, 2024).

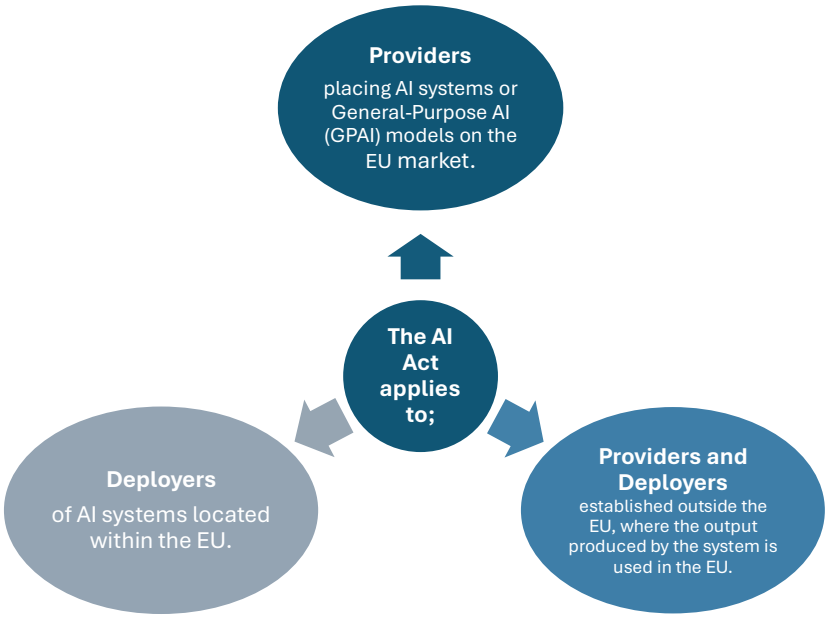

Figure 2. *Extraterritorial effect of the EU AI Act (European Union, 2024).*

The fashion & textile sector uses AI extensively across its value chain; from automating production and textile design processes to managing logistics and optimizing maintenance, AI offers a broad range of applications. The EU AI Act establishes a comprehensive framework for AI across all sectors, including the fashion & textile sectors, and sets the rules for the digital transformation of them. In this case, the Act affects every company involved, from design processes and manufacturers to retailers.

Most AI tools currently used in the fashion value chain fall into the Minimal or Limited Risk categories. Still, some critical applications are designated as High Risk due to their potential impact on fundamental rights (Fibre2Fashion, 2025).

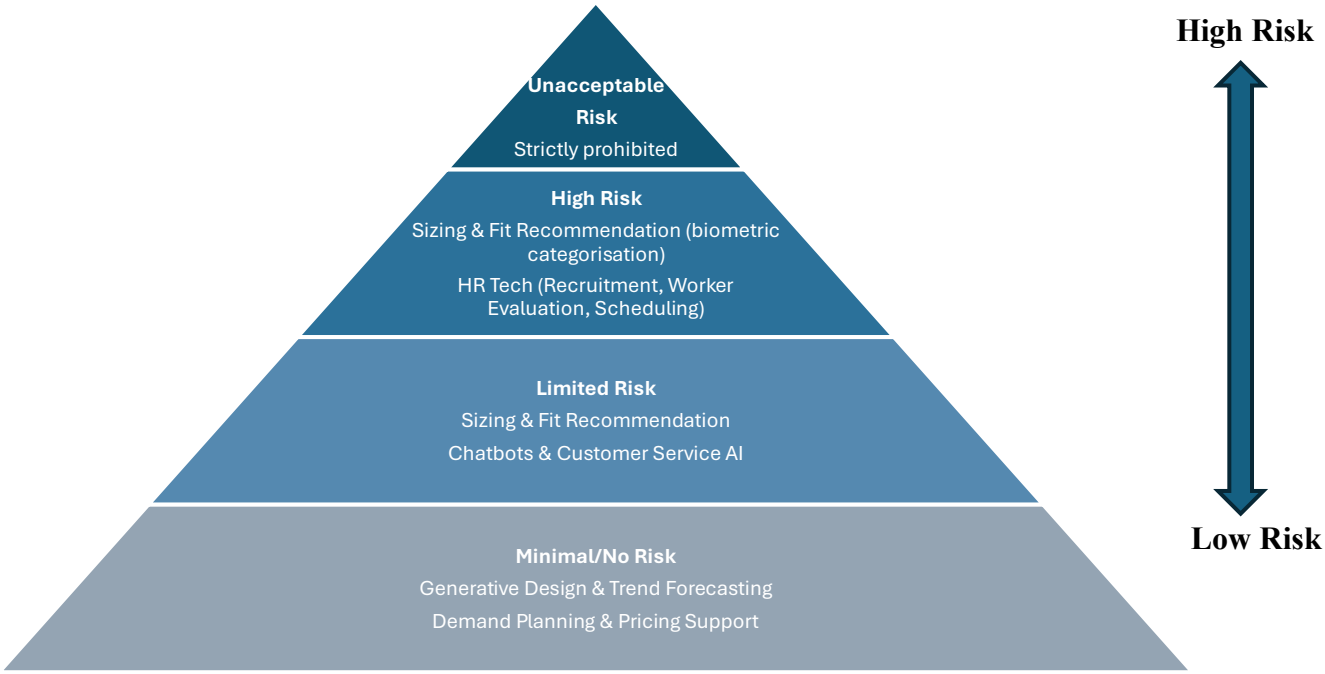

Figure 3. *Examples for risk-based classification under the AI Act for processes utilizing AI in the fashion & textile value chain (Fibre2Fashion, 2025).*

For textile and clothing (T&C) manufacturers, the most significant risk lies in worker-facing AI systems. Any AI used in HR and workforce management (e.g., automated tools

for sorting CVs, evaluating worker performance, or predicting staff scheduling) is classified as High Risk (European Commission, 2024). High-Risk AI tools must undergo a Conformity Assessment before being placed on the EU market. This is a mandatory check to ensure the system meets all AI Act requirements and earns the CE Marking (European Union, 2024).

The AI Act places stringent requirements on data governance to address bias and accuracy, which is highly relevant given the sector's reliance on large, global datasets (e.g., images of people for sizing, historical sales data). In terms of data quality and integrity, high-risk AI systems must be trained, validated, and tested on datasets that are (European Union, 2024):

Relevant and Sufficiently Representative: Datasets must reflect the geographical and demographic context where the AI will be used (e.g., avoiding bias against certain body types or ethnicities in fit recommendation tools).

Bias Mitigation: Data governance practices must include explicit measures to detect, prevent, and mitigate possible biases that are likely to impact fundamental rights or lead to discrimination negatively.

Training Data Summary (for GPAI Providers): Developers of powerful Gen AI models must publish a sufficiently detailed summary of the content used for training to comply with copyright laws (European Union, 2024).

The phased compliance timeline means T&C companies operating in the EU must begin auditing their current AI use cases immediately, with the most stringent High-Risk obligations taking full effect in 2026 (European Union, 2024.

Türkiye, with its geographical location, well-established T&C manufacturers, and the expertise and experience of its manufacturers, as well as its ability to respond quickly to customers, offers faster access to EU markets and is known as one of the leading suppliers to the EU. As the Turkish fashion & textile sector increasingly integrates digital solutions to maintain its position as a primary supplier to the EU market, understanding the EU regulatory landscape is a prerequisite for market access. The most critical aspect of the EU AI Act is its extraterritorial effect, especially for Turkish manufacturers and designers: the Act applies to any provider or deployer established outside the EU, including Türkiye, if the output of AI systems is used within the EU.

Proposed AI Liability Directive (AILD)

In September 2022, the European Commission presented the Proposal for a Directive on adapting non-contractual civil liability rules to artificial intelligence (also known as AI Liability Directive, AILD) as part of a broader effort to modernize liability law in the context of a rapidly growing AI use in the European Union. (European Commission, 2022)

The EU's 2022 Proposal for an AI Liability Directive (AILD) aimed to harmonize certain aspects of civil liability across Member States for damage caused with the involvement of AI systems. This directive was intended to update traditional liability frameworks,

particularly to tackle the unique challenges of AI systems, such as complexity, opacity, unpredictability, and difficulty in identifying causal links between AI decisions and resulting harm. Traditional liability rules, especially in civil law systems, are often fault-based and require precise proof that a specific actor's conduct caused harm. AI systems, especially those based on machine learning, can behave in nonlinear and opaque ways that make such proof difficult. The proposed directive sought to address this burden of proof problem (European Commission, 2022b).

The Directive's design incorporated several innovative legal approaches aimed at enabling more effective access to compensation for victims of AI-related harm. Firstly, uniform civil liability framework. It proposed a minimum harmonization of selected liability aspects, with the objective of reducing discrepancies between national civil law regimes and create legal certainty for AI developers, deployers and user throughout the internal market. Secondly, mechanisms to help claimants (Council of the European Union, 2024). On the one hand, rebuttable presumptions, when certain conditions are met courts would assume that an AI system's fault (e.g., non-compliance with safety standards) caused the damage, unless the defendant proves otherwise. On the other hand, presumption of causality; if a claimant shows that harm likely resulted from an AI system's action or omission, it becomes easier to satisfy causality requirements, which can otherwise be difficult given AI complexity. These tools aimed to make the legal process more accessible and predictable for victims, especially those involved in more complex AI systems where precise technical causal proof is challenging. (European Parliamentary Research Service, 2024)

Finally, access to evidence. National courts would have the authority to require AI providers or operators to disclose evidence relevant to establishing liability, especially for high-risk AI systems. This would help overcome information asymmetries where claimants lack access to internal AI system details and logs.

The current status of the proposal has changed since the initial one in 2022. Despite the ambition, the EU legislative process has been slow and uncertain. On the one hand, the European Commission announced its intention to withdraw the proposal in February 2025, finding it potentially redundant with the updated Product Liability Directive (PLD) and national laws, opting instead to focus on the PLD's broader scope for digital products and AI. On the other hand, the proposal remains a subject of debate in EU institutions, with some lawmakers pushing it to keep it on the agenda. (Euronews Next, 2025).

The AILD was not sectorized into any industry, although its principles are highly relevant for industries like textiles and clothing, especially if we consider the increasingly AI-driven systems that are appearing for design, manufacturing, supply chain optimization and customer engagement. (European Commission, 2022)

In the textile sector, if an AI system is used, for example, to automate pattern creation or quality control, it might malfunction and cause any damage or harm (like defective product batches causing injuries), which clearly liability rules would help affected parties seek for compensation and drive responsible innovation and improve safety practices among manufacturers and developers. On the other hand, AI tools are used for pricing algorithms, inventory forecasts and recommendations systems. Errors in these

systems can lead to economic losses for smaller manufacturers or unfair competitive distortions. The Directive's emphasis on evidence access and burden of proof adjustments would assist companies harmed by opaque decision systems to challenge unfair outcomes.

Although the AI Liability Directive (AILD) is currently withdrawn from the EU legislative agenda, its underlying principles remain highly relevant for the governance of Artificial Intelligence systems. The proposal articulated a clear approach to addressing liability gaps arising from AI-enabled decision-making, particularly in cases involving complex supply chains, opaque algorithms, and asymmetries of information between providers, deployers, and affected parties. Its emphasis on burden of proof, transparency obligations, and access to evidence continues to inform policy discussions and legal interpretation at both EU and national levels. Moreover, many of the concerns raised by the AILD are indirectly addressed through the combined application of the Artificial Intelligence Act, existing product liability rules, and consumer protection legislation. In this sense, the withdrawal of the Directive should not be interpreted as a rejection of AI liability regulation, but rather as a recalibration of legislative strategy, with its core concepts likely to re-emerge through alternative legal instruments and jurisprudence.

Chapter 3 – National AI Policies, Strategies & Legal Adaptations

While EU-level regulation provides a common legal and ethical framework for the development and use of Artificial Intelligence, its practical implementation is shaped by national policies, strategies, and governance models. This chapter examines how the partner countries translate European AI objectives into national approaches, regulatory adaptations, and strategic priorities, with particular attention to the fashion and textile sector. By analysing national AI strategies, legal frameworks, and policy instruments, the chapter highlights both convergences and divergences across countries, illustrating how different institutional contexts influence AI adoption, regulatory readiness, and skills development within textile and fashion ecosystems (European Commission AI Watch, 2024).

National AI Policies, Strategies & Legal Adaptations - France

Over the past decade, France's AI strategy has evolved from an initial effort to structure research and training into a comprehensive, nationwide AI ecosystem that integrates innovation, talent development and concrete economic use-cases. Throughout this process, the French approach has consistently sought to balance technological competitiveness with national sovereignty, ethical considerations and global positioning.

France's national AI strategy was first formally articulated in 2018 with the AI for Humanity initiative, following the recommendations of the Villani report on artificial intelligence. The initiative aimed to structure the French AI ecosystem from research to deployment, while ensuring that AI development served both innovation and ethical values. A central objective was to strengthen links between academic, industrial and public research, creating a coherent system capable of supporting long-term AI development.

Key priorities during this initial phase included the creation of interdisciplinary AI institutes and investment in research chairs, alongside early efforts to expand training capacity and increase the number of students and professionals with AI expertise. Public investment in infrastructure also played a significant role, most notably through the construction of the Jean Zay supercomputer to support compute-intensive research and reinforce France's research capabilities.

From 2021 onwards, France's AI strategy has been embedded within France 2030, the country's national innovation and competitiveness plan. This phase builds on earlier foundations while placing greater emphasis on scale, economic impact and international competitiveness. One of its central pillars is research excellence, with the creation of nine AI clusters around major research universities and laboratories. These clusters aim to foster synergies between research, training and innovation, strengthen international partnerships and position several French institutions among the world's leading AI centres, particularly in Grenoble and Paris.

Economic development constitutes another key pillar, with targeted measures to support the adoption of AI technologies by SMEs and accelerate digital transformation across sectors. Education and skills development are equally central, encompassing expanded AI training at bachelor's, master's and doctoral levels, as well as lifelong learning initiatives. The strategy sets an ambitious target of training up to 100,000 people in AI per year by 2030, while also prioritising international cooperation to attract AI researchers and professionals from abroad and reinforce France's talent pool.

Within this ecosystem, AI clusters operate as regional hubs bringing together universities, grandes écoles, public research organisations and industry partners. Their objectives include conducting cutting-edge research, training new generations of AI specialists through interdisciplinary and internationally oriented programmes and facilitating the transfer of innovation to industry through applied projects and startup creation. A central operational role is played by Inria, which runs national scientific programmes, supports innovative projects and provides shared tools and infrastructure that underpin the broader AI strategy.

France has also experienced rapid growth in AI-focused startups, with their number increasing from approximately 500 in 2021 to over 1,000 by 2025. A key driver of this expansion is La French Tech, launched in 2013, which has become a central platform for supporting technology and AI startups through visibility, access to funding, mentorship and international outreach. Flagship initiatives include the French Tech 120 label, which highlights high-growth startups meeting specific funding or revenue criteria, and the Next

40 label, introduced in 2019, which distinguishes the top performers within this group, including companies such as Vestiaire Collective.

A major physical and symbolic hub of the French startup ecosystem is Station F, which concentrates talent, capital and global partnerships while supporting networking, export readiness and international branding. Since 2019, Station F has also run the Future 40 programme, an annual selection of the top-performing startups on its campus. These startups are recognised for their ambition, creativity and impact, often leveraging AI to address real-world challenges. From 2022 onwards, funding partners have invested directly in selected startups from each cohort to support faster growth and international scaling. In 2025, 25% of Future 40 startups were developing AI-based solutions, although only one—Monde Singulier—was directly related to the textile and clothing sector.
The French strategies and actions are summarised in the below table:

Dimension	Key Actions	Impact
Policy & Vision	*AI for Humanity*, France 2030	Cohesive national AI agenda
French Tech	Startup acceleration, Next40/120	Growth of AI startups
Clusters of Excellence	9 AI hubs	World-class research & innovation networks

Dimension	Key Actions	Impact
Education & Talent	Expanded curricula, French Tech Visa	Larger skilled workforce
Business Adoption	*Osez l'IA* plan	Wider AI diffusion in economy
Funding	Public + private ecosystem financing	Sustained growth and competitiveness

National AI Policies, Strategies & Legal Adaptations - Sweden

Sweden's approach to artificial intelligence (AI) policy has developed within a broader national commitment to digitalisation, innovation, and sustainability. Rather than adopting an isolated or sector-specific AI policy at an early stage, Sweden has pursued a holistic and integrative model in which AI is embedded within wider digital transformation and industrial strategies. This approach reflects the country's governance tradition, which emphasises coordination among public authorities, research institutions and industry actors, as well as alignment with European Union regulatory frameworks (European Commission AI Watch, 2024).

The foundation of Sweden's AI policy was laid with the publication of the National Approach for Artificial Intelligence in 2018. This document identified education and skills development, research excellence, innovation and application, and enabling

frameworks as core pillars for AI adoption (European Commission AI Watch, 2024). Although the approach was not designed as a detailed implementation roadmap, it provided strategic direction and signalled the importance of AI across economic sectors, including manufacturing and supply chains relevant to textiles and fashion.

More recently, Sweden's AI governance has been strengthened through the work of AI Sweden, the national centre for applied artificial intelligence. In 2024, AI Sweden released an AI Strategy for Sweden, which articulates a long-term vision positioning AI as a key driver of competitiveness, societal value and sustainability. The strategy emphasises the responsible and large-scale deployment of AI across both public and private sectors, highlighting the importance of data availability, digital infrastructure, and cross-sector collaboration (AI Sweden, 2024). Sustainability is explicitly framed as a core area where AI can contribute to systemic change, including through more efficient resource use, transparency in production systems, and data-driven decision-making.

This strategic orientation is reinforced by Sweden's Digitalisation Strategy 2025–2030, which integrates AI within a broader national agenda for digital public services, business innovation and societal resilience (Government Offices Sweden, 2025). Rather than addressing AI as a standalone policy domain, the strategy embeds AI alongside data governance, cybersecurity and digital competence, creating enabling conditions for its application in industrial sectors. For the textile and fashion industry, this policy environment supports the adoption of AI tools for supply chain optimisation, predictive

quality control and sustainability monitoring, all of which are essential components of circular economy models.

From a legal perspective, Sweden's AI landscape is shaped primarily through alignment with European Union legislation. The General Data Protection Regulation (GDPR) establishes the core framework governing data processing and privacy, which directly affects AI-driven systems reliant on large datasets, including those used for traceability and consumer-facing digital fashion services. Sweden is also preparing for the implementation of the EU Artificial Intelligence Act, which will further define risk-based obligations for AI systems and influence national governance structures once fully enforced (European Commission, 2024). At national level, Sweden has not introduced AI-specific legislation; instead, it relies on horizontal legal frameworks and regulatory adaptation to ensure responsible AI use across sectors.

The interaction between AI policy and sustainability governance is particularly relevant for the textile and fashion sector. Sweden's environmental and industrial policies, including the Environmental Code and national circular economy strategies, establish expectations for resource efficiency, emissions reduction and transparency. Although these frameworks are not AI-specific, they create strong incentives for the adoption of AI-enabled solutions that support lifecycle assessment, material tracking and environmental performance monitoring in manufacturing processes (Swedish Environmental Protection Agency, 2024). In this context, AI functions as an enabling

technology that helps companies comply with sustainability requirements and advance circular economy objectives.

Concrete initiatives illustrate how national policies translate into sector-relevant applications. Organisations such as Circular Sweden support transition pathways towards a circular economy by fostering collaboration between industry, policymakers and researchers. Within these initiatives, AI-based systems have been explored for improving textile sorting and recycling processes, enabling higher material recovery rates and reducing waste streams (Circular Sweden, 2023). Similarly, the RISE Research Institutes of Sweden engage in applied research projects that utilise AI for production optimisation, predictive maintenance and quality assurance in textile manufacturing, contributing to reduced material loss and energy consumption (RISE, 2024).

Sweden's innovation governance model further supports AI adoption through public funding and experimentation rather than prescriptive regulation. Agencies such as Vinnova and Tillväxtverket finance research and innovation projects that integrate AI with sustainability and industrial competitiveness objectives. This approach allows textile and fashion actors, including small and medium-sized enterprises, to test AI-driven solutions within supportive innovation ecosystems while remaining compliant with overarching legal frameworks. The absence of sector-specific AI regulation is thus balanced by strong incentives, collaborative platforms and access to applied research expertise.

A defining characteristic of Sweden's national approach is its technology-neutral regulatory philosophy, which prioritises flexibility and innovation while safeguarding societal values. For the textile and fashion sector, this means that AI adoption is guided more by strategic alignment with sustainability goals and market incentives than by mandatory legal obligations. AI-enabled solutions supporting traceability, circular design and sustainable supply chains therefore emerge primarily through voluntary initiatives, public-private partnerships and innovation programmes rather than through sector-specific compliance mechanisms.

Overall, Sweden's national AI policies, strategies and legal adaptations create an enabling environment for the integration of AI into sustainable and circular textile and fashion systems. By embedding AI within broader digitalisation and sustainability agendas, and by aligning national initiatives with European regulatory developments, Sweden supports responsible experimentation and scalable innovation. While a dedicated AI strategy specifically targeting the textile and fashion sector has yet to emerge, the convergence of AI governance, sustainability policy and industrial innovation positions Sweden as a favourable context for AI-driven circular transformation.

National AI Policies, Strategies & Legal Adaptations - Greece

Greece's approach to artificial intelligence (AI) and digital transformation, while starting with smaller steps, it has evolved significantly over the past decade, driven by its commitment to align national policy with the European Union's digital and green transition objectives. Rather than developing AI policy in isolation, Greece has decided to embed artificial intelligence within a broader framework of digital governance, innovation, and sustainable development, while utilizing existing EU policies, reflecting the European model of integrated transformation.

The cornerstone of Greece's AI policy is the National Strategy for Artificial Intelligence, published in 2021 by the Ministry of Digital Governance which was later followed with the Blueprint for AI transformation (Ministry of Digital Governance, 2024). Additionally, a strategy was developed in cooperation with the European Commission's AI Watch and the OECD AI Policy Observatory, aiming to position Greece as a responsible adopter of AI technologies (Ministry of Digital Governance, 2021). The document defines a comprehensive framework around three strategic axes: governance and ethics, AI research and innovation, and AI deployment across sectors. It emphasises human-centric AI aligned with European values, promoting transparency, accountability, and social benefit.

A central objective of the Greek AI strategy is to strengthen data infrastructure and governance mechanisms. The government has launched initiatives to create a National

Data Governance Framework, facilitating interoperability between public and private data systems and supporting the safe use of data in AI applications. This is complemented by the Digital Transformation Bible 2020–2025, a five-year national roadmap that defines over 400 projects aimed at modernising public administration, fostering digital entrepreneurship, and integrating emerging technologies — including AI, blockchain, and the Internet of Things (IoT) — across key economic sectors (Ministry of Digital Governance, 2020).

Within this framework, the fashion and textile sector is recognised as part of Greece's broader innovation and creative industries ecosystem. The sector's digitalisation potential aligns with the National Recovery and Resilience Plan "Greece 2.0" (Government of Greece, 2021) & Greek National Digital Decade Strategic Roadmap (Ministry of Governance, 2024), which allocate resources to sustainable industry, smart manufacturing, and digital skills. These initiatives collectively promote an environment where small and medium-sized enterprises (SMEs) can adopt AI-based tools for design, production optimisation, and sustainable materials management.

Legally, Greece adheres to all EU-level digital and data protection frameworks, including the General Data Protection Regulation (Regulation (EU) 2016/679) and forthcoming AI Act, ensuring coherence with European standards on ethics, transparency, and risk-based AI oversight (European Commission, 2024). Nationally, AI-related applications are governed primarily through horizontal frameworks rather than AI-specific legislation. For example, cybersecurity and digital product safety are guided by Law 4961/2022 on

Emerging Technologies, which provides principles for AI, blockchain, and IoT adoption within both the public and private sectors. This law reinforces the obligation for transparency, algorithmic accountability, and data integrity in all AI systems operating in Greece (Hellenic Republic, 2022).

At the sectoral level, Greece's National Circular Economy Strategy (2021–2025) and Sustainable Development Strategy 2030 highlight digital innovation — including AI — as a key enabler for circular production models and sustainable value chains (Ministry of Environment and Energy, 2021). These strategies encourage the use of digital technologies for resource efficiency, waste reduction, and lifecycle management, offering fertile ground for the integration of AI in textile recycling, smart materials, and circular supply chain analytics. The Hellenic Clothing Industry Association (SEPEE) and regional clusters such as Creative Industries Cluster of Central Macedonia (CLIC) have also begun incorporating AI-driven practices in fashion design, manufacturing optimisation, and predictive market analytics, often supported by EU-funded initiatives (SEPEE, 2024).

Greece's participation in EU innovation programmes such as this one, and including Horizon Europe, EIT Manufacturing, and Digital Europe Programme further reinforces the national AI ecosystem. Greek research institutions — notably the Athena Research Center, National Technical University of Athens (NTUA), and Centre for Research and Technology Hellas (CERTH) — play an active role in developing AI solutions for sustainable manufacturing and circular economy applications. From a skills

development standpoint, Greece recognises that the success of AI adoption depends on human capital. Initiatives such as the National Digital Academy for Citizens and the Upskilling Pathways for Digital Skills programme provide foundational training on digital and AI literacy (Ministry of Digital Governance, 2023). However, vocational education and training (VET) remains a priority area for improvement. In the context of TechStyle, VET institutions can play a pivotal role in equipping learners with practical competences for operating AI tools in the fashion and textile sector, particularly those supporting circular design, traceability, and sustainability analytics.

Overall, Greece's policy and legal environment provides a solid basis for the integration of AI into sustainable and circular fashion. While the country continues to develop its institutional capacity and data infrastructure, its alignment with EU digital legislation, coupled with a growing innovation ecosystem, positions it well to leverage AI for competitiveness and environmental responsibility. For TechStyle, the Greek context offers a valuable example of how policy coherence, technological readiness, and educational innovation can converge to advance responsible AI adoption in the creative industries.

National AI Policies, Strategies & Legal Adaptations - Italy

Italy's approach to Artificial Intelligence (AI) is defined by the *Italian Strategy for Artificial Intelligence 2024–2026* (*Strategia Italiana per l'Intelligenza Artificiale*), which builds on

and expands the previous 2022–2024 framework. Developed by the national AI Coordination Committee and published by institutional bodies such as the Agency for Digital Italy (AgID), the strategy is closely aligned with the European Union's Coordinated Plan on AI and anticipates the regulatory principles established by the EU Artificial Intelligence Act (Regulation (EU) 2024/1689). The overarching objective is to position Italy within a European AI ecosystem that is human-centric, trustworthy, and sustainable, while strengthening the country's role in AI research, innovation, and deployment (AgID, 2024; European Commission, 2024).

The strategy aims to fully harness the transformative potential of AI to improve citizens' quality of life and to support Italy's economic and social development. Emphasis is placed on fostering innovation and competitiveness among Italian enterprises, especially small and medium-sized enterprises (SMEs), while ensuring that AI systems are developed and used in a manner that respects fundamental rights, promotes social inclusion, and supports environmental sustainability (AgID, 2024). In this context, Italy explicitly frames its AI policy as part of a broader European vision, based on shared governance mechanisms, data interoperability, access to high-performance computing infrastructure, and strict adherence to the ethical and regulatory framework set by the EU AI Act (European Commission, 2024).

From a governance perspective, the Italian strategy adopts a dual approach that combines the governance of AI—through risk mitigation, regulatory oversight, and the protection of individual rights—with governing through AI, by leveraging advanced digital

technologies to improve public-sector efficiency, internal processes, and the quality of public services through responsible data use (AgID, 2024). These principles are translated into concrete actions across research, public administration, enterprise development, and skills training, ensuring a coherent and integrated national approach to AI adoption.

Regulatory alignment with the EU framework is further reinforced by Law No. 132/2025 on Artificial Intelligence, which establishes Italy as the first EU Member State to adopt a comprehensive national legal framework for AI that is fully aligned with, and in some cases anticipatory of, the EU AI Act (Regulation (EU) 2024/1689). This law introduces an explicitly anthropocentric approach to AI, safeguarding human autonomy and decision-making supremacy over automated systems, while reinforcing principles of transparency, proportionality, and safety. It also provides sector-specific rules for AI use in sensitive areas such as healthcare, public administration, and the workplace, including obligations for employers to inform workers about the deployment of AI-based systems. In parallel, the law allocates up to €1 billion in public funding to support Italian companies, startups, and SMEs active in AI, cybersecurity, and related digital technologies, and designates the National Cybersecurity Agency (ACN) and AgID as the national competent authorities for AI governance and implementation (Law No. 132/2025).

In parallel with AI regulation, Italy has strengthened its digitalisation and cybersecurity framework to support the safe deployment of advanced digital technologies. This

includes the ongoing transposition of EU legislation such as the NIS 2 Directive and the Digital Operational Resilience Act (DORA), which are essential for ensuring the resilience and security of critical digital and data infrastructures underpinning AI-enabled systems across industrial sectors, including fashion and manufacturing supply chains (European Commission, 2023).

Italy's policy framework also strongly integrates sustainability and circular economy objectives, particularly in relation to the textile and fashion sector. The transposition of the EU Circular Economy Package through Legislative Decree No. 116/2020, implementing the Waste Framework Directive (Directive (EU) 2018/851), represents a key milestone. Notably, Italy anticipated the EU deadline by introducing mandatory separate collection of textile waste from 1 January 2022, thereby establishing a clear legal obligation for municipalities and waste operators. The decree further strengthens the principle of Extended Producer Responsibility (EPR), shifting the financial and organisational responsibility for the end-of-life management of textiles—collection, sorting, reuse, and recycling—to producers, including fashion brands. The full operational implementation of the national textile EPR scheme, including detailed technical and organisational rules, is expected by 2026 and is currently being finalised by the Ministry of the Environment and Energy Security (MASE) (Legislative Decree 116/2020; MASE, 2024).

Substantial financial support for the transition towards a circular textile economy is provided through Italy's National Recovery and Resilience Plan (PNRR), which allocates

significant resources to the Green Transition and Ecological Transformation. Although not a legislative act, the PNRR plays a crucial role by financing the modernisation of recycling infrastructure and the development of innovative facilities for complex waste streams such as textiles. These investments include the creation of large-scale textile treatment and recycling hubs designed to manage both pre-consumer and post-consumer textile waste, thereby strengthening national capacity to meet circular economy targets (Italian Government, 2023).

Complementing these measures, the Italian government has introduced targeted financial incentives and strategic programmes to support the ecological and digital transition of the "Made in Italy" fashion sector. The National Strategy for the Circular Economy, approved in 2022, provides a comprehensive framework promoting eco-design, product and process innovation, the development of secondary raw materials markets, and the dissemination of Minimum Environmental Criteria (CAM) within Green Public Procurement (GPP). Dedicated funding includes resources earmarked for the sustainability and digital transformation of fashion companies, alongside additional funds specifically allocated to promoting environmental sustainability within the sector (Ministry of Enterprises and Made in Italy, 2024).

Finally, Italian enterprises and research actors actively participate in national and European innovation initiatives, such as *RegioGreenTex*, which aim to develop scalable models for textile recycling and circular value chains by mapping challenges and delivering practical solutions across different European regions. These initiatives

demonstrate how Italy's integrated approach to AI, digitalisation, sustainability, and circular economy policies creates a supportive ecosystem for innovation in the textile and fashion sector, while remaining fully aligned with European regulatory and strategic frameworks (RegioGreenTex, 2024).

National AI Policies, Strategies & Legal Adaptations - Spain

Spain's national strategy for AI has evolved from the *Estrategia Nacional de Inteligencia Artificial (ENIA)* launched in 2020 as part of the *España Digital* agenda to the recently approved *Estrategia de Inteligencia Artificial 2024,* which updates and expands the policy framework to address rapid technological change, global competition and ethical governance. (Ministerio de Asuntos Económicos y Transformación Digital, 2024).

The ENIA was designed to promote the integration of AI into the Spanish economy and society, focusing on digital transformation, competitiveness, public administration and ethical governance. Moreover, the strategy was built to support infrastructure, research and development investments, and accelerate SME adoption of AI technologies across sectors. (Gobierno de España, n. d.)

On the other hand, the new *Estrategia de Inteligencia Artificial 2024* builds on ENIA with a strengthened roadmap focusing on reinforcing capacities and talent, including supercomputing and sustainable data centres; development of language models to reduce bias and broaden usability (ALIA family in Spain and co-official languages);

integration of AI in public and private sectors with ethical, transparent and sustainable principles; emphasis on environmentally responsible AI, including initiatives to measure and reduce environmental footprint, such as the UNE 0086, which it will be in charge of measuring the energy consumption, carbon footprint, water consumption and the performance of AI systems. This alignment with the Agenda España Digital 2026 underscores AI's role as a transversal strategic vector for Spain's digital transformation and productivity growth. (Ministerio de Asuntos Económicos y Transformación Digital, 2024).

Regarding the national AI governance and regulation, Spain is actively adapting its legal framework to govern AI beyond the EU level. Firstly, in March 2025, the Spanish government approved the *Anteproyecto de Ley para el buen uso y la gobernanza de la IA,* a draft law to guarantee the ethical, inclusive and beneficial use of AI. It adapts the Spanish legislation to the EU 2024/1689 regulation (Instituto Autor, 2025). The key features include obligation to identify/label AI generated content (audio, video, text and images) to ensure transparency and combat any manipulation. It is also stipulated a sanctioning regime that anticipates fines up to €35M for serious infringements and it categorizes them by risk levels. Secondly, Spain's national supervisory authority, the Agencia Española de Supervisión de la Inteligencia Artificial (AESIA), was established by Real Decreto 729/2023 to oversee compliance with AI norms, supervise ethical use, inspect applications in the market, and promote responsible innovation. (Secretaría de Estado de Digitalización e Inteligencia Artificial, 2025). This organisation prepares Spain for the full implementation of the EU AI Act and ensure national enforcement. Besides

this legal framework, in Spain it does not exist an AI regulation isolation. Instead, it implements broader EU digital rules at the national level like the DSA (Digital Services Act).

Nevertheless, Spain favours and intersects the AI when it comes to sustainability and circular economy legal frameworks. For example, Spain's Circular 2030 strategy, sets long-term goals to shift production and consumption patterns towards resource efficiency, waste reduction and material use, with direct implications for textiles and fashion (like non-toxic chemicals that pollute water). The strategy is implemented through triennial actions plans (2021-2023 and 2024-2026), which include measures on innovation, training and competitiveness, which is important for digital transformation and AI-supported sustainability solutions. (Refashionable, n. d.).

Spain does not yet have a sector-specific national AI policy exclusively for textiles or fashion, but several key frameworks and programmes support AI integration and sustainability in these fields. On the one hand, the circular economy and fashion strategy alignment. The "España Circular 2030", recognizes the fashion industry as a priority and calls on it to embrace sustainable practices, like creating clothes that are easy to recycle, employing eco-friendly materials, and minimizing overall impact on the planet. The strategy urges fashion industry stakeholders to redesign the textile production process, promoting the use of secondary raw materials and non-toxic substances to make garments more sustainable and durable. With this, as previously mentioned, the national strategy intersects with AI by evaluating environmental footprints using AI-

enabled LCA tools, optimising material flows or textile recycling processes with smart automation (Formació i Treball for example applies this in Catalonia) and boosting supply-chain transparency through digital traceability solutions linked to sustainability criteria.

On the other hand, Integration of AI into value chains. España Digital promotes AI integration into industrial value chains, with public programmes to facilitate AI adoption by SMEs, improving operational efficiency and competitiveness and funding for R&I missions and innovation pilots across strategic sectors, which can be leveraged by textile and fashion firms to adopt AI solutions for circular design, logistics optimisation, or quality control. Lastly, UNE 0086, the first Spanish standard to measure sustainability impacts (energy, water, carbon emissions) of AI systems, supporting textile and fashion companies what want to responsibly deploy AI while minimising environmental footprint. (Secretaría de Estado de Digitalización e Inteligencia Artificial, 2025).

National AI Policies, Strategies & Legal Adaptations - Türkiye

In the era of modern technological advancements, AI is emerging as a cutting-edge change and a significant disruptor across various sectors, with the potential to reshape industries with its profound capabilities. The adaptation of AI, however, is not uniform but influenced by the unique ecosystems of socio-economic, cultural, and political landscapes of individual nations.

As AI continues to have a transformative impact on the global stage, many countries are pursuing a balance between innovation and regulation. Thus, countries worldwide are attempting to design and implement AI governance policies commensurate with this technology's rapid and widespread development. These efforts include comprehensive legislation, national AI strategies and policies, sector-specific regulation, and voluntary guidelines.

Türkiye's AI policy is anchored in the National Artificial Intelligence Strategy (NAIS), which was prepared in cooperation with the 'Digital Transformation Office of the Presidency of the Republic of Türkiye', 'Ministry of Industry and Technology', and the participation of many stakeholders. It was published and entered into force in August 2021. The NAIS aims to create value on a global scale with an agile and sustainable AI ecosystem. The Strategy sets out six strategic priorities **(Figure 4)** that range from training 50,000 AI specialists and 10,000 graduate-level diploma holders and boosting R&D and start-ups, expanding secure access to quality data and technical infrastructure, accelerating socioeconomic adaptation through regulation, strengthening international cooperation, and driving structural and workforce transformation. It outlines 24 objectives and 119 specific measures for AI integration across all sectors. The Digital Transformation Office and the Ministry of Industry and Technology coordinate these measures (MoIT, 2021).

The Digital Transformation Office has released the updated national AI strategy 2024-2025 action plan, aligning with the 12th National Development Plan to address AI advancements and national needs. The plan, developed with input from various sectors,

aims to strengthen Türkiye's global AI position by focusing on productive AI technologies, Turkish language models, R&D, innovation, and workforce transformation (National AI Strategy 2024-2025 Action Plan, 2024).

The NAIS provides the strategic backbone for AI transformation of Turkish manufacturers, setting targets, providing infrastructure, and establishing the necessary legal barriers for the responsible and large-scale adoption of AI solutions. On the other hand, the EU AI Act (as stated in Chapter 2) has an extraterritorial reach and fines up to €35M or 7% of global turnover, so Turkish providers selling into European countries must factor EU obligations in addition to national policies into compliance planning (MoIT, 2021).

In Türkiye, the strategic embrace of AI is inevitable, especially for the fashion & textile sector, which is one of the crucial sectors in terms of the national economy, positioning Türkiye as one of the largest suppliers to the EU. As this export-oriented sector is exposed to AI-based challenges but must maintain its competitiveness in the EU market, national and sectoral strategies and action plans are necessary.

Overall, the Turkish legal and policy environment is being harmonized with EU digital governance to ensure seamless trade and data exchange. Given the export-oriented nature of Türkiye's fashion & textile sector, national legal adaptations are designed to reflect EU legislation.

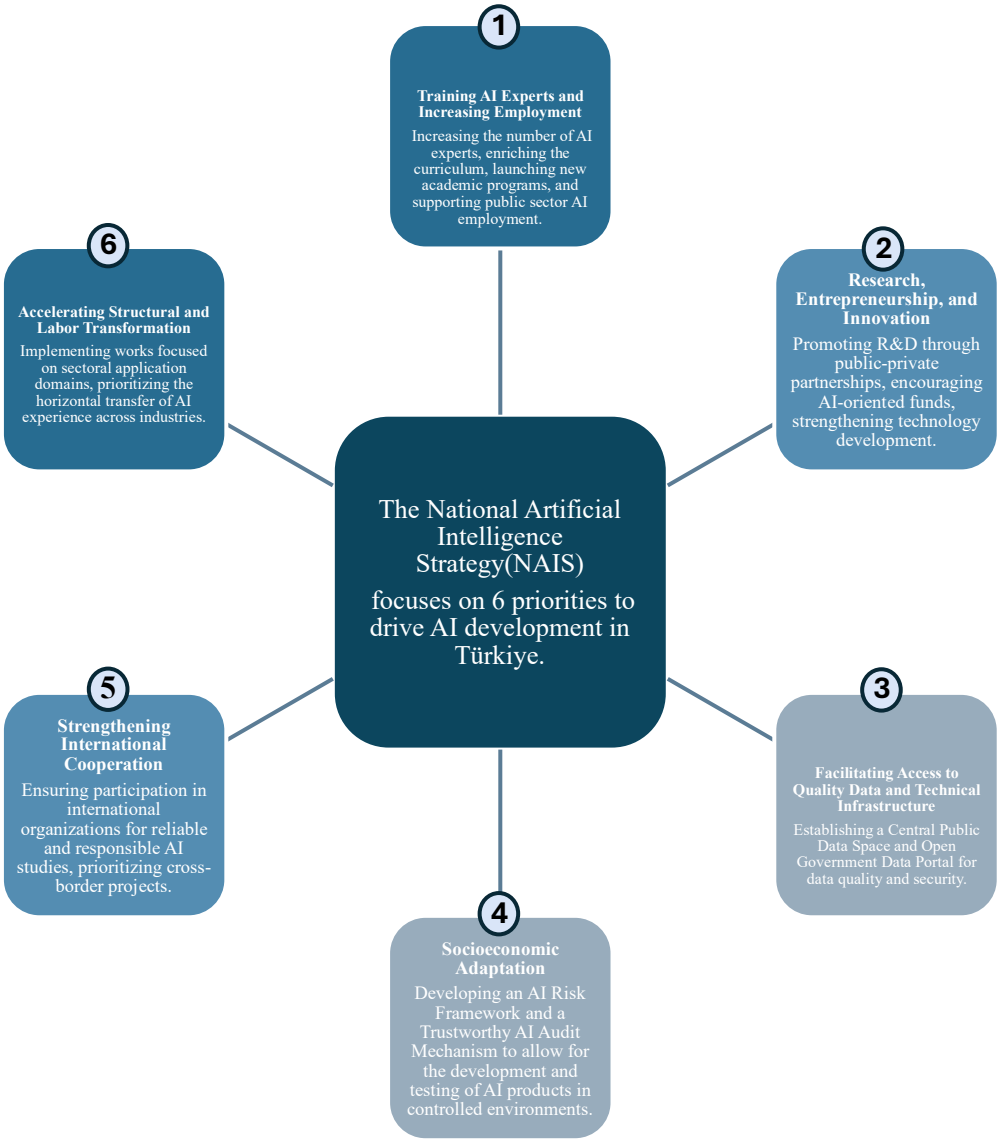
The National Artificial Intelligence Strategy(NAIS)
focuses on 6 priorities to drive AI development in Türkiye.
1
Training AI Experts and Increasing Employment
Increasing the number of AI experts, enriching the curriculum, launching new academic programs, and supporting public sector AI employment.
2
Research, Entrepreneurship, and Innovation
Promoting R&D through public-private partnerships, encouraging AI-oriented funds, strengthening technology development.
3
Facilitating Access to Quality Data and Technical Infrastructure
Establishing a Central Public Data Space and Open Government Data Portal for data quality and security.
4
Socioeconomic Adaptation
Developing an AI Risk Framework and a Trustworthy AI Audit Mechanism to allow for the development and testing of AI products in controlled environments.
5
Strengthening International Cooperation
Ensuring participation in international organizations for reliable and responsible AI studies, prioritizing cross-border projects.
6
Accelerating Structural and Labor Transformation
Implementing works focused on sectoral application domains, prioritizing the horizontal transfer of AI experience across industries.

Figure 4. *Six strategic priorities of the NAIS (MoIT, 2021).*

As a national strategy and action plan, the **Turkish Ready-to-Wear and Apparel Sector Sustainability Strategy and Action Plan** focuses on integrating sustainability, circularity, and digitalization within the textile value chain. It was developed by the Istanbul Apparel Exporters' Association (IHKIB) to comply with the policies and legal regulations adopted in the EU. It's structured around several strategic themes, with digitalization and AI (IHKIB, 2023):

Circularity and Waste Management: This pillar aims to significantly reduce waste generation and increase the collection, sorting, and recycling of textile waste. Therefore, the development and implementation of advanced technologies for textile sorting and material identification are necessary. For instance, AI-powered image processing and sensor technologies are required to accurately classify complex, mixed textile waste and move away from manual sorting. GenAI and ML-based programs assist designers by suggesting material combinations optimized for recycling or predicting a product's environmental footprint (PEF) during the initial design phase.

Digital Product Passport (DPP): The Action Plan encourages the widespread adoption of DPP practices, supported by technologies like IoT and Blockchain. The DPP aims to provide reliable, accessible information about a product's composition, durability, repair, and recycling instructions throughout its lifecycle. It requires robust data collection, management, and verification systems across the entire supply chain. AI is crucial for data integrity, automated data logging, and lifecycle analysis. AI-driven softwares are

used for standardizing data input, ensuring that material choices comply with regulations and that all necessary information for the DPP is recorded accurately and automatically.

Production Efficiency and Resource Optimization: The Action Plan focuses on reducing the environmental footprint during manufacturing, particularly in resource-intensive processes (e.g., dyeing, finishing). It's also aimed at optimizing industrial processes to minimize the consumption of water, energy, and chemicals. AI-powered algorithms can analyze production data in real-time to fine-tune machinery settings, chemical formulas, and energy use. This reduces consumption and ensures material quality consistency, directly contributing to both sustainability and cost efficiency. AI software minimizes fabric waste (deadstock) during the pattern-making process, directly supporting the Action Plan's target for reducing waste.

Governance and Stakeholder Engagement: Establishing a coordinated sectoral sustainability management system and engaging all actors (from raw material suppliers to retailers and consumers) is necessary. Therefore, actions are needed to encourage the formation of specialized corporate sustainability and supply chain units within businesses. AI tools are used for measuring, verifying, and reporting GHG emissions and corporate carbon footprints, providing the scientific data required for mandated reporting and ensuring accountability across the value chain (IHKIB, 2023).

As Türkiye is one of the major T&C suppliers to the EU, this Action Plan is critical for navigating new EU legislations such as the Ecodesign for Sustainable Products Regulation (ESPR) and the EU AI Act.

By providing the legal "guardrails" and the industrial roadmap (Turkish Apparel Sector Sustainability Strategy and Action Plan), Türkiye is positioning its textile workforce to transition from traditional manufacturing to high-tech, sustainable fashion leadership.

Chapter 4 – EU Platforms and R&I Initiatives Enabling AI for Circular Fashion

Beyond regulatory frameworks and national strategies, the effective deployment of Artificial Intelligence in circular fashion is strongly supported by a growing ecosystem of EU platforms and research and innovation (R&I) initiatives. This chapter explores key European-level infrastructures, collaborative projects, and excellence networks that facilitate access to data, AI tools, and applied research relevant to the fashion and textile sector. By examining initiatives such as data spaces, digital twin platforms, intelligent sorting systems, and AI-on-demand services, the chapter highlights how EU-funded ecosystems enable experimentation, interoperability, and skills development, while supporting the transition towards more circular, data-driven, and sustainable textile value chains.

TRICK Platform

The TRICK platform is an EU-funded digital innovation developed under the European Union's Horizon 2020 research and innovation programme (Grant Agreement No. 958352). It uses blockchain, AI and advanced data management to support traceability, transparency and circularity in textile and clothing supply chains. It is a key EU-level reference tool because it was piloted specifically in the textile sector to help SMEs prepare for upcoming requirements on product environmental information, digital product passports and circular business models. (TRICK Project, n. d.).

TRICK provides an SME's-oriented digital platform that collects, structures and secure product and process data along the entire value chain, from raw material to end of life. Data are stored and shared through a blockchain-based architecture to ensure integrity, while a service marketplace gives access to additional modules such as traceability, sustainability assessments and anti-counterfeiting. (CORDIS, 2020).

The platform was tested in pilot demonstrations in the textile-clothing sector (main pilot) and in perishable food for replication, showing that the same digital backbone can support circularity and transparency in complex, fragmented value chains. Technological coordination is led by INTEXTER (UPC) together with a consortium of more than 30 partners, including technology providers, brands and associations. (TRICK Project, n. d.).

The European textile and fashion industry is a major contributor to environmental degradation due to short lifecycles of clothing, limited traceability, and weak circular

practices. In the EU, garments tend to be worn only a few times before disposal, generating significant waste and lost economic value, both economic and ecological. TRICK was explicitly designed to respond to these challenges by enabling trusted, granular data flows that underpin circularity, transparency and informed decision-making along the fashion value chain. (CORDIS, 2020).

For circular fashion, TRICK enables companies to document and prove circular practices by linking each production lot with reliable information on origin, materials, processes, environmental performance and end-of-life options. This is directly aligned with EU policies such as the Ecodesign for Sustainable Products Regulation (ESPR) and future Digital Product Passports (DPP) for textiles, which require digital record of product data to support circular design, repair, reuse and recycling.

The platform goes beyond basic traceability to offer dedicated services for circularity assessment, product environmental footprint (PEF) calculations, and social and health impact modules at lot level. This tool helps SMEs identify where circular strategies (e.g. recycled content, design for durability, recycling routes) can be improved and provide evidence to customers, regulators and financiers which reduces the risk of falling into greenwashing campaigns. (Textile ETP, 2024.).

Key features

Blockchain-enabled secure data foundation	At its core, TRICK uses blockchain technologies to provide a secure, decentralised data layer for product information. This ensures that stakeholders, from raw material suppliers to consumers, can trust the accuracy and provenance of the data. The use of smart contracts enables differentiated access levels (e.g., public vs internal data), guaranteeing confidentiality where needed while maintaining transparency where appropriate.
Standardised data collection and interoperability	TRICK was designed to collect, standardise and harmonise data across diverse supply chain systems and legacy IT environments. To do this, the platform uses semantic standards and ontologies, interoperability connectors and agreed document formats, enabling interoperability between blockchain networks and existing data sources. This reduces fragmentation, a major barrier for SMEs transitioning to circular models.
Marketplace and tools	It supports a service marketplace that includes: Traceability and Preferential Certification of Origin (PCO): Helps companies prove origin and supply chain steps.

	Circularity Assessment: Uses lifecycle data to evaluate product circularity, including reuse potential and end-of-life performance. Product Environmental Footprint (PEF): Measures environmental impacts. Health Protection Assessment: Ensures compliance with health and safety norms. Social and Ethical Assessment: Evaluates social dimensions across the value chain. AI for Anti-Counterfeiting / Data Verification: Applies AI models to detect anomalies, verify data authenticity and prevent greenwashing.

Key benefits

Accelerating circular transition for SMEs	One of TRICK's core aims is to make advanced traceability and sustainability tools affordable and standardised for SMEs, which typically lack the resources to adopt cutting-edge digital technologies on their own. (TRICK Project, n. d). By creating a ready-to-use platform coupled with

	marketplace services, TRICK lowers barriers to digital transformation and circularity adoption across the textile and fashion ecosystem.
Supporting compliance with EU Regulations	TRICK directly supports compliance with EU regulatory frameworks (ESPR, DPP) by structuring product data and facilitating lifecycle transparency. (CORDIS, 2020). This helps companies prepare for mandatory digital product passports and sustainability disclosures that are becoming a legal requirement within the EU.
Enabling enhanced trust and consumer engagement	By leveraging secured data and transparent traceability, TRICK increases stakeholder trust, from supply chain partners to end consumers, and enables consumers to make informed purchasing decisions based on credible product information. This supports market demand for sustainability and circular products (TRICK Project, n. d).
Fostering innovation and replicability	Although tested primarily in textiles and food, TRICK's architecture and services are replicable across industries, indicating potential wider adoption beyond fashion, as for example seen in the project, to the food sector (Idem).

The TRICK platform represents a significant EU-level digital innovation for circular fashion, combining blockchain security, AI analytics and a service marketplace to empower SMEs with reliable product data and sustainability services. It bridges technical, regulatory and economic gaps that have traditionally hindered the uptake of circular business models in the textile sector, aligning with EU environmental strategies and enabling compliance with emergent product standards such as digital product passports. As both a traceability solution and a catalyst for circular practices, TRICK demonstrates how integrated digital tools can accelerate the transition to more sustainable and resource-efficient fashion systems (Idem).

European Data Space for Manufacturing

The EU DATA SP4CE (European Data Spaces 4.0) is a Coordination and Support Action (CSA) funded under the Digital Europe Programme (Grant Agreement: 101083939). Launched in 2022, it addresses the fragmentation in data-driven manufacturing efforts across Europe by consolidating various national and EU-based Industry 4.0 initiatives under a cohesive governance framework.

The initiative focuses on unifying data-driven manufacturing efforts across Europe through a pan-European reference and sustainable Data Space 4.0 alliance. Its primary objectives include establishing governance and guidelines to raise awareness on collaborative data spaces for manufacturing, breaking down data silos both in data sources and among isolated development projects, providing centralized access to a

diverse portfolio of manufacturing data assets, and supporting interoperability via common technical blueprints and standardized processes.

The EU DATA SP4CE has engaged in extensive community-building through over 180 events (online, onsite, and hybrid) including workshops, conferences, and webinars. Dissemination efforts have reached over 30,000 people through LinkedIn, Twitter/X, newsletters, and websites.

The initiative has developed several key resources that form the backbone of its knowledge infrastructure. The Body of Knowledge Catalogue consolidates documents, reports, and guidelines, while the Innovation Catalogue inventories components and standards. Additionally, the Lighthouse Factory Network showcases use cases, and the Data in Manufacturing Initiatives Catalogue is featured on the Digital Factory Alliance platform. Coordination efforts extend to key initiatives including IDSA, Gaia-X, FIWARE, BDVA, Manufacturing-X, and national platforms across Europe.

A significant achievement has been the engagement with European Digital Innovation Hubs (EDIHs), where the initiative leads the Data in Manufacturing Thematic Working Group with 130+ individual participants from 78 EDIHs across 28 EU countries.

The EU DATA SP4CE documentation does not specifically address textile or fashion manufacturing applications. The initiative focuses on manufacturing in general, with documented use cases primarily from sectors such as automotive (Catena-X), general industrial manufacturing, and smart production environments.

However, the fundamental infrastructure and capabilities developed by EU DATA SP4CE could potentially be adapted for circular fashion and textile ecosystems, as the core challenges of data sharing, traceability, and supply chain transparency are common across manufacturing sectors.

Potential Applicability to Textiles (By Analogy)

The following features, while developed for general manufacturing, could theoretically support circular fashion initiatives:

- **General Sustainability Focus.**The initiative aligns with European Green Deal objectives and circular economy principles through data-driven transformation. Its focus on resource utilization optimization across manufacturing processes could be relevant to textile manufacturing, though no specific textile applications are documented in the source material.
- **Manufacturing Use Cases with Potential Textile Relevance.** The platform supports digital traceability of assets throughout the entire supply chain. While documented examples don't include textiles, this capability could theoretically enable fashion brands to track materials from raw fiber to finished garment. Data exchange capabilities for carbon footprint tracking are mentioned in the context of general manufacturing, particularly Catena-X automotive applications, and similar principles could potentially apply to textile supply chains.
- The framework mentions support for closed-loop systems relevant to circular economy implementation, though specific applications are not detailed in textile

contexts. The documented "Predictive Unit Real-Time Information Service (PURIS)" for supply chain management could theoretically benefit textile supply networks, which often involve complex multi-tier supplier relationships.

- **Digital Product Passport Potential.** The initiative includes specific work on Digital Product Passports (DPP) through multiple workshops, including "CIRPASS: Shaping the future of the Digital Product Passport" and "Data Spaces for Manufacturing and Digital Product Passports for Circularity." This work involves integration with the CIRPASS project and standards development for product lifecycle data sharing. *Note: While Digital Product Passports are highly relevant to EU textile regulations, the documented work does not specifically address textile or fashion applications. The applicability to fashion would require sector-specific adaptation and implementation.*
- **Data Infrastructure Capabilities.** The platform provides documented capabilities that could theoretically support data-driven decision-making in any manufacturing context, including real-time data exchange frameworks across value chains, standardized data sharing protocols, quality management systems, and Environmental and Social Standards (ESS) compliance tracking mechanisms. However, implementation for textiles would require sector-specific configuration and potentially additional development.

Key Features, Outputs and Enabling Benefits

- **Technological Frameworks**

Core Technical Components. The platform catalogues 30+ data space connector solutions, including Eclipse Dataspace Components (EDC), IDSA-certified connectors (TNO Security Gateway, TRUE Connector, VTT DSIL Connector), and various open-source and commercial options. Interoperability is supported through the Dataspace Protocol (DSP) as a common language for connector communication, the IDS Reference Architecture Model for sovereign data sharing, the Gaia-X Trust Framework for compliance and governance standards, and FIWARE data models for standardized data representation.

Smart data models are implemented through FA3ST (FASI Asset Administration Shell Tools) for digital twins, semantic interoperability frameworks, and OPC-UA integration for industrial IoT.

Data Infrastructure. The initiative provides several testbeds and validation environments. The Gaia-X Digital Clearing House (GXDCH) offers automated compliance validation, while the IDSA Testbed enables real-time component testing for IDS compliance. The SQS Integration Test Camp (ITC) serves as an accredited laboratory for validation, and T-Systems Living Lab provides a sandbox environment for prototyping.

Extensive open-source resources are available through GitHub repositories from IDSA, Eclipse Foundation, and FIWARE. Notable solutions include SIMPL Middleware for secure IoT communication and Tractus-X KITs, which provide 20+ ready-made specialized solutions covering traceability, quality, sustainability, and other critical areas for rapid deployment.

Collaboration Mechanisms - Multi-Level Ecosystem. The collaboration operates at three interconnected levels. At the European level, the initiative partners with DSSC (Data Spaces Support Centre) and integrates with major initiatives including IDSA, Gaia-X, FIWARE Foundation, and BDVA, coordinated through the Manufacturing-X International Council. National-level connections extend to platforms such as Plattform Industrie 4.0 (Germany), Smart Industry (Netherlands), Industria Conectada 4.0 (Spain), and Piano Nazionale Industria 4.0 (Italy), alongside regional hubs and competence centres. Industry-level collaboration is facilitated through the Digital Factory Alliance (DFA), which serves as PR office and community platform with 1,600+ LinkedIn followers, along with sector-specific initiatives like Catena-X (automotive sector data space) and SCSN (Smart Connected Supplier Network).

- **Knowledge Resources:**

Training and Skills Development. The BAIDATA Academy provides training services for data space skills, complemented by the BAIDATA Accreditation professional certification programme based on IDSA standards. EDIH Training Programs offer skills development through Digital Innovation Hubs, while over 67 online workshops cover technical and business aspects of data space implementation.

Documentation and Guidance. Comprehensive resources include the Data Space Blueprint (DSSC), which provides a complete framework for implementation, and the IDSA Rulebook for governance and operational standards. Over 350 documented

implementations are catalogued in Use Case Catalogues, while the Deployment Bootstrapping Guide offers a practical roadmap for initiating data space projects.

Documented Infrastructure Benefits for the general Manufacturing Context. The platform provides several documented capabilities for manufacturing organizations. Standardization through common frameworks reduces the complexity of connecting to data ecosystems. Data sovereignty mechanisms ensure organizations maintain control over who accesses their data and under what conditions. Interoperability features enable standardized connectors to communicate across different systems and organizations, while pre-built components eliminate the need for custom point-to-point connections, reducing integration complexity. The modular architecture documented in frameworks like Tractus-X allows for incremental scalability.

- **AI-Related Capabilities: A Careful Assessment:**

Important Caveat About AI. The EU DATA SP4CE documentation primarily focuses on data space infrastructure, data sharing frameworks, and Industry 4.0 digital transformation—not specifically on AI implementation. While the document mentions "AI" in various contexts (particularly in connection with related initiatives like BDVA, CLAIRE, and ELLIS), explicit AI adoption frameworks or AI-specific tooling are not the primary focus.

Data Infrastructure That Could Support AI Applications. The platform provides foundational data infrastructure that is prerequisite for AI but does not constitute AI solutions itself. Standardized data models and semantic frameworks provide structured

data access that could theoretically be used for machine learning applications. Governance mechanisms ensure data quality and reliability, which is fundamental for any AI training. The connector infrastructure supports real-time data streams for continuous data flow, potentially enabling real-time AI applications. The FA3ST framework and Asset Administration Shell standards provide digital twin integration that could be used in AI-driven simulations.

What This Means for AI Adoption. The EU DATA SP4CE platform provides enabling infrastructure rather than AI solutions. It creates the "plumbing" for data flow but doesn't implement AI algorithms. Organizations would still need to develop or procure AI/ML capabilities separately. The standardized data access could reduce one barrier to AI adoption by ensuring data availability and quality, but AI implementation would require additional technical expertise, tools, and resources beyond what the data space infrastructure provides.

Potential Benefits for Circular Fashion (Theoretical Application). If adapted for the textile and fashion sector, the infrastructure could potentially support several key functions. The traceability frameworks could theoretically track materials across complex textile supply chains, though sector-specific implementation would be required. Carbon footprint and sustainability data exchange capabilities exist in the framework and could be configured for textile-specific metrics. The governance and standards frameworks could potentially support emerging textile regulations, such as EU

Digital Product Passport requirements for textiles. The connector infrastructure could enable data sharing among fashion brands, manufacturers, suppliers, and recyclers.

Critical Note: These potential applications are extrapolations based on general manufacturing capabilities. Actual implementation for circular fashion would require sector-specific data models for textiles, adaptation of standards to fashion industry requirements, development of textile-focused use cases, engagement with fashion industry stakeholders, and potentially additional technical development.

The EU DATA SP4CE initiative provides a comprehensive foundation for data-driven manufacturing transformation across Europe. The platform is documented primarily for general manufacturing applications, with specific emphasis on automotive and industrial sectors.

The initiative has established robust data sharing frameworks, standardized protocols, and collaborative mechanisms for manufacturing data spaces. However, while the fundamental infrastructure is sector-agnostic, application to circular fashion and textiles would require adaptation, including textile-specific data models, industry engagement, and possibly additional development. It's important to note that the platform provides foundational data infrastructure that could support AI applications but does not constitute an AI implementation framework itself. Nevertheless, the extensive open-source resources, testbeds, training programs, and documentation provide a solid starting point for sectors, including potentially textiles, looking to implement data space solutions. The documented work on Digital Product Passports is particularly relevant

given EU regulatory developments, though textile-specific implementation is not documented in the source material.

Organizations in the circular fashion sector interested in leveraging this infrastructure should assess the applicability of existing frameworks to textile-specific requirements and engage with the EDIH network and Digital Factory Alliance to explore sector adaptation. Pilot projects could test the infrastructure with textile use cases, and participation in the broader data space community would help advocate for textile-specific developments.

This initiative represents significant potential for circular fashion, but realization of that potential would require focused effort on sector-specific implementation and adaptation.

CircularTwAIn – Digital Twin AI for Circular Economy

The following analysis presents CircularTwAIn as an EU-level reference initiative rather than as an industry case study. CircularTwAIn is a European research and innovation initiative developed under the Horizon Europe framework, aiming to leverage artificial intelligence and digital twin technologies to support circular economy transitions in manufacturing sectors. The platform focuses on the creation of AI-enabled digital twins that replicate physical products, processes and systems in a virtual environment,

allowing stakeholders to simulate, analyse and optimise resource flows, production processes and lifecycle impacts in real time (CircularTwAIn Consortium, 2023).

At its core, CircularTwAIn integrates advanced AI models with digital twin architectures to enable data-driven decision-making across the entire product lifecycle. By combining real-time data from sensors, production systems and supply chains with machine learning algorithms, the platform allows manufacturers to predict system behaviour, assess alternative scenarios and optimise processes regarding efficiency, waste reduction and environmental impact. This approach is particularly relevant for complex and material-intensive value chains, where circularity depends on accurate data, system-level visibility and predictive capabilities (European Commission, 2023).

The relevance of CircularTwAIn to the fashion and textile sector lies in its capacity to address some of the key structural challenges hindering circular fashion, including limited lifecycle visibility, inefficient resource use and fragmented data flows across supply chains. Textile and fashion products typically involve multiple stages of production, processing and distribution, often across different geographical locations. CircularTwAIn's digital twin framework enables the modelling of these interconnected stages, allowing stakeholders to simulate material flows, assess the environmental performance of different design and production choices, and identify opportunities for reuse, recycling and waste reduction (CircularTwAIn Consortium, 2023).

From a practical perspective, CircularTwAIn supports the integration of AI-driven analytics into decision-making processes related to product design, production planning

and end-of-life management. In the context of fashion, digital twins can be used to evaluate alternative materials, production methods or logistics configurations before physical implementation, thereby reducing trial-and-error processes that generate waste and emissions. AI-enabled prediction models further enhance the ability to anticipate system inefficiencies, enabling proactive interventions that support resource efficiency and circularity (OECD, 2022).

A key benefit of the CircularTwAIn platform is its contribution to traceability and transparency within circular value chains. By consolidating data across different lifecycle stages into a unified digital twin environment, the platform facilitates more accurate tracking of materials and products over time. This enhanced traceability supports circular fashion practices such as fibre-to-fibre recycling, extended product lifecycles and informed end-of-life decision-making. Moreover, the platform's emphasis on interoperability and data integration aligns with emerging European initiatives on data spaces and digital product information, reinforcing its relevance within the evolving EU digital and sustainability policy landscape (European Commission, 2023).

Overall, CircularTwAIn represents a key EU-level AI tool supporting circular economy objectives by enabling systemic analysis and optimisation through AI-powered digital twins. Its application to the fashion and textile sector illustrates how advanced digital technologies can support circular design, sustainable production and transparent supply chains. By providing predictive insights and lifecycle-level visibility, CircularTwAIn

contributes to the transition from linear production models towards more regenerative and circular fashion systems.

While these initiatives do not constitute end-user tools, they provide the technological and data foundations upon which practical AI applications and tools for SMEs and VET contexts are developed, as examined in subsequent chapters.

SORT4CIRC – Intelligent Textile Sorting for Circularity

The SORT4CIRC project is an EU-funded research and innovation initiative that aims to enable a smarter and more circular textile industry through advanced digital and AI-based technologies (European Commission, 2023). The project addresses one of the most critical bottlenecks in textile circularity: the absence of efficient, automated and traceable solutions for sorting post-consumer textiles at scale. By integrating artificial intelligence with multisensory systems and digital product identification frameworks, SORT4CIRC upgrades conventional sorting infrastructure, allowing textiles that would otherwise be sent to landfill or incineration to be redirected into high-value recycling and reuse streams.

The European textile sector generates millions of tonnes of waste annually, while only a limited share is currently collected, sorted and reintroduced into the economy. This imbalance has made automated sorting technologies a strategic priority for achieving the EU's circular economy objectives, particularly those outlined in the EU Strategy for

Sustainable and Circular Textiles (European Commission, 2022). In response, SORT4CIRC combines machine learning–based classification with advanced sensor technologies, including hyperspectral imaging and near-infrared spectroscopy, to enable accurate and scalable identification of textile fibres, blends and material compositions (SORT4CIRC Consortium, 2024). These technologies enhance recycling efficiency, improve material purity and create new value streams for secondary raw materials.

A core innovation of SORT4CIRC lies in its system-level architecture, which connects digital tools across the entire textile value chain. Data generated through AI-assisted sorting processes are linked to digital systems capable of recording material histories and supporting the future integration of digital product passports and traceability mechanisms. This enhanced traceability not only improves resource-efficient recycling but also strengthens transparency for brands, regulators and consumers, while supporting compliance with emerging requirements related to extended producer responsibility (European Commission, 2022).

From a vocational education and training (VET) perspective, SORT4CIRC offers a concrete and practice-oriented example of how AI, sensor technologies and data analytics are applied to end-of-life challenges in the fashion and textile sector. Integrating insights from SORT4CIRC into the TechStyle curriculum can help learners and SMEs understand how digital technologies intersect with circular value chain solutions, a critical competence area for sustainable textile management. Familiarity with

automated sorting systems, AI-based material classification and digital traceability prepares future professionals to engage with real industrial tools already shaping the transition to circular production models.

Finally, by prioritising interoperable digital architectures, SORT4CIRC anticipates forthcoming regulatory developments in the textile sector, including digital product passport obligations and sustainability disclosure frameworks. In this way, the project demonstrates not only applied AI innovation but also the importance of digital literacy, regulatory awareness and systems thinking as core skills for circular fashion education (European Commission, 2024).

AI4EU – AI-on-Demand Platform

The AI4EU project is a large-scale European initiative designed to bring together, connect and open up EU artificial intelligence resources in support of innovation, technology transfer and the growth of start-ups and SMEs across all industrial sectors (European Commission, 2019). Its most significant and enduring outcome is the creation of the European AI On-Demand Platform (AIoD), the first comprehensive digital ecosystem for AI at European level. Initially developed within AI4EU and subsequently sustained through successor initiatives such as AI4Europe and DeployAI (running until 2027), the platform aims to lower barriers to AI adoption, enhance technology transfer and accelerate the growth of AI-driven start-ups and SMEs through open calls and targeted support actions (AI4EU Consortium, 2021).

Through approximately €3 million in cascade funding, the initiative has directly stimulated the development and scaling of AI-based ventures across multiple sectors (European Commission, 2022). The project deliberately combined industry-driven pilot activities—covering domains such as robotics, the Internet of Things and healthcare—with advanced scientific research structured around five core pillars: Explainable AI, Physical AI, Verifiable AI, Collaborative AI and Integrative AI (Villani et al., 2018; AI4EU Consortium, 2021). Beyond technical assets, the AIoD platform incorporates an Ethical Observatory and offers certified training programmes aimed at engineers, policymakers and civic leaders, directly addressing the EU's persistent skills gap in AI (OECD, 2021; European Commission, 2023).

The long-term sustainability of the initiative has been ensured through the establishment of the AI4EU Foundation, which is responsible for the continued governance, maintenance and development of the AIoD platform (AI4EU Foundation, 2022). Importantly, the cumulative knowledge generated by the project—including platform usage data, scientific outputs and ethical analyses—has been synthesised into a comprehensive Strategic Research and Innovation Agenda (SRIA) for AI in Europe. This agenda continues to inform EU investment priorities, research directions and policy development, reinforcing Europe's ambition to secure a more autonomous and competitive position within the global AI landscape (European Commission, 2024).

The scale of the AIoD platform is reflected in its broad scope and inclusiveness. It serves a wide range of stakeholders, including researchers, SMEs, technology providers,

students, EU-funded projects and public institutions (AI4EU Consortium, 2021). The platform hosts an extensive metadata catalogue providing access to more than 1.5 million AI-related assets—datasets, models, publications and tools—of which approximately 8,000 are related to fashion and design. In addition, it offers nearly 900 educational resources to support AI skills development, including around 50 training materials specifically focused on fashion and design. By indexing and unifying metadata from major external repositories such as Zenodo, Hugging Face and OpenML, the platform avoids duplication while improving discoverability and reuse of AI resources (European Commission, 2022).

The AIoD platform further includes advanced technical tools such as the Research and Innovation AI Lab (RAIL), which enables reproducible AI experimentation, RoboCompass, which addresses the non-technical and governance aspects of responsible robotics and AI, and the AI-Builder, a no-code environment for machine learning model development (AI4EU Consortium, 2021). Together, these components position the platform as a strategic bridge between advanced European AI research and its practical application across industrial sectors, including fashion and textiles.

This bridging role is particularly relevant as the fashion and textile industry faces increasing pressure to transition from a linear “take–make–waste” model toward a circular and sustainable production ecosystem (Ellen MacArthur Foundation, 2017). The AIoD platform provides the technological infrastructure, data access and ethical frameworks required to support this transformation at scale. Its relevance to circular

fashion lies in its capacity to enable data-driven decision-making across the entire value chain. Access to fashion-specific AI resources allows designers and manufacturers to apply predictive modelling techniques and “Design for Disassembly” principles at the earliest stages of garment development, thereby embedding recyclability and sustainability before production begins (Bocken et al., 2016; European Commission, 2020).

Designed as a centralised ecosystem for Europe’s AI landscape, the AIoD platform supports SMEs, researchers and public institutions in moving from theoretical AI concepts to real-world implementation through integrated technological, data-driven and human-centric resources (OECD, 2021). This is particularly important for textile SMEs, which often lack in-house software engineering expertise. The AI-Builder tool enables users to develop AI solutions—such as image recognition systems for fabric defect detection—through a drag-and-drop interface without writing code, lowering the technical threshold for adoption (AI4EU Consortium, 2021).

Similarly, RAIL functions as a virtual experimentation environment where AI applications can be tested and validated before deployment. For example, predictive models designed to optimise water usage in textile dyeing processes can be evaluated within RAIL, reducing financial risk and supporting evidence-based investment decisions prior to real-world implementation (European Commission, 2022). In the context of increasing regulatory scrutiny following the adoption of the EU AI Act, RoboCompass plays a critical role by guiding users through ethical, legal and societal considerations associated with

AI systems. By translating regulatory requirements into actionable guidance, it helps organisations ensure compliance with data protection, labour and AI governance standards (European Parliament, 2024).

For projects such as TechStyle, the AIoD platform can therefore function both as a strategic reference model and as a practical resource base. It offers access to fashion-oriented AI assets, integrates ethical and legal compliance mechanisms through tools such as RoboCompass, and provides educational materials that support the assessment of existing VET provision and skills gaps. Furthermore, its technical tools—AI-Builder and RAIL—offer concrete examples of industry-ready AI applications, supporting the development of realistic and relevant curriculum recommendations. In this way, the platform contributes to ensuring that WP3 outputs are grounded in actual industry needs and aligned with the regulatory and technological realities faced by textile workers and entrepreneurs across Europe (AI4EU Consortium, 2021; European Commission, 2024).

ELISE - European Network of AI Excellence Centres

ELISE (the European Network of AI Excellence Centres) is not a specific software application or digital platform, but a large-scale European network of leading research centres focused on Artificial Intelligence. Its primary objective is to build a genuine

"Powerhouse of European AI" by strengthening excellence and coordination in AI research across Europe (European Commission, 2020; ELISE, n.d.).

The network promotes the dissemination of AI knowledge, methodologies, and research outcomes across academia, industry, and society. A strong emphasis is placed on the development of explainable, trustworthy, and ethically responsible AI systems, with particular attention to data safety and security (ELISE, n.d.). ELISE operates in close cooperation with ELLIS (the European Laboratory for Learning and Intelligent Systems), contributing to a shared vision for advancing machine learning and intelligent systems in Europe (ELLIS, n.d.).

Although ELISE is not specifically designed for a single industrial sector, its work has clear relevance for circular fashion due to its broader commitment to addressing global societal and environmental challenges through AI. The network explicitly highlights that advances in AI provide new tools to tackle the climate crisis, a goal that aligns closely with circular fashion principles such as waste reduction, resource efficiency, and extended product lifecycles (ELISE, n.d.; European Commission, 2020). Initiatives like the ELLIS/ELISE AI for Learning Weather and Climate workshop demonstrate how AI research can support environmental monitoring and climate-related solutions relevant to circular economy models (ELLIS, n.d.).

In addition, ELISE supports industrial innovation by connecting companies with advanced AI expertise and research networks. This creates opportunities for the development of AI-driven solutions applicable to circular fashion, including predictive

maintenance, material classification and sorting, and supply chain optimisation for textile reuse and recycling (European Commission, 2020).

ELISE structures its activities around four core pillars: the development of a coordinated European Strategic Research Agenda in AI, the training of future AI talent through a pan-European PhD and postdoctoral programme, researcher mobility schemes that encourage collaboration and knowledge exchange, and strong engagement with industry to translate research excellence into practical and scalable innovation (ELISE, n.d.).

Chapter 5 – Practical AI Tools for Circular Fashion Skills Development

The integration of artificial intelligence (AI) into fashion and textile processes is becoming increasingly relevant within the French fashion ecosystem, which is characterised by a strong presence of luxury and high-end brands, creative industries, and an expanding fashion technology landscape. In France, AI-driven tools are progressively applied across design, trend forecasting, marketing, and supply chain management, supporting both creative innovation and operational efficiency. At the same time, AI is being leveraged to address sustainability challenges, including overproduction, inventory management, and traceability across complex and global value chains. These developments align with France's broader strategic priorities in digital innovation and

sustainable industry, positioning AI as a key enabler of circular practices within the fashion and textile sector.

Practical AI Tools for Circular Fashion Skills Development – France

Heuritech

AI tools have become instrumental in guiding decision-making processes related to market trends, strategic planning, and business models—including circular models—by leveraging real data analytics. In the context of market trends, AI systems process information from social media and other sources to forecast demand and identify emerging opportunities, thereby enabling organizations to minimize risk and align product offerings with relevant trends. Depending on the specific algorithm employed, businesses may choose to replicate successful products or pursue innovation through the development of niche items.

Heuritech (www.heuritech.com) specializes in trend prediction for brands by analyzing visual content across social media platforms. Established in 2013 by scientists dedicated to continual algorithmic improvements, Heuritech provides valuable insights to brands, retailers, and the broader fashion industry.

For instance, a fashion brand can utilize Heuritech to assess social media imagery and anticipate future trends, which informs production decisions to meet anticipated demand. Retailers benefit by optimizing inventory management based on these

forecasts, reducing risks associated with overstock and unsold merchandise. PUMA successfully implemented this approach when launching new footwear models, such as ballet flats in their women's sneaker collection.

Heuritech offers an advanced alternative to traditional trend forecasting by combining historical analytics with forward-looking projections. Notably, when leopard print experienced a 128% surge in popularity on social media in Europe during 2024, Heuritech accurately forecasted burgeoning interest in a wider array of animal prints.

Midjourney

More than 80% of a garment's circularity is determined during the design phase, underscoring the importance of integrating sustainability considerations at the earliest stages. Within the framework of circularity, material and fabric selection are critical decisions. Artificial intelligence (AI) streamlines the evaluation of various fabrics, enabling efficient comparison of their environmental impact, as well as facilitating the adoption of innovative bio-based alternatives to traditional fossil-based materials.

AI also confers significant benefits in the creation of zero-waste prints and markedly accelerates the creative process—from reducing timelines from two to eight months down to as little as one day to one month, depending on the product. This enhances decision-making and ensures products are more closely aligned with market trends and consumer preferences.

Generative AI has elevated design capabilities to unprecedented levels. Among such platforms, Midjourney (www.midjourney.com) specializes in generating illustrations, artistic visuals, and animations from textual descriptions. By converting text prompts into digital artworks, Midjourney enables fashion industry professionals to create distinctive assets for diverse applications, including both design and marketing.

Fashion designers utilize Midjourney to develop innovative and exclusive textile patterns, integrating unique artistic elements into their collections.

Browzwear

Large-scale textile manufacturing has undergone extensive automation and is increasingly leveraging artificial intelligence. Digital integration now spans the majority of production workflow stages—from pattern development through to pre-cutting prior to sewing—although robotic solutions have not yet matched the accuracy and dexterity exhibited by skilled dressmakers. While AI adoption is progressing in areas such as design and raw material procurement, its implementation within garment assembly remains challenging due to the indispensable role of human craftsmanship. Consequently, small and medium-sized enterprises providing high-value, limited-series production are integrating AI technologies at a more measured pace.

Browzwear (www.browzwear.com) delivers collaborative solutions that enhance communication between designers and manufacturers, beginning with its “VStitcher”

platform and expanding into additional collaborative tools for style creation, workflow optimization, and fabric analysis. The company also supports integration with brands' existing platforms. Using VStitcher's advanced 3D design capabilities, designers and production teams can construct virtual prototypes, modify designs in real time, and achieve photorealistic visualizations prior to full-scale production.

Established in Paris in 1983, Kookaï was founded to offer fashionable, high-quality apparel at accessible price points. Now an Australian women's fashion brand, Kookaï represents femininity, confidence, allure, and independence. In response to today's dynamic fashion landscape, minimizing lead times and accelerating product development are paramount. Kookaï employs Browzwear's 3D technology to rapidly implement technical and fit adjustments to garments, thereby shortening time to market. The technology also facilitates accurate visualization during sampling and removes the necessity for physical mock-ups or repeated trial processes.

Veesual

Customers increasingly demand high-quality experiences, particularly in online environments where AI technology optimizes each phase—from initial awareness through to purchase. Advanced features such as visual search, discovery tools, online fitting solutions, and interactive chatbots now support customers throughout their digital journey.

Established in 2020, Veesual (www.veesual.ai) emerged as an early innovator in facilitating online commerce. The company specializes in developing augmented shopping experiences for fashion e-commerce by harnessing artificial intelligence to create dynamic imagery. Its suite of solutions—including "Switch Model," "Look Inspiration," and "Mix & Match"—enables consumers to visualize apparel on mannequins tailored to their body type, age, or skin tone, and to assemble personalized outfits. Veesual serves online catalogs, brands, and retail platforms as its primary clients.

These technologies are designed to enhance customer engagement, improve conversion rates, and decrease product returns. For instance, visual search powered by AI allows shoppers to locate products based on color and style, streamlining the browsing experience, increasing conversions, and minimizing lost sales due to ineffective searches.

La Redoute, France's oldest sales catalog (established in 1837), has been a leader in online commerce since 1994, becoming the preferred shopping partner for approximately 20 million households by the early 2000s. La Redoute collaborated with Veesual prior to its official launch, co-developing the company's initial algorithms. Today, Veesual regularly partners with La Redoute—known as Dame de Roubaix—to optimize their collections. The "Mix & Match" feature assists clients in selecting outfits that best suit their individual style and silhouette, while "Switch Model" aids in identifying the optimal garment fit, thereby reducing dissatisfaction upon delivery and minimising product returns.

Summary of AI tools

In addition to the tools discussed in this chapter, the table below provides an overview of categories of AI tools and their primary applications throughout the value chain.

Theme	Types of AI Tools	Description
Strategy	Trend analytics, e.g. Heuritech (FR), Stylumia (IN)	AI platforms for trend analysis and demand forecasting based on social media (Heuritech) or best sellers (Stylumia) to optimize collections, avoid overproduction and better meet customer needs — helps reduce unsold inventory and waste
Design	Generative AI specialists e.g. Textil'IA (FR), SXD (US)	Accelerates design catalogues and archives, facilitates ideation (shapes, patterns, silhouettes), reduces physical prototypes (Textil'IA) or provide zero-waste patterns (SXD)
Production	Predictive maintenance and defect detection e.g.	Intelligent machine learning systems and inspection systems to detect defects and

	Lectra (FR), Smartex (PT)	production errors, reducing textile waste and scrap.
	Digital printing or knitwear e.g. IMKI (FR)	Design optimization system for textile printing or circular knitting
	Product traceability e.g. ODITH/Textil'IA (FR)	Share information to ensure traceability
Branding & communication	A full range of AI tools among which Canva (AUS), Dall-E or Sora (OpenAI), Midjourney (US) etc.	Generation and improvement of visual and textual content for communication that expresses the brand's personality and is consistent across all chosen media, and that helps cutting costs and environmental print.
Sales	AI-powered online platforms of first or second-hand sales e.g. Woocommerce (RSA/EU), Shopify	Personalised product recommendations and dynamic pricing to increase conversion and reduce returns (which generate waste/exchanges)

	(CAN), Vestiaire Collective (FR)	
Customer experience	AI-powered search agents for virtual shopping e.g. United Commerce Protocol for major search engines	Personalized outfit recommendations based on style and occasion to increase numbers of product wears

Practical AI Tools for Circular Fashion Skills Development - Sweden

AI Factory – RISE Research Institutes of Sweden

The AI Factory operated by RISE Research Institutes of Sweden constitutes a key national platform for the applied development and deployment of artificial intelligence in industrial contexts. It provides companies with access to AI expertise, testing environments, and data-driven tools that support the implementation of machine learning and computer vision solutions in manufacturing and material-intensive sectors (RISE, 2024). Within the textile and fashion industry, the AI Factory has supported use cases such as AI-assisted quality inspection, predictive maintenance of textile production equipment, and optimisation of material flows during processing. These

applications contribute directly to sustainability objectives by reducing production errors, minimising material waste, and lowering energy consumption. From a circular economy perspective, AI-enabled quality control and process optimisation support longer product lifecycles and more efficient use of raw materials, while generating data that can be used to improve traceability across production stages.

AI-Enabled Textile Sorting and Recycling Systems – SIPTex

A nationally significant application of AI in Sweden is found in large-scale textile sorting and recycling systems, particularly through the work of SIPTex (Swedish Innovation Platform for Textile Sorting). SIPTex operates an automated textile sorting facility that integrates AI-based image recognition, sensor technologies and machine learning algorithms to identify fibre composition, colour and garment characteristics at scale. These systems enable high-precision sorting of post-consumer textiles, which is a critical prerequisite for fibre-to-fibre recycling and closed-loop textile systems (Circular Sweden, 2023). The relevance of this application to circularity lies in its ability to overcome one of the main structural barriers in textile recycling, namely the lack of accurate and scalable sorting technologies. By improving material recovery rates and enabling the production of higher-quality recycled fibres, AI-supported sorting directly contributes to waste reduction, resource efficiency and the development of secondary raw material markets within the Swedish textile sector.

H&M Group – AI-Driven Demand Forecasting and Supply Chain Analytics (In-house Systems)

In addition to collaborative innovation ecosystems, AI-driven supply chain analytics in Sweden are also implemented through company-specific solutions developed by major fashion brands. A notable example is H&M Group, which applies machine learning models to analyse sales data, consumer behaviour, and logistics flows in order to support demand forecasting, inventory optimisation, and production planning. These AI-supported systems aim to reduce overproduction and excess stock, contributing to lower waste generation and more resource-efficient supply chain operations. Improved data integration further enhances transparency and traceability across global value chains, supporting sustainability objectives within the company's broader circular economy strategy.

Practical AI Tools for Circular Fashion Skills Development - Greece

CLO 3D

One prominent category of tools enhances design and prototyping. Platforms such as CLO 3D provide advanced 3D garment simulation that allows designers to visualize how fabrics drape and behave without producing physical samples, reducing material waste and shortening development cycles. CLO 3D is widely used by leading industry players to create realistic virtual garments, enabling students and professionals to experiment with form and function in a sustainable digital environment (CLO 3D, n.d.; Wearview, 2025). By integrating AI-assisted pattern generation and predictive fit modelling, these tools help future designers understand the interplay of style, function, and material efficiency before physical production.

T-Fashion

AI also supports trend forecasting and market insight with tools like T-Fashion (TrendGenius), which combines large-scale data analysis with machine learning to predict emerging fashion trends. By analysing consumer behaviour, social media

signals, and historic sales patterns, such platforms guide designers and brands toward more informed decisions that align with sustainability goals and minimise unsold inventory—a core circular fashion challenge (Modelia.ai, 2025). Exposure to trend-forecasting AIs in VET curricula fosters critical skills in data interpretation and strategic planning for sustainable product development.

Vue.ai

In the field of AI-driven retail and personalisation, Vue.ai provides an integrated suite of tools powered by computer vision and natural language processing to personalise shopping experiences, automate product tagging, and optimise merchandising decisions. By improving product recommendations and automating cataloguing, Vue.ai reduces returns and operational inefficiencies—key factors in lowering the environmental footprint of e-commerce. For VET learners, understanding such AI solutions highlights the interplay between customer experience, efficiency, and sustainability (Vue.ai, 2024).

Another critical application involves traceability and circular value chain management. The CircularID™ Protocol by Eon assigns unique digital identities to garments, allowing stakeholders to record and share information about material composition, ownership, and lifecycle events. This infrastructure supports compliance with the EU's upcoming Digital Product Passport regulation, helping manufacturers, retailers, and consumers

make informed circular choices. For Greek SMEs and VET institutions, exploring CircularID provides valuable insights into how AI and IoT can enable data-driven sustainability (Eon Group, 2023).

Together or even individually, these AI tools represent a range of practical, real-world applications that link technological innovation with circular fashion principles. For Greece's VET ecosystem, integrating knowledge of these tools into coursework and training modules supports the development of digital competences that align with both industry readiness and sustainability goals. By working with design platforms, forecasting engines, virtual fitting technologies, lifecycle tracking systems, and consumer-oriented AI, learners gain a comprehensive understanding of how AI can be harnessed within circular and regenerative fashion value chains.

Practical AI Tools for Circular Fashion Skills Development – Italy

YOLO - AI-Enabled Digital Product Passports and Supply Chain Traceability

YOLO is an AI-enabled traceability and digital product passport solution designed to support transparency and data integration across fashion and textile supply chains. The system combines data analytics, AI-supported verification processes, and digital labelling technologies to enable the collection, management, and sharing of product-

level information related to materials, production processes, and lifecycle impacts (YOLO, 2024).

From a circular fashion perspective, YOLO contributes to improved traceability and accountability across complex value chains, which is a critical requirement for circular business models and extended producer responsibility schemes. By enabling reliable access to product data, the tool supports reuse, recycling, and responsible end-of-life management, while also facilitating compliance with emerging EU requirements on digital product passports and sustainability disclosure.

In terms of skills development, the adoption of AI-enabled traceability tools such as YOLO requires competences related to data governance, supply chain analysis, and regulatory awareness. Learners and professionals must understand how product-level data is generated, verified, and used across the value chain, as well as how AI supports automation and risk detection within traceability systems. Within VET and higher education programmes, such tools provide practical learning opportunities at the intersection of digitalisation, sustainability, and compliance, equipping future professionals with skills increasingly demanded by the Italian and European fashion industry.

POLI.design (Politecnico di Milano) – AI-Supported Fashion Technology and Product Innovation

POLI.design, the postgraduate design school of the Politecnico di Milano, integrates AI-supported tools and data-driven methodologies within fashion technology and product innovation programmes. Through applied laboratories and industry-linked projects, learners engage with AI-enabled systems for material analysis, digital prototyping, lifecycle assessment, and product optimisation, supporting the development of innovative and sustainable fashion solutions (POLI.design, 2024).

From a circular fashion perspective, POLI.design's relevance lies in its focus on embedding circular economy principles directly into the product development process. AI-supported analysis is used to evaluate material performance, production scenarios, and lifecycle impacts at early design stages, enabling more informed decisions that reduce resource consumption and environmental footprint. This approach aligns with Italy's strong design-manufacturing nexus and supports the transition towards regenerative and circular product models.

In terms of skills development, POLI.design provides a structured learning environment where learners and professionals acquire competences at the intersection of design, data analysis, and sustainability. Participants develop the ability to work with AI-supported tools, interpret performance and impact data, and collaborate across creative and technical disciplines. Within VET and professional training pathways, such

applied environments strengthen strategic, digital, and sustainability-oriented skills that are increasingly demanded by the Italian fashion and textile industry.

Lectra – AI-Enabled Production Planning and Material Optimisation

Lectra offers AI-enabled CAD, cutting, and production planning solutions that integrate data analytics and machine learning to optimise pattern making, grading, marker efficiency, and manufacturing workflows. These systems are widely used in industrial fashion environments to improve precision, reduce errors, and enhance overall production efficiency (Lectra, 2024).

From a circular economy standpoint, Lectra's relevance lies primarily in its contribution to material efficiency and waste reduction during manufacturing. Fabric waste generated during cutting represents a significant environmental and economic cost for fashion companies. AI-assisted marker optimisation enables more efficient fabric usage, while data-driven production planning reduces rework, defective outputs, and unnecessary resource consumption. These improvements contribute directly to more sustainable manufacturing practices and lower environmental impact.

In terms of skills development, Lectra exemplifies how AI is integrated into real industrial processes. Training on such systems enables learners to develop competences in digital pattern engineering, production data analysis, and sustainable manufacturing

optimisation. These skills are particularly relevant for technicians, production planners, and sustainability managers working in circular fashion systems, where efficiency, traceability, and waste reduction are increasingly intertwined.

Taken together, Heuritech, CLO3D, and Lectra demonstrate how AI can support circular fashion objectives across multiple stages of the value chain, while also highlighting the diversity of skills required for effective adoption. Rather than focusing solely on technical proficiency, these tools require a combination of analytical skills, digital competences, sustainability awareness, and critical thinking.

For SMEs and VET providers, concentrating on a limited number of strategically relevant tools allows for deeper learning outcomes and more meaningful integration into training programmes. This approach supports the development of transferable skills that can be applied across different technologies and contexts, reinforcing the role of AI as an enabler of circular fashion rather than an end in itself (European Commission, 2020).

Practical AI Tools for Circular Fashion Skills Development – Spain

CircularPass by Blue Room Innovation

CircularPass is a blockchain-enabled traceability and Digital Product Passport (DPP) platform designed to capture, secure, and manage product and material data across the

full lifecycle of a textile product. It enables traceability from raw materials to end-of-life, integrating sustainability metrics and supporting compliance with EU sustainability regulations such as the Ecodesign for Sustainable Products Regulation (ESPR) and corporate reporting standards like CSRD and PEFCR (CircularPass, n. d.)

The solution emerged from a collaboration between Blue Room Innovation (the technology provider behind CircularPass) and partners including bAwear, combining blockchain-based traceability with environmental scoring mechanisms that monitor key indicators (carbon footprint, water use, waste) in real time. CircularPass has several use cases in the national industry, like Circularport (track waste from vessels) or Cartrack (automotive), but particularly for the scope of this report, CircularTech takes the lead (Idem).

CircularTech is a groundbreaking digital platform designed for the textile industry, offering complete traceability from the sourcing of raw materials to the product's end-of-life. By utilizing a blockchain-based Digital Product Passport, it ensures an immutable record of key data, such as materials, processes, and environmental impact. (CircularPass, n. d). The benefits of this tool are; Enhanced traceability and transparency: Through the integration of blockchain, the platform ensures complete and immutable tracking of products and materials throughout their entire life cycle, enabling verification of environmental impacts; Real-Time environmental assessment and regulatory compliance: The platform continuously monitors key indicators such as carbon footprint, water consumption, and waste generation, facilitating compliance with

European regulations and optimizing sustainable processes.; Support for circular business models and scalability: The project promotes the adoption of circular economy principles by enabling the reuse and recycling of materials, while offering a modular and accessible platform for businesses of all sizes, allowing expansion into other sectors (Idem).

Its modular structure and no-code framework make it easy for both small and large businesses to adopt, while its flexible design allows for expansion into industries like construction, aerospace, and advanced manufacturing.

By integrating these elements, CircularTech transforms data across the value chain into practical insights, enabling manufacturers, retailers, and recyclers to streamline operations, minimize environmental impact, meet regulatory standards, and openly showcase their sustainability efforts to both consumers and authorities (Idem).

IVISITAGS – Integrated labels for garment traceability

INVISITAGS is a research-led initiative (2024-2027) to develop embedded UHF-RFID labels that are integrated into garments at the manufacturing stage rather than applied externally. Developed by Trace ID and Twin Investors in collaboration with the Textile Technology group (TECTEX) at INTEXTER-UPC (Universitat Politècnica de Catalunya), INVISITAGS aims to advance physical traceability technology for textile products,

enabling durable and longitudinal monitoring throughout a garment's lifecycle (Centre for Innovation and Technology (CIT UPC), n. d.).

Unlike conventional RFID tags that are attached externally and can be removed or lost, INVISITAGS are designed to be integrated into seams or hidden within garments during production, making them resilient throughout wear, reuse cycles and recycling processes. It does not have any use case yet, as it is an ongoing project with no pilot demonstration yet. However, it can be foreseen the relevance to circularity and traceability, such as physical layer for digital traceability. INVISITAGS provides the hardware foundation for digital systems (DPPs, traceability platforms), enabling the seamless capture of lifecycle data that is otherwise lost once a tag is removed. Moreover, the lifecycle monitoring and reuse support, as the tags are durable and integrated during manufacturing, they enable tracking across multiple use cycles, which is essential for circular economy models (reuse, resale, repair). Also, it facilitates recycling. Persistent identification throughout end-of-life sorting enhances the quality and reliability of recycling streams, as recyclers can sort and recover materials based on authentic embedded identifiers rather than paper or removable labels (Idem). Finally, it allows integration with digital platforms like CircularPass and future national data spaces, strengthening the overall data ecosystem.

Practical AI Tools for Circular Fashion Skills Development - Türkiye

Refabric

Refabric is an AI-powered platform designed to revolutionize fashion and textile manufacturing by focusing on visual rendering speed and the elimination of physical sampling waste. The tool integrates sketches, patterns, and conceptual prompts to generate original design variations on diverse, customizable models within minutes. Its advanced photo-shooting feature supports inclusive marketing by allowing brands to showcase designs across various genders, races, and body types. By digitizing the sampling process, Refabric addresses the significant logistical and environmental burdens caused by the global transport and eventual destruction of physical prototypes. The AI analyzes a brand's historical best-sellers and mood boards to capture its unique stylistic fingerprint, ensuring new collections maintain brand heritage. For SMEs and entrepreneurs, the platform acts as a virtual design partner, reducing the need for large creative teams while balancing tight budgets. Digital fabric simulations replace multiple physical versions of a garment, drastically lowering material, labor, and shipping expenses. Environmental sustainability is a core benefit, as the tool reduces the carbon footprint associated with the design phase and minimizes the risk of unsold deadstock. From a circular economy standpoint, Refabric facilitates the use of low-impact materials and monomaterials during the early design stages. It also optimizes fabric layouts and

generates seamless patterns, which directly reduces pre-consumption textile waste during production. Furthermore, each design creates a digital file that provides the necessary traceability for a more transparent and accountable supply chain. The tool offers a vast, updated library of trends and design elements that inspire creativity while shortening the transition from trend analysis to bulk production. Ultimately, Refabric empowers brands to transition into the future by merging technological innovation with sustainable and circular business practices (Refabric, 2023).

SwatchLOOP

SwatchLOOP serves as a "Zero Waste" digital platform designed to function as the essential backbone for the textile recycling industry. The global fashion sector currently faces severe inefficiencies where production waste and unsold inventory lead to massive environmental losses. It's estimated that 8% of yarns, 13% of fabrics, and 20% of finished textiles in the EU may be lost during manufacturing (Huygens et al., 2023). To address this crisis, SwatchLOOP implements a system that assigns unique QR codes to waste batches at the point of origin, such as the fabric cutting section. These digital tags record critical data including fiber composition, chemical treatments, and the material's specific origin. By digitizing this information, the platform ensures that recycling facilities receive materials with pre-verified technical properties, eliminating traditional processing hurdles. Beyond tracking, the platform operates a B2B marketplace that fosters industrial symbiosis by connecting brands with recyclers and upcyclers. For SMEs and entrepreneurs, this system transforms fabric scraps from a costly liability into

a potential revenue stream. Small businesses can now easily find specific buyers for their classified waste, effectively monetizing materials that were previously destroyed. Consumers also benefit from this transparency, as they can scan QR codes to view a product's entire waste cycle and ecological savings. This visibility into carbon and water conservation efforts helps build brand trust and encourages more sustainable consumption habits. The platform's core relevance lies in its ability to transform "invisible" textile waste into high-value, digitized assets. By using AI-based tools to classify waste at the source, SwatchLOOP keeps materials within the production loop for as long as possible. Ultimately, the platform provides the necessary traceability to meet modern environmental standards and global recycling targets (SwatchLOOP, 2022).

Digital Transformation Center (DTM)

The Digital Transformation Center (DTM) was established through the Metamorphosis project by the İstanbul Apparel Exporters Association (IHKIB) and the İstanbul Fashion Academy (IMA) to guide the fashion and apparel sector toward a digital and green future. It utilizes the Smart Industry Readiness Index (SIRI) to conduct digital maturity assessments, providing companies with strategic roadmaps for growth. These services are specifically designed for fashion brands, e-commerce businesses, and manufacturers seeking to become more competitive and technology oriented. DDM

offers a comprehensive suite of high-tech tools, including 3D fashion design programs, computer-aided pattern making, and additive manufacturing. Entrepreneurs and SMEs can leverage DTM's infrastructure to experiment with advanced technologies like transfer printing and automation without the high cost of initial investment. The SIRI assessment identifies critical areas across the supply chain or shop floor that require digitization for maximum impact. Through the Model Factory, businesses can integrate automated cutting and computerized sewing systems to modernize their production lines. This shift toward automation eliminates human error and ensures highly precise material usage during manufacturing. Consequently, the reduction in fabric waste directly lowers production costs while simultaneously improving the brand's sustainability profile. DTM's 3D Fashion Design Labs allow for the digital creation of garments, which reduces the need for physical prototypes and optimizes resource use. AI-driven algorithms within the center also help optimize fabric layouts, further minimizing the environmental footprint of textile production. The integration of Industry 4.0 and IoT-connected machinery allows companies to monitor energy consumption in real-time. This real-time data helps identify "carbon hotspots" on the factory floor, enabling targeted interventions to reduce emissions. The SIRI assessment specifically includes dimensions focused on energy efficiency to ensure alignment with global green standards. Ultimately, DTM acts as a catalyst for a more technology-oriented, eco-friendly, and globally competitive textile ecosystem (DTM, 2021).

These three pillars—Refabric (Design), SwatchLOOP (Waste), and DTM (Digitalization)—create a complete circular loop in Türkiye. Refabric ensures that only what is needed is

designed; DTM ensures that it is produced in the most efficient way possible; and SwatchLOOP ensures that nothing from this process goes to waste.

AI is emerging in the fashion and textile sector, offering tools to advance sustainable production practices. By harnessing the ability of AI algorithms to analyze vast datasets, designers and manufacturers can gain a deeper understanding of consumer demand patterns, optimize production processes, and minimize waste. This data-driven approach empowers the industry to move away from the traditional linear model of production and embrace a more circular and sustainable system.

Chapter 6 – National Case Studies in AI-Driven Circular Fashion (Industry Applications)

While regulatory frameworks, strategies, and technological infrastructures set the enabling conditions for AI adoption, their practical impact becomes visible through concrete industry applications. This chapter presents a selection of national case studies illustrating how Artificial Intelligence is applied across the fashion and textile sector to support circular and regenerative practices. The case studies highlight real-world uses of AI in areas such as production optimisation, material sorting, traceability, and data-driven decision-making, while also reflecting the influence of regulatory requirements, market conditions, and organisational capacity. By focusing on industry-

level implementation, the chapter provides practical insights into both the opportunities and challenges of AI-driven circular fashion in different national contexts.

National Case Studies in AI-Driven Circular Fashion (Industry Applications) – France

While regulatory frameworks, strategies, and technological infrastructures set the enabling conditions for AI adoption, their practical impact becomes visible through concrete industry applications. This chapter presents a selection of national case studies illustrating how Artificial Intelligence is applied across the fashion and textile sector to support circular and regenerative practices. The case studies highlight real-world uses of AI in areas such as production optimisation, material sorting, traceability, and data-driven decision-making, while also reflecting the influence of regulatory requirements, market conditions, and organisational capacity. By focusing on industry-level implementation, the chapter provides practical insights into both the opportunities and challenges of AI-driven circular fashion in different national contexts.

IMKI

Founded in 2020 in Strasbourg (67) by Frédéric Rose, Imki draws on his passion for craftsmanship, two decades of experience in creative value chains, and enthusiasm for

cutting-edge technology. The company now has 25 employees—including AI engineers, Ph.D.-level data scientists, and stylists.

Imki's primary mission is to deliver Augmented Creative AI solutions specifically designed for the luxury and fashion industries. The company offers specialized "business" AI through an AI-as-a-Service (AIaaS) model, which includes a streamlined, one-time setup for rapid integration into client workflows. Clients also have access to ongoing subscription options that provide continuous maintenance and support for AI evolution.

The Imki platform is accessed via a user-friendly web application ("WebApp") and is hosted on secure company servers to ensure the highest level of confidentiality. Importantly, Imki's artificial intelligence operates without utilizing third-party data, upholding strict respect for client intellectual property. As a result, clients retain full ownership of all creations produced by the AI, ensuring that their proprietary designs and innovations remain fully protected.

For the past two years, Imki has convinced major fashion brands (among which Jonak, Jules, The Kooples) to experiment with its tools, which design products that align with their aesthetic.

- Imki teamed up with JONAK, a European shoemaker established in 1964, to use AI and 5,000 archival images to design six new models of ankle boots, sandals, and ballet flats, that were presented at CES 2025 in metallic grey tones, to be followed by other colours. As Lina Nakam, Jonak's managing director said, "*The process took two*

months, refining everything from shaft length to heel height, and the collection successfully preserves Jonak's signature style".

- Imki also collaborated with The Kooples to create a fully AI-generated capsule collection. Artificial intelligence systems were trained on the brand's signature products and subsequently utilized by the artistic, collection, and style teams for product development. The resulting creative proposals adhered strictly to the brief and maintained the key attributes of The Kooples brand, leading to a tenfold increase in concept generation. Items such as biker jackets, handbags, dresses, and denim pieces were developed at three times the usual speed.

Circularity and AI insights in this case study

- Integrate branded codes, product attributes, and foundations to design small series.
- Shorten lead times from initial creativity through technical finalization to 2 months, compared to 6.
- Align products with demand to minimize unsold inventory, overstock, and waste.

HAASE Innovation

Founded in 1905, Haase Innovation is a family-run company specialising in circular and flat knits, with particular expertise in velvet knitting. They are labelled Entreprise du Patrimoine Vivant, a state label established in 2005 to distinguish French artisanal and industrial companies with rare and exceptional know-how. At its Manthes workshops (26), the company once employed over 600 people. In 2014, Marine Anton acquired both

Histoire de Women—a garment making workshop—and the struggling Haase Innovation. At just 28 years old, her goal was to preserve jobs and keep French expertise alive.

Her strategy for taking over both companies was to go beyond basic garment production: "*The acquisition allows us to offer customers a comprehensive service, from knitting and product development to garment production in both knits and woven fabrics, as well as production management. The customer simply provides a sketch, and we handle everything from start to finish*," she explains proudly. Marine adds, "*Being vertically integrated lets us control our schedules and efficiently coordinate the knitting and garment-making steps*."

Haase Innovation has expanded its offerings to include creative design advice, strengthening partnerships with clients. They've also diversified their products; besides developing new velvets—primarily for autumn and winter—they now produce jersey, interlock, and lighter fabrics, enabling them to fulfil orders for spring and summer collections too. This diversification helps ensure steady business throughout the year. The company also seeks out threads that balance design excellence, durability, and easier recyclability at a product's end-of-life.

Continuous improvement and innovation are central to Haase Innovation's mission. They use 3D prototyping and artificial intelligence to set scratch marks and patterns on advanced cutting tables, as well as to detect material defects. According to Marine Anton, investing €300,000 in automated cutting technology significantly boosted

productivity, reducing cutting times from 17 minutes to just 2 minutes 30 and drastically cutting waste—though complex material blends can still be challenging.

Circularity and AI insights in this case study

- Preserve traditional knitting expertise to sustain jobs and ensure generational succession.
- Keep production near clients to avoid unnecessary production, support the local economy and avoid issues with remote manufacturing.
- Utilize AI as a tool.

Vestiaire Collective

Vestiaire Collective, a Paris-based online marketplace for pre-owned luxury fashion, has emerged as a leader in the resale market, the fastest growing sector in the T&C market. Founded in 2009, it facilitates transactions between private buyers and sellers with authentication and logistics support. By promoting second-hand sales, Vestiaire Collective helps extend item lifespans and lower the environmental impact of new clothing production. The company operates in over 70 countries, supports 9 languages, employs 600 people, and reported a turnover of €157 million in 2023 from 2.3 million purchases and an average basket of €350.

Circularity is at the core of Vestiaire Collective mission and business model

- Vestiaire Collective closely tracks the extent to which purchases of second-hand items on its platform replace the need for buying new products—a key metric for evaluating the platform's contribution to circularity. Recent analyses of consumer behavior indicate a 79% displacement rate, meaning that the majority of purchases made through Vestiaire Collective directly replace the purchase of new items. This high displacement effect leads to a considerable reduction in demand for newly manufactured garments, resulting in more avoided production and, consequently, a decrease in the environmental footprint associated with the textile and clothing industry.
- The company also quantifies its environmental impact by comparing the effects of a resale purchase to those of buying a new item. Internal reports show that Vestiaire Collective's operations prevent 3.3 times more carbon emissions than they generate, primarily through the avoidance of emissions typically associated with the production and shipping of new goods. This demonstrates the platform's positive net effect on reducing greenhouse gas emissions within the fashion industry.
- Impact surveys conducted by Vestiaire Collective reveal significant changes in the behavior of its user base. According to these surveys, 84% of sellers use the platform to give their items a second life, rather than simply disposing of them. This practice of reusing quality items helps to extend their average lifespan by approximately 1.4 years, in contrast to the typically shorter use period of around 4 years before disposal. By facilitating the continued use of pre-owned fashion, Vestiaire Collective

encourages more sustainable consumption patterns and further supports the principles of circularity.

AI is a strategic enabler of Vestiaire Collective's ambitions

- AI-driven search engines use keywords and visual pattern recognition so users can find items that match design attributes, colors, shapes or styles, increasing conversion rate.
- AI tools suggest optimal prices, speeding up product circulation
- AI helps localizing transactions and launching new language versions of their websites, supporting growth markets

National Case Studies in AI-Driven Circular Fashion (Industry Applications) - Sweden

H&M Group – AI-Driven Demand Forecasting and Circular Product Management

H&M Group represents a large-scale industrial application of artificial intelligence within the Swedish fashion industry. The company employs machine learning models to analyse extensive datasets combining historical sales data, regional demand patterns, consumer behaviour and supply chain variables in order to improve demand forecasting and inventory management across multiple brands and markets (H&M Group, 2023).

The outcomes of these applications are directly linked to sustainability and circularity objectives. Improved demand forecasting reduces overproduction and excess inventory, which in turn lowers material waste and decreases emissions associated with unsold garments. In parallel, AI-supported analytics are integrated into product lifecycle management processes to inform resale, repair and recycling decisions, contributing to extended product lifespans and more circular business models.

While H&M Group operates at a scale beyond that of most SMEs, this case provides transferable insights into how AI-driven demand forecasting, lifecycle data integration and data-informed decision-making can support circular strategies across organisations of different sizes. From a skills perspective, the case highlights the importance of data literacy, AI-supported planning and sustainability analytics for professionals working in the fashion and textile sector.

SIPTex – AI-Enabled Automated Textile Sorting for Circular Recycling

SIPTex (Swedish Innovation Platform for Textile Sorting) constitutes a nationally significant industrial application of AI addressing one of the main bottlenecks in circular fashion systems. The initiative operates an automated textile sorting facility that integrates AI-based image recognition, near-infrared sensors and machine learning algorithms to identify fibre composition, colour and material quality in post-consumer textiles (Circular Sweden, 2023).

By enabling rapid and precise sorting of garments into fractions suitable for reuse or fibre-to-fibre recycling, AI-supported sorting at SIPTex improves recycling yields and supports the development of closed-loop textile systems. The application contributes to reduced landfill and incineration rates and strengthens the availability of secondary raw materials at national level.

From a skills and training perspective, this case illustrates the relevance of competences related to AI-assisted material identification, data interpretation and the operation of automated systems within circular textile value chains, particularly for technicians and operators involved in recycling and end-of-life processes.

Södra OnceMore® – Data- and AI-Supported Fibre Recycling and Regeneration

Södra OnceMore® provides a robust example of data-driven and AI-supported optimisation within industrial-scale circular textile material systems. Developed by the Swedish forest industry group Södra, the OnceMore® process focuses on recycling cotton-rich textile waste and blending it with sustainably sourced wood pulp to produce regenerated cellulose fibres for new textile applications. Advanced data analytics and digital process monitoring are used to optimise feedstock composition, production efficiency, and quality consistency across recycling and fibre regeneration stages (Södra, 2024).

From a circular fashion perspective, the relevance of OnceMore® lies in its ability to scale textile-to-textile recycling while maintaining industrial reliability and material quality. Data-supported process optimisation enables more efficient sorting and utilisation of textile waste, reduces resource intensity, and supports lower environmental impacts compared to virgin fibre production. These capabilities contribute to the development of stable and traceable circular material flows within the European textile ecosystem.

From a skills development perspective, this case highlights the growing importance of competences related to data analysis, digital process control, and AI-supported quality management within advanced recycling and fibre manufacturing environments. Professionals working with such systems must be able to interpret production data, collaborate across material science and digital domains, and support continuous process optimisation. As such, the OnceMore® case illustrates how AI and data-driven approaches are becoming integral to the operation and scaling of circular textile manufacturing in Sweden.

Houdini Sportswear – Data-Driven Circular Design and Product Lifecycle Intelligence

Houdini Sportswear represents a best practice among sustainability-oriented fashion companies in Sweden, illustrating how data-driven and AI-supported analytics can inform circular design and product lifecycle management. The company collects and

analyses data related to material performance, product durability and customer usage patterns in order to guide design decisions focused on longevity, repairability and recyclability (Houdini Sportswear, 2023).

Machine learning-supported analysis is used to interpret product performance data and identify opportunities for improved circular design. The outcomes include extended product lifespans, reduced material throughput and improved transparency regarding product composition and environmental impact.

From a skills development perspective, this case illustrates how AI-supported insights can be embedded within design and product development roles, emphasising competences related to data-informed design, lifecycle thinking and sustainability-oriented innovation.

CircularID – AI-Supported Digital Product Passports for Circular Fashion

CircularID is a Swedish social enterprise and technology startup developing AI-supported digital infrastructure to enable circular business models in the fashion and textile sector. The company provides digital product passport solutions that attach structured product-level data to garments, including information on material composition, production origin, care instructions and end-of-life options (CircularID, 2023).

The platform integrates AI-supported analytics to process lifecycle data and support decision-making related to reuse, repair, resale and recycling. By reducing information loss across lifecycle stages, AI-supported data analysis enhances traceability and transparency within circular value chains.

As a mission-driven social enterprise, CircularID provides an important counterbalance to large-scale industrial applications, illustrating how AI-enabled solutions can support circular fashion models for SMEs and emerging actors. From a skills perspective, the case highlights competences related to data management, traceability systems and AI-supported sustainability compliance.

National Case Studies in AI-Driven Circular Fashion (Industry Applications) - Greece

Zelus – AI-Powered Circular Fashion and Industrial Intelligence

Zelus is a Greek technology provider based in Athens that develops AI-enabled platforms for circularity, including tools aimed at reducing waste, improving traceability, and supporting sustainable operations (Zelus, 2025). Their solutions apply AI, blockchain, and data analytics to help businesses optimise energy and carbon tracking and deliver digital experiences that increase transparency and circular value creation in fashion and other sectors. The company emphasises sustainability consulting tailored to EU

regulatory standards (such as the Green Deal and Product Passport requirements) and deploys smart digital tools grounded in EU-funded innovation projects.

Fabric Republic – AI-Supported Clothing Recycling and Sorting

Fabric Republic, a Greek social enterprise, manages textile waste collection and redistribution networks across major urban centres. Since 2022, it has collaborated with technology partners to integrate AI-based image recognition into its sorting facilities, improving categorisation accuracy for second-hand clothing donations. The system assists in identifying textile types, colours, and wear quality, allowing for better allocation between reuse, upcycling, and recycling streams.

This digitalisation effort supports Greece's transition toward a circular economy by combining social impact with technology-driven efficiency. Fabric Republic's initiative exemplifies how small enterprises can adopt AI for sustainability and social inclusion simultaneously (Fabric Republic, 2023).

DigiFashTech – Digital & Sustainable Innovation Hackathon (Athens)

The DigiFashTech consortium staged a multiday fashion innovation hackathon in Athens, bringing together designers, technology creators, educators, and sustainability

practitioners to co-create solutions for digital fashion and sustainable textile systems (MFA, 2025). The event emphasised technology adoption, creativity, and sustainability ideation, helping participants prototype digital tools and approaches that can inform future educational pathways and industry practices.

Circular Cultures – Creative & Circular Design Programme

The Circular Cultures Design School — organised in Athens in collaboration with the British Council and Onassis Foundation — focuses on sustainable design and circularity across creative fields, including fashion (British Council, 2025). This programme fosters skills development, critical dialogue, and collaborative networks that embed circular economy principles into creative practice, often integrating digital tools, workflow experimentation, and design research methods.

NTZNS – Virtual Fashion & Digital Innovation (Greek Startup)

The Greek startup NTZNS is developing applications at the intersection of virtual fashion and metaverse experiences, aiming to bring fashion into digital environments through emerging technologies (Forbes Greece, 2023). While not exclusively AI in its current scope, NTZNS is representative of how Greek creative tech ventures are exploring digital fashion ecosystems that can integrate future AI-based workflows (e.g., generative design, virtual prototyping).

National Case Studies in AI-Driven Circular Fashion (Industry Applications) - Italy

YOLO – AI-Enabled Digital Product Passports

YOLO S.r.l. is an Italian company providing digital traceability solutions for fashion brands through AI-enabled Digital Product Passports (DPPs). Its platform supports the structured collection, management, and integration of data related to raw materials, production processes, certifications, and product lifecycle information. By leveraging AI-supported data structuring and validation, YOLO enables brands to manage complex supply chain information in a reliable and scalable manner (YOLO, 2024).

The adoption of YOLO's solutions has led to improved traceability and transparency across fragmented and multi-tier supply chains, while enhancing data reliability and accessibility for both brands and end consumers. These capabilities also support compliance with emerging EU sustainability and product transparency regulations. From a circularity perspective, full lifecycle visibility enables business models such as reuse, recycling, and take-back schemes, while reinforcing consumer trust and informed purchasing decisions through greater transparency (YOLO, 2024).

Orange Fiber – AI-Supported Circular Material Innovation

Orange Fiber S.r.l. is an Italian company specialising in the development of sustainable textile fibres derived from waste generated by the citrus juice industry. The company applies AI-supported data analysis to optimise material processing, quality control, and production efficiency, ensuring consistency, scalability, and reduced environmental impact throughout the manufacturing process (Orange Fiber, 2024).

Through the valorisation of agri-food waste into high-quality textile fibres, Orange Fiber represents a clear example of circular economy implementation in practice. The integration of AI contributes to improved production efficiency and reduced resource consumption, while supporting traceability and responsible sourcing of raw materials. Collaboration with major fashion brands for sustainable collections further demonstrates how AI-enabled material innovation can be successfully integrated into mainstream fashion value chains (Orange Fiber, 2024).

Max Mara Fashion Group – AI for Demand Forecasting and Inventory Optimisation

Max Mara Fashion Group has implemented AI-based demand forecasting and inventory optimisation systems across its retail network to analyse sales data, customer behaviour, and market trends. These systems support more accurate demand predictions and enable better alignment between production volumes and actual market needs (Max Mara Fashion Group, 2024).

As a result, the company has achieved increased forecasting accuracy, a reduction in overproduction and unsold stock, and improved inventory management across both physical and digital retail channels. From a sustainability and circularity perspective, AI-supported forecasting plays a key role in waste prevention by limiting excess production and optimising resource use, contributing to more efficient and responsible retail operations (Max Mara Fashion Group, 2024).

Re.Crea Consortium – AI-Supported Textile Recycling and Traceability

The Re.Crea Consortium is an Italian organisation supporting textile recycling and Extended Producer Responsibility (EPR) schemes at national level. The consortium employs AI-supported data systems to monitor material flows, recycling processes, and compliance with regulatory requirements across post-consumer textile streams (Re.Crea, 2024).

The use of AI-enabled monitoring tools has improved the tracking and management of textile waste streams, enhanced data accuracy for recycling and recovery processes, and strengthened the operational transparency of circular textile value chains. By supporting data-driven waste management and traceability, Re.Crea contributes to more efficient recycling systems and reinforces the implementation of circular fashion models aligned with national and EU-level sustainability objectives (Re.Crea, 2024).

Overall, these national case studies demonstrate a growing level of industry readiness in Italy and provide tangible reference points for understanding how AI-driven solutions can effectively support circularity, sustainability, and traceability in the fashion and textile sector. They highlight the versatility of AI applications and their potential to scale across different segments of the value chain, from material innovation and production planning to post-consumer recycling and product transparency (European Commission, 2020).

National Case Studies in AI-Driven Circular Fashion (Industry Applications) - Spain

Mango and The Post Fiber: circular fibres and AI-systems

The Post Fiber is a start-up dedicated to waste management that supports the fashion industry in its transition to circular model, focusing on postconsumer waste. It is born from the collaboration and knowledge transfer among companies that have been pioneers in sustainability: Moda re, Margasa, Textil Santanderina and Hallotex. All technological developments are carried out based on the know-how and innovation of the participating companies. (ThePostFiber – Circular Fashion, n. d)

The Post Fiber solution, developed its own circular process, starting with the collection of all used garments with smart containers, to later on sort them by material using AI

systems. Once sorted, they move into the mechanical removal system of disrupter materials to finally reduce the size of the clothing into scraps. From that, they create a high-quality fiber to move later into yarn, fabric and garment development processes. (Idem).

Recently, a new big actor joined the alliance, MANGO. Through Mango Start-up Studio, the company affirms its commitment with circularity in the textile industry, integrating recycled materials in its garments and promoting best practices among the fashion sector. It is a pioneer company in incorporating this kind of fiber into its collections, with the latest launch of a capsule collection for MANGO Teen. (Mango Fashion Group, 2024).

This limited-edition capsule, contains 80% of recycled materials, with a 15% coming from The Post Fiber. The remaining materials are based from post-industrial waste. Moreover, the garments have been dyed with *Pigmentura*, a technique that reduces significantly water and energy consumption. (Idem).

With the investment in The Post Fiber, MANGO has moved forward with its transition to be more circular and sustainable. It has used by now a 25% of fibers coming from The Post Fiber, with the final objective to achieve 40%. (Modaes, 2024).

Recovo (Barcelona): AI-driven circular fabric marketplace

Recovo is a Barcelona-based circular fashion technology company founded in 2021 conceived as a B2B marketplace for textile surplus materials. Recovo has evolved into a

comprehensive circularity platform offering technology-driven solutions to help fashion brands and manufacturers integrate circular practices directly into their operations (Recovo, n.d)

Recovo's platform now includes a suite of digital tools and services that support surplus textile materials management, recommerce (second-life marketplaces), circular inventory and reuse solutions and data-driven impact tracking (environmental impact mainly). It has partnered with well-known brands, both Spanish and international, such as Brownie, Pronovias, Alohas, Paloma Wool, SKFK, JC Pajares and others, building a broad and engaged user base across Europe of more than 770 partnerships. (Europa Press, 2023).

The Recovo Recommerce solution uses AI to automate inventory recognition, price recommendation, authentication and listing, making resale channels viable for brands without deep technology stacks (Revoco – Recommerce, n. d). It has several use cases published, some examples are:

Recovo x ALOHAS: Alohas has teamed up with Recovo on "The Harringbone Collection" capsule, consisting of five pieces made from reused wool. The five pieces consist of a blazer, a short skirt, a long skirt, a pair of pants, and a top made from the same herringbone wool fabric from a well-established fashion house. By reusing these fabrics, Alohas has saved precious natural resources used in the production of new fabrics. It saved 343.679 litre of water and 3.018kg of Co2 emissions. (Recovo – Caso de éxito: Alameda, n. d.).

Recovo x ALAMEDA: Alameda has partnered with Recovo to launch three complete outfits using deadstock fabrics. The green outfit consists of a sheer top and skirt made from pistachio-coloured tulle that would otherwise have been wasted. The pink ensemble consists of a coat, top, and skirt made from cotton denim fabric recovered from denim manufacturer Evlox. The red ensemble consists of a top and trousers made from red mesh recovered from the Angel Schlesser brand. By reusing these fabrics, Alameda has saved precious natural resources used in the production of new fabrics. It saved 680.880 litre of water and 2.080kg of Co2 emissions. (Recovo – Caso de éxito: Alohas, n. d).

Sepiia (Spain): smart, recyclable garments and circular service model

Sepiia is a Spanish sustainable fashion company founded in 2016 with the mission to transform the fashion industry through technology and sustainability. The brand is known for producing “smart garments”, everyday clothing engineered with advanced textile technology to be functional, durable and environmentally friendly. Its product range includes shirts, trousers, outerwear and other wardrobe staples designed to be stain-resistant, wrinkle-free, odor-neutralizing and breathable, making them long-lasting and easier to care for than conventional apparel. (Sepiia, n. d).

Sepiia controls much of its production process, ensuring supply chain transparency and alignment with ecological standards. It operates via e-commerce and physical retail

stores (e.g., in Madrid and Barcelona) and collaborates with third-party retailers such as El Corte Inglés and Zalando (Idem).

Sepiia develops garments using recycled and recyclable materials, prioritising monomaterials that can be easily recovered and reprocessed at end-of-life. The fabrics are engineered to reduce common environmental impacts such as water use and pollution by enabling garments that require fewer washes and less maintenance. The company's design philosophy emphasises garments that are durable, timeless and multifunctional, reducing the need for frequent replacement and countering the "fast fashion" model. This extension of product lifespan is a core tenet of circular fashion. (Interempresas, 2023). It also partnership with the previous case Recovo, to reuse and redistribute production surplus.

Sepiia exemplifies how innovation, sustainability and circular principles can be embedded in a fashion brand's core strategy: Producing long-lasting garments that need less water, energy and care; Delivering high-quality, multifunctional garments whose durability reduces the frequency of replacement; Engaging in circular ecosystems like Recovo's marketplace; Working with local suppliers in Spain and Portugal (Sepiia, n.d)

A successful story from the brand is the collaboration with El Ganso "Dressy but Messy". It introduced their technologic fabrics on a limited-edition collection. (El Ganso, n. d).

National Case Studies in AI-Driven Circular Fashion (Industry Applications) - Türkiye

Ekoten Textile - AI-Driven Precision in Manufacturing

Ekoten Textile, a leading Turkish knit fabric manufacturer, has addressed the critical issue of pre-consumer waste by integrating advanced AI-based monitoring tools into its production lines. The company installed high-resolution AI cameras and sensors directly onto circular knitting machines to provide constant, autonomous oversight of the fabric as it is manufactured. Unlike traditional quality control methods that identify faults only after a roll is completed, this real-time system recognizes specific knitting errors, such as holes, oil stains, or needle drops, at the exact moment they occur. Upon detection, the system instantly stops the machine, allowing operators to rectify the issue before any further material is processed. This transition to an AI-monitored model has yielded immediate and measurable outcomes, including a nearly 80% reduction in defective fabric production. Furthermore, the system prevents the production of over 4.5 tonnes of faulty raw fabric annually, leading to significant savings in raw materials. By automating the inspection process, Ekoten has also managed to reduce energy consumption and improve overall operational efficiency. This case study perfectly exemplifies the principle of "Waste Prevention at the Source", as it stops the creation of waste before it even exists. Every kilogram of fabric saved from being faulty also prevents the unnecessary use of thousands of liters of water in the subsequent dyeing and

finishing stages. Additionally, it eliminates the waste of substantial amounts of energy and chemicals that would otherwise have been applied to defective material. Ekoten's use of AI serves as a practical blueprint for how digital transformation can provide high-level resource efficiency. Ultimately, this approach ensures that manufacturing is as efficient as possible while significantly minimizing the industry's environmental footprint (Ekoten Textile, 1995).

Hugo Boss Textile Industries Ltd. (Hugo Boss İzmir) – Industry 4.0

The Hugo Boss factory in İzmir, Türkiye, serves as a premier global benchmark for the "Smart Factory" concept and stands as the largest production site for the Hugo Boss Group. By transitioning from a traditional labor-intensive facility to an Industry 4.0 pioneer, the factory has integrated artificial intelligence across the entire garment lifecycle. A primary AI application includes pattern nesting, which optimizes the layout on fabric rolls to minimize gaps and reduce raw material consumption. Additionally, predictive maintenance systems analyze vibration and sound patterns in sewing machines to prevent mechanical failures before they cause downtime. The factory has created a "connected workforce" by integrating tablets into production lines, allowing AI to suggest real-time optimizations for logistics and personnel placement. For employee development, "Virtual Dojos" utilize augmented reality to teach complex stitching skills in a digital environment, eliminating the need for physical training fabric. These

technological advancements have resulted in a significant 2% reduction in annual fabric waste, saving thousands of meters of material. Furthermore, line setup times have been reduced by approximately 30 minutes, leading to fewer discarded or reworked materials. This "produce only what is needed" model directly supports global sustainability goals by lowering the factory's total carbon footprint. The precision afforded by AI-driven cutting ensures that pre-consumption waste is minimized and meticulously categorized. Such high-purity categorization is essential for the circular economy, as it allows fabric scraps to be efficiently returned to a textile-to-textile recycling loop. Ultimately, the İzmir facility demonstrates how digital transformation can harmonize large-scale industrial output with resource efficiency and environmental responsibility (Hugo Boss, 1999).

This case study offers a roadmap for VET programs that can be used to teach students how to interact with AI dashboards and interpret data-driven production reports.

Mavi — Data-Driven Sustainable Design and Supply Chain Precision

Mavi, a globally recognized Turkish denim brand, has integrated advanced AI algorithms into its core operations to harmonize commercial success with its "All Blue" sustainability strategy. By revolutionizing the design-to-production lifecycle, the brand utilizes sophisticated algorithms to analyze vast customer datasets and global trend signals. This predictive capability allows Mavi to iterate on designs, such as the Tech Fusion collection, with remarkable speed and precision. Identifying styles that resonate

with consumers before production begins enables the creative phase to move rapidly while ensuring the final product meets actual market demand. Furthermore, Mavi leverages AI for Material Selection Optimization, a critical phase that assists designers in choosing eco-friendly inputs. The system cross-references predicted consumer interest with a database of certified sustainable materials, including BCI (Better Cotton Initiative) cotton and recycled polyester. This strategic alignment ensures that sustainable options are prioritized for products most likely to succeed commercially. By relying on data-driven insights rather than traditional guesswork, Mavi achieves a highly efficient manufacturing model that significantly minimizes deadstock. This proactive use of AI to prevent overproduction serves as a direct intervention against the fast fashion crisis of overconsumption (Ceylan et al., 2024).

Consequently, the brand maximizes the environmental impact of its green investments by applying them to the products with the highest market volume. Mavi's approach also provides a valuable blueprint for vocational learners and modern educational training modules. These programs can emphasize the importance of digital trend-tracking in protecting small business capital from being wasted on unsuccessful products. Ultimately, the Mavi case study demonstrates how technology merges ecological goals with commercial viability through supply chain precision (Mavi, 1991).

Sun Textile — Digital Prototyping and Circular R&D

Sun Textile has undergone a transformative shift by moving a massive portion of its design cycle into the digital realm using 3D pattern-making and AI-driven visualization. A cornerstone of this digital transition is their extensive digital fabric library, which contains over 2,000 textures. The company's R&D center serves as a hub for circular innovation, using data analytics to develop and track the performance of new materials made from recycled fibers. By analyzing material performance data, the R&D team can optimize the blend of recycled and virgin fibers to ensure durability and recyclability. This data-driven approach supports their goal of using 100% sustainable raw materials in the coming years. By shifting to digital iterations, Sun Textile saves thousands of physical samples annually. This eliminates the waste generated during the traditional sampling phase, where prototypes are typically destroyed rather than sold. Virtual prototypes remove the need for the cutting, sewing, and global shipping of physical samples. Digitalization allows a faster time-to-market for sustainable collections, enabling the brand to respond to consumer demand for circular products with greater precision and less overproduction (Sun Textile, 1987).

Chapter 7 – Existing VET & HE Programs on AI, Circular Fashion, and Sustainable Textiles

The effective adoption of Artificial Intelligence in circular and sustainable fashion depends not only on technological availability, but also on the existence of relevant education and training pathways that equip current and future professionals with appropriate skills and competences. This chapter provides an overview of existing Vocational Education and Training (VET) and Higher Education (HE) programmes related to AI, circular fashion, and sustainable textiles across the partner countries. By mapping current educational provision, the chapter highlights how AI and sustainability-related competences are currently addressed within formal learning contexts, while also identifying structural gaps and opportunities for skills development that are directly relevant to the objectives of the TechStyle project.

Existing VET & HE Programs on AI, Circular Fashion, and Sustainable Textiles - France

Vocational Education and Training (VET) in France features diverse curricula tailored to the fashion and textile students, workers or lifelong learners. Technical programs equip young learners with professional competencies at 150 French vocational high schools, offering qualifications such as Certificat d'aptitude Mode et Couture and Bac

Professionnel, with options for further study through Licence or DNMade (Diplôme des métiers d'art et du design). Adult education is available in areas like management, creativity, and entrepreneurship through specialised fashion schools, universities, which provide summer courses, alternating programmes, and executive curricula designed for individuals seeking career advancement or transition within the textiles and clothing sector. Incubators and accelerators offer entrepreneurs targeted training and expert mentorship in key business domains. Additionally, an extensive selection of online and hybrid courses is offered, providing varied formats and themes to meet a range of professional needs.

There are few key education programs specifically connecting AI with Circularity in the T&C industry. Current AI programs are mainly generalists or linked to sustainability.

• AI for business: executive programmes in management schools e.g. EM Lyon; ESCP, HEC, ESSEC or University in clusters e.g. Mines de Paris or Grenoble University

• Circular economy literacy: certificates included in business and management schools e.g. PSL, Cegos, Circulab

• AI + Sustainability: targeted short courses, to check AI readiness e.g. local CCIs (Chambre de commerce et d'industrie), or to reduce AI environmental print e.g. Green IT

• Fashion, innovation and sustainability: online courses or MOOCs e.g. France Université Numérique (FUN) or Coursera

Since public education in schools and universities is generally free in France, students often consider what these institutions offer first. However, in the textile and clothing sector, AI for circularity is mainly taught through private or public-private programs at university level (Bac+2, adult education, lifelong learning). Tuition fees are typically co-financed by OPCO (Opérateurs de compétences for work–study programs) and CPF (Compte personnel de formation that grants workers lifelong learning rights).

Presented below is a selection of initiatives designed to integrate artificial intelligence with circularity in the development of T&C skills.

Textile engineering / ENSAIT

The “Textile Engineering Apprenticeship” program at ENSAIT, available following two or three years of higher education, integrates theoretical instruction with practical experience to address the demands of the textile industry. Participants engage in lectures, laboratory sessions, and company-based projects under expert supervision. The curriculum is designed to enable students to: identify fundamental textile processes and position them within the textile production chain (including stakeholders, materials, and relative costs); distinguish and classify basic textile structures, their treatments, and assembly methods; understand, measure, and assess the properties of textiles; establish requirements for reproducing textile products; analyze existing items and document all phases of their development; connect textile properties to their structural

characteristics or manufacturing processes, and vice versa; and link products and processes to specific functional specifications.

ENSAIT - Ecole nationale supérieure des arts et industries textiles - offers a range of Bachelor's, Master's, and Doctorate programs (with GEMTEX), as well as training for professionals. It was founded in 1881 in Roubaix, France. Since 2001, it is a leading public engineering school specialising in textiles and part of the UP-TEX cluster.

Reference Link: https://www.ensait.fr/formations/ingenieur-ensait-formation-apprentissage/

AI and creativity / IFM

The "AI and Creativity" course is designed to provide managers and professionals with an in-depth understanding of AI-driven creativity and digital strategies in the fashion sector over two intensive days. The curriculum covers essential topics including the economic and societal impacts, challenges specific to Fashion and Luxury, an overview of current trends, and future outlooks. Participants will examine business use cases and real-world examples from throughout the value chain—spanning design and development, supply chain and logistics, manufacturing, marketing, distribution, and sales. The course explores the application of creative AI through practical tools and a business innovation framework, incorporating collaborative team exercises focused on designing experiential scenarios. Additionally, a curated selection of generative AI tools

will be presented, with discussion around their capabilities and limitations, alongside methodologies for integrating these technologies into creative processes. Participants will have opportunities to experiment with generative AI tools relevant to image creation and retail applications.

IFM - Institut français de la mode - is a top Paris-based fashion school, established in 1986 and recently merged with Ecole de la chambre syndicale de la haute couture. It offers over 15 yearly or short programs ranging from technical to executive levels.

Reference Link: https://www.ifmparis.fr/fr/programmes/programmes-courts/creativite-et-intelligence-artificielle

CLO3D + AI Optimisation / ESMOD

"CLO3D + AI Optimisation" is a comprehensive course designed to equip participants with practical expertise in CLO3D software and the integration of artificial intelligence to enhance design productivity and visual quality. The program targets professionals such as textile designers, digital stylists, visual managers, and content producers seeking to develop or advance their skills. Key topics include mastering CLO3D fashion software, incorporating AI into design workflows, optimizing rendering techniques, and leveraging AI tools for texture, draping, and collection communication. The course consists of 66 hours of evening instruction (two sessions of two hours per week).

CLO3D is an advanced 3D modeling software widely adopted by leading fashion brands for virtual garment design. It enables users to create and assemble patterns, visualize garments on avatars in real time with exceptional realism, and accurately simulate volumes, fabrics, and movements. This process eliminates the necessity for physical garment construction during the design phase.

ESMOD – Ecole supérieure de la mode et du design – was founded in 1841 by Alexis Lavigne, and now offers accredited Bachelor's and Master's programs in several French cities, and several international countries.

Reference Link: https://www.esmod.com/en/formations_pro/training-in-clo-3d-software-and-ai-based-optimization/

Fashion and CSR / Conscious fashion

Conscious Fashion delivers comprehensive training on circular economy practices within the fashion and apparel sector, emphasizing eco-design and sustainable business models. The majority of its courses target professionals and entrepreneurs seeking ongoing development, with a central focus on Corporate Social Responsibility (CSR), sustainable strategies, and the implementation of circular approaches in the industry. Although the integration of artificial intelligence is not consistently addressed, selected modules facilitate incorporating AI into circularity initiatives. Training options range from half-day introductory and operational sessions to intensive two-day expert programs.

The specialized “Fashion and CSR” course is designed for all textile and clothing professionals interested in deepening their understanding of sustainability in fashion. The curriculum includes: historical and sociological perspectives of the textile industry; current market expectations and standards; essential concepts of eco-design and product lifecycle management; company and product certification processes; leading practices in responsible sourcing and purchasing; environmentally conscious production techniques; proactive recycling strategies; and effective responsible communication.

Since 2020, Conscious Fashion has operated as a responsible fashion accelerator, holds Qualiopi certification, and is recognized as an expert training provider by Refashion and the Fédération française du prêt à porter.

Reference Link: https://consciousfashion.fr/wp-content/uploads/2024/07/FORMATION-MODE-ET-RSE-1.pdf

AI and Fashion / Crews education

“AI and Fashion” is a specialized programme designed to equip professionals with expertise in generative AI tools by leveraging pertinent case studies. Structured over two days, the curriculum is intended to: provide insight into the transformations driven by artificial intelligence within the fashion sector; highlight practical applications of AI in design, production, and marketing; develop proficiency in generative AI tools to foster

creativity and enhance operational efficiency; and examine the ethical, environmental, and societal considerations associated with implementing AI in the fashion industry.

Crews Education, founded in 2023, was created to offer digital literacy training for diverse industries via a hybrid online–offline model. Endorsed by “La French Tech” and “Réseau entreprendre” (a network to support entrepreneurs), the institution provides certified Bachelor’s and Master’s programs. Its Textile and clothing courses are included into the Digital and Luxury path, covering product development, production, and marketing processes with an emphasis on ethics and sustainability.

Reference Link: https://www.crews-education.com/formations/formation-ia-mode

AI and Fashion / Innov8Learn

“AI and Fashion” is a specialised programme designed to equip professionals and managers with the skills necessary to leverage generative AI for content creation and collection development within the fashion industry. This course enables participants to master the art of composing effective, structured prompts for high-quality, professional outcomes; employ platforms such as ChatGPT, Perplexity, and Midjourney in a professional setting; and generate and refine textual and visual content tailored to the standards of fashion and luxury brands. The training is delivered in a comprehensive one-day session.

Established in 2021 with the goal of advancing digital education, Innov8learn provides adults with training in cybersecurity, AI, CSR, cryptocurrency, and digital communication. They offer foundational courses in AI applications for a wide variety of company employees or managers across many sectors.

Reference Link: https://www.innov8learn.fr/copie-de-ia-pour-la-fonction-marketing

Existing VET & HE Programs on AI, Circular Fashion, and Sustainable Textiles - Sweden

In the Swedish context, higher vocational education (Yrkeshögskolan) and higher education currently coexist in addressing skills for the textile and fashion sector, with VET programmes focusing on operational and production-oriented competences and HE programmes covering more advanced analytical and managerial profiles

Nordic Textile Academy – Higher Vocational Textile & Fashion Programme (VET)

Programme name and level of education: Higher Vocational Textile & Fashion Programme , Higher Vocational Education (Yrkeshögskolan; post-secondary, 2-year programme)

Institution: Nordic Textile Academy

The Nordic Textile Academy offers a two-year higher vocational programme that integrates theoretical and practical learning with industry engagement and workplace training (LIA). Students gain hands-on experience in textile production, quality control, production development and sustainability-oriented practices, preparing them for operational roles in the fashion and textile industry.

This programme's focus on practical industry competencies aligns with emerging skill needs for AI-supported quality inspection, production optimisation and data-informed decision-making. Its industry partnerships and workplace components exemplify how VET can directly prepare learners for technology-enhanced roles within circular textile systems.

Reference Link: https://www.nordiskatextilakademin.se/om-nta/about-us-eng/

YH Textil & Mode – Vocational Courses (VET)

Programme examples:

Garment Technical Designer (3D) – approx. 2-year vocational training

Mönsterkonstruktör – approx. 1-year vocational training

Hållbar kvalitets- och produktionsutvecklare inom textil/mode – 2-year vocational training

Institution: Various vocational training providers (Yrkeshögskolan, municipal adult education)

These programmes are offered within Sweden's vocational training framework and combine hands-on practice with industry-linked learning. They prepare learners for textile production, pattern design, sustainable production development and quality roles — all of which can be enhanced through AI-supported tools such as automated pattern analysis, production data dashboards and sustainable process monitoring.

The structured workplace learning (LIA) component ensures relevance to current labour market demands and facilitates transitions into employment.

Reference Link: https://www.yhutbildningar.se/utbildning/textil-mode-sverige/c1056-d247

University of Borås – Swedish School of Textiles - Master's Programme in Textile Management (HE)

Programme name and level of education: Master's Programme in Textile Management (HE)

Institution: University of Borås

The Swedish School of Textiles at the University of Borås offers a Master's Programme in Textile Management that focuses on sustainable textile production, innovation and global value chains. The programme integrates digital tools, data analysis and technology-driven decision-making within textile and fashion management contexts. Students are exposed to concepts related to digitalisation, traceability and sustainability reporting, which are increasingly supported by AI-based systems in industry.

The relevance of the programme to AI and sustainability lies in its strong emphasis on circular textile systems, lifecycle thinking and innovation management. Although AI is not taught as a standalone technical discipline, students develop the analytical and digital competences necessary to engage with AI-supported tools used in production planning, supply chain management and sustainability assessment in the textile sector (University of Borås, 2024).

Reference Link: https://www.hb.se/en/international-student/program/programmes/masters-programme-one-year-in-textile-management/

University of Borås – Swedish School of Textiles - Bachelor's Programme in Textile Production and Innovation (HE)

Programme name and level of education: Bachelor's Programme in Textile Production and Innovation (HE)

Institution: University of Borås

The Bachelor's Programme in Textile Production and Innovation at the Swedish School of Textiles focuses on textile materials, manufacturing processes, product development and sustainable production systems. The programme combines technical knowledge with innovation-oriented project work, enabling students to understand textile production across the value chain, from raw materials to finished products. Emphasis is placed on sustainability, resource efficiency and industrial innovation within the textile sector.

The relevance of the programme to AI and sustainability lies in its focus on digitally supported production processes, data-informed decision-making and process optimisation. Although artificial intelligence is not taught as a standalone subject, students develop technical and analytical competences that allow them to engage with AI-enabled manufacturing environments, such as automated production monitoring, quality control systems and data-driven optimisation of material flows. These competences are directly applicable to circular textile production and sustainable manufacturing practices (University of Borås, 2024).

Reference Link: https://www.hb.se/en/international-student/program/programmes/textile-production-and-innovation/

University of Borås – Swedish School of Textiles - Master's Programme (Two Years) in Textile Engineering (HE)

Programme name and level of education: Master's Programme (Two Years) in Textile Engineering (HE)

Institution: University of Borås

The Master's Programme in Textile Engineering at the Swedish School of Textiles provides advanced education in textile technology, material science and manufacturing processes. The programme builds strong competences in fibre and fabric engineering, textile chemistry and production technologies, while integrating sustainability considerations into technological development and industrial applications.

The programme is relevant to AI and sustainability through its emphasis on advanced production systems, process control and material optimisation, areas where AI-based tools and data analytics are increasingly applied in industry. Graduates acquire the technical background necessary to collaborate with or apply AI-supported systems for predictive quality control, production optimisation and lifecycle assessment in textile manufacturing. These competences support the development of circular textile systems by improving resource efficiency and reducing waste throughout the production process (University of Borås, 2024).

Reference Link: https://www.hb.se/en/international-student/program/programmes/masters-programme-two-years-in-textile-engineering/

University of Borås – Swedish School of Textiles - Master's Programme in Textile Value Chain Management (HE)

Programme name and level of education: Master's Programme in Textile Value Chain Management (HE)

Institution: University of Borås

The Master's Programme in Textile Value Chain Management at the Swedish School of Textiles focuses on the comprehensive analysis and management of textile and fashion value chains, with particular emphasis on sustainability, transparency and traceability. The programme addresses key aspects of supply chain governance, sourcing strategies, production planning and sustainability integration across global textile value chains. Students are trained to understand the interdependencies between different stages of the value chain and the challenges associated with sustainable and circular textile systems.

The relevance of the programme to artificial intelligence and sustainability lies in its strong focus on data-informed decision-making, supply chain analysis and traceability systems. Although artificial intelligence is not taught as a standalone technical

discipline, the competences developed closely align with AI-supported tools used in industry for demand forecasting, supply chain optimisation, sustainability analytics and lifecycle-based decision support. Graduates are therefore well equipped to engage with AI-enabled data management and analytical systems that support circular economy strategies and sustainability performance in the textile and fashion sector (University of Borås, 2025).

Reference Link: https://www.hb.se/en/international-student/program/programmes/masters-programme-in-textile-value-chain-management/

Existing VET & HE Programs on AI, Circular Fashion, and Sustainable Textiles - Greece

Greece's vocational and higher education landscape increasingly integrates digitalisation, artificial intelligence (AI), and sustainability skills within both formal and non-formal training contexts. While no national programme yet focuses exclusively on AI for fashion and textiles, several initiatives—spanning VET, lifelong learning, and Erasmus+ partnerships—lay the groundwork for digital and circular competences that directly align with the TechStyle project's aims.

Kainotomia - TEX4.0 – Industry 4.0 Skills for the Textile Sector

Programme name and level of education: Vocational Education and Training (VET) in Industry 4.0 Skills for the Textile Sector

Institution: Kainotomia (Larissa, Greece)

The TEX4.0 project, coordinated by the organisation Kainotomia in Larissa, represents a tangible Erasmus+ KA220-VET initiative designed to strengthen Industry 4.0 skills for small and medium-sized enterprises (SMEs) in the textile sector. The project develops modular training materials addressing digitalisation, automation, IoT, and data-driven manufacturing—themes essential to AI readiness in textiles (Kainotomia, 2023). By focusing on upskilling trainers and VET learners, TEX4.0 bridges traditional manufacturing expertise with the technological foundations required for circular and AI-enabled production systems.

Reference Link: https://www.kainotomia.com.gr/en/tex4-0-skills-en

AKEP & SAEK PAIC – Promoting Artificial Intelligence Competences in VET

Programme name and level of education: Vocational Education and Training (VET) in Promoting Artificial Intelligence Competences in VET

Institution: Academy of Entrepreneurship (AKEP) and SAEK Aigaleo

The Promoting Artificial Intelligence Competences (PAIC) project piloted the introduction of AI literacy into Greek VET classrooms through collaboration between the Academy of Entrepreneurship (AKEP) and the Lifelong Learning Centre of Aigaleo (SAEK Aigaleo). The initiative's curriculum included basic machine-learning concepts, ethical AI use, and digital citizenship skills. It demonstrated how Greek VET providers can integrate emerging technology competences into standard programmes, enhancing labour-market relevance (Academy of Entrepreneurship, 2024).

Reference Link: https://akep.eu/piloting-the-paic-curriculum-in-greek-vet-classrooms

Training Centre Greece - TEXMODA MOOC – New Technologies for the Textile and Apparel Industry

Programme name and level of education: Online VET / Higher Education (MOOC) in New Technologies for the Textile and Apparel Industry

Institution: Training Centre Greece (with Erasmus+ partners)

Developed under the Erasmus+ TEXMODA framework, the Massive Open Online Course (MOOC) on New Technologies for the Textile and Apparel Industry offers open-access training in digital transformation and smart manufacturing for textile professionals and learners. The course introduces innovations such as 3D design tools, digital product lifecycle management, and automation systems, directly relevant to sustainable and AI-

assisted production (Training Centre Greece, 2024). This initiative represents one of the few openly accessible Greek-hosted resources linking technology and textile skills development.

Reference Link: https://trainingcentre.gr/el/courses/seminar-type-el/e-learning-el/mooc-new-technologies-textile-industry

K.E.DI.VI.M. – Artificial Intelligence Course (University of Crete)

Programme name and level of education: Higher Education Programme (20ECTS) / Lifelong Learning in Artificial Intelligence Course

Institution: University of Crete – Centre for Training and Lifelong Learning (K.E.DI.VI.M.)

The Centre for Training and Lifelong Learning (K.E.DI.VI.M.) at the University of Crete offers a course titled Artificial Intelligence for Humanities and Social Sciences. It introduces participants to AI concepts, algorithms, and societal applications, aiming to foster critical understanding of AI's capabilities and limitations (University of Crete, 2025). While interdisciplinary, this course provides an academic foundation in AI awareness and ethical reflection—competences increasingly relevant for future educators, designers, and sustainability professionals in fashion.

Reference Link: https://kedivim.uoc.gr/index.php/el/programmata/ola-ta-programmata/ana-thematiko-pedio/alloi-tomeis/392-artificial-intelligence-for-humanities-and-social-sciences-2

Existing VET & HE Programs on AI, Circular Fashion, and Sustainable Textiles - Italy

Vocational Education and Training (VET) plays a strategic role in the Italian education and skills development system, particularly in supporting the competitiveness and transformation of industrial sectors such as fashion and textiles. The Italian VET model is characterised by strong links with industry, practice-oriented learning, and a significant emphasis on work-based training. A key pillar of this system is the Higher Technical Institutes (Istituti Tecnici Superiori – ITS), which deliver post-secondary programmes at EQF Levels 4 and 5 and are designed to address sector-specific skills gaps through specialised technical training (Italian Ministry of Education, 2022).

In recent years, national reforms and European policy frameworks have increasingly promoted the integration of digitalisation, sustainability, and innovation within VET pathways. In the fashion and textile sector, this includes the gradual incorporation of competences related to data analysis, Artificial Intelligence, and circular economy principles, responding to growing demands for sustainability, transparency, and digital transformation. Within this context, Italian VET programmes provide a crucial bridge

between policy objectives and labour market needs, supporting the development of practical skills required for the adoption of AI-enabled and circular solutions, particularly among SMEs (European Commission, 2020).

ITS TAM – Textile, Apparel and Fashion System

Programme name and level of education: ITS Diploma in Textile, Apparel and Fashion System – EQF Level 5 (VET / Post-secondary)

Institution: ITS TAM – Istituto Tecnico Superiore Tessile Abbigliamento Moda (Biella)

The ITS TAM programme provides advanced technical training for the textile and fashion sector, combining classroom-based learning with strong work-based learning components. The curriculum covers textile production processes, product development, quality control, sustainability and digital technologies applied to manufacturing.

The programme introduces digital tools for production optimisation, process monitoring and quality control, which are increasingly integrated with AI-supported systems in industrial contexts. These competencies are relevant for AI-enabled efficiency, waste reduction and sustainable production practices.

Reference Link: https://itstam.it/

ITS MITA – Made in Italy Academy

Programme name and level of education: ITS Diploma in Fashion Product Development and Production Management – EQF Level 5 (VET / Post-secondary)

Institution: ITS MITA – Made in Italy Academy (national network)

ITS MITA programmes focus on fashion product development, supply chain management and industrial production processes. Sustainability, traceability and innovation are addressed through applied modules and collaboration with fashion companies. Digital tools for supply chain monitoring, production planning and traceability are embedded in the curriculum. These areas are directly connected to AI-supported demand forecasting, inventory optimisation and traceability solutions used in circular fashion systems.

Reference Link: https://mitacademy.it/

H-Farm Education – AI and the New Fashion Value Chain

Programme name and level of education: AI and the New Fashion Value Chain – Professional / Short Programme (Continuing Education, VET-relevant)

Institution: H-Farm Education (Italy)

This programme explores the application of artificial intelligence across the fashion value chain, including trend analysis, consumer behaviour, digital innovation and sustainability strategies. It combines theoretical inputs with hands-on activities and case-based learning.

The programme explicitly addresses AI-driven decision-making and its role in reducing overproduction, improving resource efficiency and supporting circular business models. Its applied and modular structure makes it relevant for upskilling and reskilling pathways.

Reference Link: https://college.h-farm.com/en/ai-and-the-new-fashion-value-chain/

Transitions Project – Textile and Fashion Innovation Training

Programme title and educational level: Innovation and training initiative with workshops and modules (VET-relevant / Continuing Education)

Institution: Transitions Lab – Textile and Fashion Innovation (Biella)

The Transitions project is a collaborative initiative focused on sustainability, digitalisation and regenerative approaches in the textile and fashion sector. Training activities include workshops, laboratories and industry-driven learning experiences. While not exclusively AI-focused, the project integrates digital tools, data-driven sustainability analysis and circular design approaches. It represents a relevant national

example of ecosystem-based training aligned with future AI-enabled circular fashion practices.

Reference Link: https://www.cittastudi.org/news/news/transitions/

Politecnico di Milano – Master in Fashion Tech Design

Programme title and educational level: Specialising Master in Fashion Tech Design – EQF Level 7 (HE)

Institution: Politecnico di Milano – POLI.design

This postgraduate programme integrates fashion design, digital technologies and innovation, with a focus on advanced materials, digital prototyping and technology-driven fashion processes. Sustainability is addressed as a transversal theme. The programme introduces advanced digital design and simulation tools that are increasingly converging with AI-supported applications in fashion. It provides a complementary pathway for learners progressing towards higher-level technical and innovation-oriented roles.

Reference Link: https://www.polidesign.net/en/formazione/fashion-design/master--fashion-tech/

Existing VET & HE Programs on AI, Circular Fashion, and Sustainable Textiles - Spain

Spain's VET and HE centres have recently seen a rapid expansion of AI, digital fashion tools and circular/sustainable textiles. For that reason, they have integrated some modules of the recent technologies and sustainability topics but still haven't developed a specialized program. This is seen much in VET centres, according to TEXFOR's training specialist, but there are some HE masters, that offer this kind of education:

Master in Fashion management, marketing and sustainability – ESDI (Escola Superior de Disseny Internacional)

Programme title and educational level: Master in Fashion management, marketing and sustainability

Institution: *ESDI (Escola Superior de Disseny Internacional)*

The Máster en Fashion Management, Marketing y Sostenibilidad is an advanced programme offered by ESDI – Escuela Superior de Diseño e Innovación under Universitat Ramon Llull in Barcelona. It combines strategic business management, brand positioning, innovation and digital transformation with core sustainability principles applied across the fashion value chain.

The curriculum integrates transformation digital modules, exposing students to the digital tools, methodologies and technologies reshaping fashion business models, including data and generative technologies for customer experience, brand innovation and strategic decision-making. Students may explore how AI tools (e.g., generative AI for design, predictive analytics for trend forecasting, digital marketing optimisation) can be deployed in fashion strategy contexts, especially within the innovation and transformation digital modules. (ESDI, 2026).

The programme embeds sustainability, ESG (Environmental, Social & Governance) criteria, circularity and traceability across modules. These themes are integrated not as isolated topics but as strategic lenses, for example in courses on *economía circular, cadena de valor responsable y sostenibilidad aplicada* to real cases. Students work on real projects, workshops and business cases with brands and agencies, emphasising sustainable decision-making, purpose-driven brand management and impact measurement (Idem).

Reference Link: https://esdi.es/estudios/masters-y-postgrados/master/gestion-de-la-industria-de-la-moda-y-el-diseno/#plan

Master in Design for Sustainable Fashion Technology – IED (Instituto Europeo di Design)

Programme title and educational level: Master in Design for Sustainable Fashion Technology **Institution:** IED – Instituto Europeo di Design

The Master in Design for Sustainable Fashion Technology, delivered by the Istituto Europeo di Design (IED) Barcelona, is an interdisciplinary programme taught in English that blends fashion design, advanced materials, digital fabrication and sustainability. It focuses on the intersection of fashion and technology with an eye on future industry needs. (IED, 2026).

The programme includes components on digital tools and fabrication processes, equipping students with the skills to work with computational design systems, digital manufacturing platforms and advanced materials technologies, all of which increasingly incorporate AI-assisted design and optimization workflows (Idem). Students undertake individual research projects that often involve digital experimentation and exploration of emerging technologies such as smart materials, parametric design and digital prototyping, where AI-assisted tools enhance creative and functional outcomes.

Core modules such as Circular and Regenerative Design and Sustainable Material Innovation emphasise lifespan thinking, material impact reduction, recyclability and resource optimisation, all central to circular fashion frameworks.

Reference Link: https://www.ied.es/cursos/barcelona/master/design-for-sustainable-fashion-technology

Master Universitario in Tecnología Textil y Moda Sostenible – Universidad de A Coruña

Programme title and educational level: Master Universitario in Tecnología Textil y Moda Sostenible

Institution: Universidad de A Coruña

The Máster Universitario en Tecnología Textil y Moda Sostenible, offered by the Universidade da Coruña (UDC) through its Escuela Politécnica de Ingeniería de Ferrol (EPEF), is an official master's degree that prepares professionals to address textile manufacturing, product development and sustainability challenges using advanced technology and integrated strategies. (Máster Universitario en Tecnoloxía Textil e Moda Sustentable. (n. d.).

The programme includes modules in Data Analysis, Digital Design and Textile Product Development, which introduce students to digital tools used in industry workflows, including potential applications of data analytics, digital design software and intelligent process control. ngagement with digital and technological innovation — particularly in textile structures, digital design, ecotextiles and process optimisation — creates a context where AI-assisted methods (e.g., predictive modeling for material behaviour, simulation, quality control systems) can be integrated into technical learning (Idem).

The master extensively covers circular textiles, Ecodesign and Recycling, and includes a compulsory module on Circular Economy, ensuring that students understand how textile products can be designed, manufactured, evaluated, and repurposed according to circular principles. Content on new materials, quality control and sustainability

marketing helps learners grasp environmental assessment, end-of-life strategies, and sustainability metrics, crucial for future leaders in sustainable textiles.

In general, all of these studies do not precisely focus on AI, but each of them includes digital tools, data analysis, digital design and technology innovation modules, that build foundational skills relevant for AI-driven workflow in textiles and fashion. On the other hand, sustainability and circularity are more tangible and can be more easily taught and can prepare graduates to engage with circular supply chains and design innovation practices.

Finally, what it is more common to found in Spain are courses of independent organizations or even VET schools that offer short courses on specific topics related to sustainability and recent technology advancements (3D printing, AI, etc).

Reference Link: https://www.udc.es/es/epef/masteres/master-universitario-en-tecnoloxia-textil-e-moda-sustentable/

Existing VET & HE Programs on AI, Circular Fashion, and Sustainable Textiles - Türkiye

Turkish universities and research centers make contributions to AI, but the scale and impact of these efforts are limited. Bilkent University, Boğaziçi University, and Koç University are at the forefront of AI research and education, offering specialized AI

programs and conducting research in this field. The landscape of Textile and Fashion education in Türkiye is currently undergoing a massive "Twin Transformation"; an intentional shift toward digitalization and sustainability to align with the EU Green Deal. Both HE and VET centers are integrating AI to move from traditional craftsmanship to data-driven engineering.

İstanbul Moda Academy (IMA) - Digital Fashion Design Program (VET)

Programme name and level of education: Digital Fashion Design Program (VET; 10–12 week professional certification)

Institution: İstanbul Moda Academy (IMA)

The İstanbul Fashion Academy offers a specialized vocational programme focused on the intersection of creative design and advanced technology. Students master the entire digital design cycle through high-fidelity 3D visualization, virtual prototyping, and digital fitting using industry-standard software like CLO 3D. The curriculum emphasizes a digital-first mindset, training participants to create realistic avatars and virtual photoshoots, which effectively replaces the need for resource-intensive physical sampling. By integrating AI for trend forecasting and collection planning, the programme directly addresses industry inefficiencies such as overproduction and pre-consumer waste. This training supports the textile sector's "twin transformation" by establishing a zero-waste prototyping pipeline that eliminates the carbon emissions associated with global sample shipping. Graduates are prepared for high-demand roles such as Digital

Fashion Designers, 3D Technologists, and Virtual Prototype Managers, essential for competitive, circular textile systems.

Reference Link: https://www.istanbulmodaakademisi.com/en

Faculty of Textile Technologies and Design at Istanbul Technical University (İTÜ)

Programme name and level of education: Faculty of Textile Technologies and Design (HE; 4-year Undergraduate Programme)

Institution: İstanbul Technical University (İTÜ)

İTÜ offers Türkiye's leading textile engineering programme, focusing on the "Twin Transformation" through technical textiles, sustainable production, and design technology. The four-year curriculum is delivered in English and integrates future-oriented coursework in Industry 4.0, Artificial Intelligence for Engineering, and Life Cycle Assessment (LCA) to address global sustainability challenges. Through the ITU-BTS Digital Twin Application and Research Center, students and researchers utilize virtual replicas of manufacturing processes to simulate production cycles, significantly minimizing material waste and pre-consumer losses. The programme emphasizes laboratory-based R&D and industry collaborations, focusing on AI-optimized supply chains and 3D printing for functional textiles. Graduates are prepared for advanced roles

in demand prediction and circular system design, aligned with international sustainability standards and UN Sustainable Development Goals.

Refrence Link: https://tekstil.itu.edu.tr/en/education/departments/textile-engineering

Textile and Fashion Design at İzmir University of Economics (İEÜ)

Programme name and level of education: Department of Textile and Fashion Design (HE; 4-year Undergraduate Programme)

Institution: İzmir University of Economics (İEÜ)

İzmir University of Economics offers a creative and tech-driven undergraduate programme that emphasizes Textiles 4.0 and circular economy principles. The curriculum moves beyond traditional garment construction by integrating 3D digital visualization (CLO 3D) to enable a zero-waste design process, effectively eliminating physical sampling waste.

Through high-impact regional partnerships with brands like Lee and Wrangler, students engage in hands-on upcycling projects that transform industrial denim waste and excess stock into contemporary collections. The programme fosters industrial symbiosis through collaborative "Hackathons" with industry leaders like Sun Textile and Refabric, where students use generative AI to solve real-world sustainability challenges.

Graduates are equipped with a "waste-as-resource" mindset, preparing them for advanced roles in digital fashion and circular design.

Reference Link: https://mt.ieu.edu.tr/en

Chapter 8 – Conclusion

The findings of this report confirm that Artificial Intelligence (AI) is increasingly embedded in the transformation of the fashion and textile sector, particularly in relation to circularity, sustainability, and digital competitiveness. Across policy, industry, and education, AI is no longer treated as an experimental technology but as a structural component of emerging production, distribution, and governance models. However, the analysis conducted within Work Package 2 (WP2) also demonstrates that the pace and quality of AI adoption remain uneven, shaped by regulatory complexity, sectoral readiness, and skills availability.

At EU level, the regulatory framework governing AI and digitalisation is both comprehensive and demanding. Instruments such as the General Data Protection Regulation, the Digital Markets Act, the Digital Services Act, the Cyber Resilience Act, and the Artificial Intelligence Act collectively establish a robust governance architecture for data use, algorithmic accountability, cybersecurity, and risk-based AI deployment (European Union, 2016; European Union, 2022a; European Union, 2022b; European

Union, 2024a; European Union, 2024b). While these frameworks are horizontal rather than sector-specific, their implications for the fashion and textile industry are substantial. Compliance with EU digital regulation is rapidly becoming a prerequisite for market access, technological innovation, and participation in data-driven value chains, including those supporting circular and regenerative business models.

The comparative analysis of national AI policies and strategies reveals both convergence and divergence across the partner countries. All participating countries align broadly with EU-level objectives, emphasising trustworthy, human-centric, and sustainable AI development. At the same time, national approaches differ in terms of governance structures, investment priorities, and integration of AI into industrial and sustainability strategies (European Commission AI Watch, 2024). These differences directly affect the fashion and textile sector, particularly SMEs, which often operate with limited regulatory capacity and uneven access to digital infrastructure. The findings underline the importance of contextualised approaches that take national specificities into account while maintaining coherence with EU regulatory standards.

From an industry perspective, the mapping of EU platforms, innovation initiatives, and practical AI tools illustrates that the technological foundations for AI-driven circular fashion are already in place. Data spaces, digital twins, AI-on-demand platforms, and intelligent sorting or traceability systems demonstrate clear potential to enhance resource efficiency, transparency, and lifecycle management within textile value chains (European Commission, 2023b). However, the report also highlights that technological

availability does not automatically translate into effective adoption. Barriers persist in the form of limited skills, fragmented knowledge, and uncertainty regarding regulatory obligations—particularly in relation to high-risk AI systems, data governance, and platform dependency.

The analysis of national case studies further confirms that successful AI adoption in circular fashion depends not only on technology, but on organisational capacity, regulatory awareness, and workforce competence. Companies that integrate AI strategically tend to combine digital innovation with sustainability objectives, while ensuring compliance with evolving legal frameworks. Conversely, a lack of skills and regulatory understanding can limit experimentation, slow down adoption, or expose organisations to legal and reputational risks (OECD, 2021; European Commission, 2023a).

Within this context, vocational education and training emerges as a critical leverage point. The review of existing VET and higher education programmes demonstrates that, while relevant initiatives exist, significant gaps remain between educational provision and industry needs—particularly with regard to applied AI skills, regulatory literacy, and the practical integration of circular economy principles into digital workflows (Cedefop, 2020). This skills gap is especially pronounced for SMEs and regional actors, reinforcing the strategic relevance of VET-oriented interventions that translate complex regulatory and technological developments into accessible, practice-oriented learning pathways.

Overall, the conclusions of WP2 confirm the core rationale of the TechStyle project. The transition towards AI-driven circular and regenerative fashion requires more than technological solutions; it demands integrated knowledge frameworks, cross-sectoral understanding, and future-oriented skills development. By systematically mapping regulatory conditions, national strategies, industry practices, and educational provision, this report provides a solid evidence base for the next phases of the project.

The insights generated through WP2 will directly inform the design of TechStyle's curricula, training methodologies, and pilot activities. In doing so, the project aims to strengthen the capacity of VET systems to support responsible, compliant, and impactful AI adoption in the fashion and textile sector—contributing to a more sustainable, competitive, and socially responsible European fashion ecosystem.

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