TEX-BREIN – Interregional community of TEXtile ecosystems for the circular transition: Building capacities, REINforcing network and organisations

DELIVERABLE 1.2 – REGIONAL INNOVATION BOOSTING ACTION PLAN – TEX-BREIN CONTRIBUTIONS

Author(s)	Miloš Beran, Marek Urban
Partner name	CLUTEX, CIRI

Publication date	30.10.2025

Funded by the European Union

TEX-BREIN

Funded by the European Union

PROJECT DETAILS AND DELIVERABLE INFORMATION

Project title	Interregional community of TEXtile ecosystems for the circular transition: Building capacities, REINforcing network and organisations
Acronym	TEX-BREIN
Grant agreement	no. I3-2023-Cap2b; 101180358
Duration	1.11.2024 – 31.10.2026
Deliverable information	D 1.2 Regional Innovation Boosting Action Plan – TEX-BREIN Contributions Document report, Public

REVIEWERS

Miloš Beran	CLUTEX
Maria José Carvalho	CITEVE

VERSION HISTORY:

1	20.10.2025	Draft
2	27.10.2025	2nd Draft
3	29.10.2025	Final version

DISCLAIMER

This deliverable may be subject to final acceptance by the European Commission. The results of these deliverables reflect only the author's view and the Commission is not responsible for any use that may be made of the information it contains

EXECUTIVE SUMMARY

This Deliverable D1.2 serves as a core output of Work Package 1 of the **TEX-BREIN** project (Interregional community of TEXtile ecosystems for the circular transition). The project unites 8 partners from 6 European regions: three Less Developed Regions (LDRs: Severovýchod/CZ, Norte/PT, Łódzkie/PL) and three More Developed Regions (MDRs: Tuscany/IT, Catalonia/ES, Vastra Gotaland/SE). TEX-BREIN's central objective is to build innovation capacity, strengthen resilient value chains, and promote the circular and digital transition, particularly within LDR textile ecosystems.

The purpose of this Action Plan is to **translate the results of ecosystem mapping and in-depth needs analysis** (derived from interviews and questionnaires with Quadruple Helix actors) into a cohesive, **actionable strategic roadmap**.

Key Findings and Critical Gaps

The analysis identified several systemic bottlenecks hindering the acceleration of the circular transition:

1. **Infrastructure and Technology:** A critical and widespread gap exists in **collection and advanced sorting infrastructure** for textile waste, particularly mixed fabrics (prioritized in Łódź/PL). Partners also noted a technological gap in efficient, automatic sorting processes in LDRs (e.g., Norte/PT).
2. **Regulation and Policy:** Policy inconsistencies and slow implementation impede necessary investment. It is essential to accelerate the adoption of national **Extended Producer Responsibility (EPR) schemes** and harmonize **End-of-Waste (EoW) regulations** (critical for IT and CZ).
3. **Systemic Support for Reuse:** There is a critical need for the **systemic anchoring of reuse centers and RE-hubs** within regional strategic documents (S3 and Waste Management Plans) and their formal recognition as a public service. LDRs (CZ, PL) require **multi-year operational funding** to replace dependence on short-term project grants.
4. **SME Digitalization:** While RIS3 strategies generally target SME digitalization, there is consensus on the need to develop and distribute **simplified reporting systems and guidelines** tailored for SMEs to ease compliance with green and digital requirements (e.g., SE).

Strategic Outlook and Forward Linkages

The findings of D1.2 are fully **consistent with the RIS3 strategies** of the involved regions, particularly aligning with goals related to ecological transformation and circular business models. The document serves as a **direct input** for the subsequent TEX-BREIN Work Packages:

- **WP2 (Capacity Building):** The identified skills gaps (circular principles, digital competence) directly inform the program content.
- **WP3 and WP4 (Investment):** Concrete regional needs form the foundation for defining **3 textile RE-hub pilots** in Less Developed Regions (LDRs) and generating a **portfolio of minimum 17 SME investment project ideas** for future I3 funding opportunities.

By implementing these recommendations, supported by **interregional collaboration and model transfer** (WP4) from MDRs to LDRs, the TEX-BREIN project will significantly contribute to establishing resilient, circular, and competitive European value chains.

TEX-BREIN

Funded by the European Union

CONTENT

1. About TEX-BREIN.....7

2. Introduction and Methodology.....9

2.1 Context: Accelerating the Twin Transition in European Textiles.....9

2.2 Project Background and the Role of this Report.....9

2.3 Methodology for Needs & Opportunities Analysis.....10

3. Building on the Ecosystem Baseline.....11

3.1 Regional Diversity and Complementarity:.....11

3.2 Common Critical Gaps Identified:.....11

3.3 Innovation Potential and Barriers:.....12

4. Regional Needs & Opportunities for Textile Transition.....13

4.1 Catalonia Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector.....14

4.2 Norte (Portugal) Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector.....23

4.3 Tuscany (Italy) Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector.....29

4.4. Lodz Region (Poland) Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector.....35

4.5 Västra Götaland (Sweden): Insights Report: Green, Digital, and Smart Manufacturing Transformation in the Region's Textile Sector.....39

4.6 Severovýchod region (Czechia): Insights Report: Green, Digital, and Smart Manufacturing Transformation in the Textile Sector.....42

5. Strategic alignment with regional innovation priorities and recommendations for boosting regional innovation ecosystems 47

5.1. Value Chain Perspectives and Regional Challenges 47

Significant Needs and Opportunities for Improvement (Value Chain Gaps)..... 47

5.2 Alignment with RIS3 Strategies & Recommendations for S3 49

Consistency of Conclusions with RIS3 Strategies..... 49

6. Conclusions and strategic outlook 52

6.1 Summary of Key Recommended Actions 52

6.2 The Role of Interregional Collaboration (TEX-BREIN Facilitation)..... 57

6.3 Links to Subsequent TEX-BREIN Activities 57

6.4 Concluding Statement on Impact 58

1. ABOUT TEX-BREIN

The TEX - Brein project aims to build innovation capacity for textile ecosystems in Europe. It aims to create and support innovative and resilient textile value chains and to support circular transformation in line with the EU Strategy for Sustainable Textiles in Circular Economy. The project is intended to support and develop inter-regional cooperation between actors within the quadruple helix and seek to upskill sectoral employers. The project aims to increase the number of circular economy solutions in less developed regions through the transfer of knowledge and accepted practices from more developed regions, through the development of cross-border cooperation plans for SMEs and the transfer of textile recycling centre models from more to less developed regions. It will strengthen the innovation capacity of textile companies, improve sustainable links among industrial textile areas and foster closer cooperation on waste management and circular economy. The project aims to accelerate cooperation between the involved textile territories. As part of the cooperation in TEX-BREIN, the competences of public entities and innovation intermediaries helping SMEs in formulating investment portfolios at the interregional level for textile ecosystems are to be increased. The key objective is to transform the textile industry into a circular economy that protects the environment and innovative production processes reduce textile waste. The project aims to reduce the asymmetry between less and more developed regions. This will be achieved by mapping and assessing innovation turning points (e.g. textile centres in more developed textile regions). The project will develop a portfolio of 20 business cases, 3 of which concern the design of textile recycling centres in less developed regions. The project involves 8 partners from 6 European regions: 3 are classified as less developed - Severovýchod (CZ); Norte (PT) and Łódzkie (PL) and 3 as developed - Tuscany (IT), Catalonia (ES) and Vastra Gotaland (SE).

Work packages

- WP1 ECOSYSTEMS BUILDING: The aim is to analyse and set the context of the innovation ecosystems in all involved regions, by: Identifying the main actors and ecosystems in innovation and business domains in all involved regions, pinpointing capabilities and possibilities to foster synergies among regions in complementary innovative value chains and assess the local strengths to support the involvement of these actors the development of European value chains; identifying the real needs of the textile and correlated sectors in their path to a greener, digital and smarter manufacturing that

can be translated into regional S3 based roadmaps; connecting with S3 policy makers to provide inputs for the improvement of the current strategies by integrating the identified needs and innovation capabilities; and as such, design and display the umbrella framework that will guide partners and participants in their path to generate innovative ideas that address real sector needs and opportunities.

- WP 2 CAPACITY BUILDING: The main goal is the deployment of capacity building activities aiming at enhancing the skills of the different stakeholders to boost innovation in the value chains linked to the recycling in the textile sector making them more prepared to participate in the I3
- WP3 SMES ENGAGEMENT; PORTFOLIO OF PROJECT IDEAS DEFINITION: The objective is the development of an engaged cooperative ecosystem for SMEs, supported by relevant stakeholders, able to promote resilience, empowerment and innovation of the textile value chains. The ecosystem favour the generation of project ideas for new cooperative investments to be exploited in future funding opportunities, I3 new calls in primis. The objective is to have SMEs of textile sector ready for new investments once the external conditions will allow for their implementation. The investments will fall under the domain of green and digital transition and will be connected to WP4, i.e. will liaise with the re-hub pilots.
- WP 4 RE HUBS PILOT CASES - The objective of this WP is to support European SMEs in the generation of new collaborative projects in the field of circular economy, more specifically, textile re-hubs, to accelerate the development of circular textiles business models, supported by cross-regional and cross-sectoral technology knowledge transfer. This WP goal is to have textile re-hub pilot cases defined and ready to apply to future I3 instrument calls.

2. INTRODUCTION AND METHODOLOGY

2.1 Context: Accelerating the Twin Transition in European Textiles

The European textile and clothing sector faces a critical juncture, navigating the complex demands of the twin green and digital transitions. Driven by the EU Strategy for Sustainable and Circular Textiles and broader Green Deal objectives, the industry must shift from linear models towards circularity, encompassing enhanced durability, reuse, repair, and high-value recycling. Simultaneously, digitalization offers pathways for increased efficiency, transparency, traceability (crucial for initiatives like the Digital Product Passport), and the development of smart, functional materials and manufacturing processes. The TEX-BREIN project, funded under the Interregional Innovation Investments (I3) Instrument, directly addresses these challenges by fostering robust interregional collaboration within diverse textile ecosystems across Europe, with a specific focus on bridging gaps between Less Developed/Transition Regions and More Developed Regions participating in the consortium.

2.2 Project Background and the Role of this Report

The initial phase of the TEX-BREIN project involved foundational work to analyse and understand the innovation ecosystems in all involved regions. This included mapping key actors, identifying capabilities and needs, assessing local strengths, benchmarking performance, and connecting findings to regional Smart Specialisation Strategies (S3). This foundational mapping culminated in the project's **"Innovation Mapping Report,"** which provided a comprehensive baseline understanding of the participating regions' landscapes, highlighting both unique strengths and shared critical challenges.

This report, the **"Regional Innovation Boosting Action Plan - TEX-BREIN Contributions,"** builds directly upon that foundation. It moves beyond mapping ('what is') towards actionable strategy ('what needs to be done'). Its core purpose is to synthesize the findings from the initial ecosystem mapping with an in-depth needs and opportunities analysis conducted through extensive stakeholder engagement, alongside insights gathered from dialogue with S3 policymakers.

Based on this integrated analysis, this report proposes concrete, actionable recommendations designed to boost the innovation capacity of the regional textile ecosystems, guide policy development, and strategically inform subsequent activities within the TEX-BREIN project aimed at capacity building, investment project development, and pilot case implementation.

2.3 Methodology for Needs & Opportunities Analysis

The recommendations presented in this report are grounded in a multi-stage methodology executed within the project's initial phase:

- **Baseline Ecosystem Mapping:** Utilized desk research and partner contributions to map stakeholders (following the Quadruple Helix model), assess regional structures, benchmark circularity performance, and analyze innovation capabilities, as detailed in the preceding "Innovation Mapping Report."
- **Needs & Opportunities Identification:** Conducted targeted stakeholder engagement across all six partner regions between 06/2025 and 09/2025. This involved structured interviews and workshops guided by specifically developed regional personas (including SMEs, Large Companies, RTOs/Universities, Policymakers, Clusters, DIHs, and Hub Specialists) to capture diverse perspectives on the needs, gaps, and opportunities related to the green, digital, and smart manufacturing transition.
- **Connecting to Regional Strategies:** Each partner carried out dialogues with regional S3 policymakers and relevant managing authorities to discuss the alignment of identified sectoral needs with the current RIS3 priorities (2021–2027 period), collect inputs for the deliverables, and explore potential leverage points for policy integration.

The combined qualitative and quantitative insights gathered through these activities form the evidence base for the analysis and recommendations presented herein.

3. BUILDING ON THE ECOSYSTEM BASELINE

The preceding **"Innovation Mapping Report"** provided the foundational analysis of the six TEX-BREIN regional ecosystems. Before detailing the specific needs identified through stakeholder engagement, it is crucial to recall the key structural findings and critical gaps highlighted in that initial report, which set the context for this action plan. The "Innovation Mapping Report" should be consulted for the full detailed mapping and benchmarking data.

3.1 Regional Diversity and Complementarity:

The initial mapping confirmed significant diversity across the partner regions. Key structural aspects relevant here include:

- **LDR/MDR Dynamics:** Clear differences exist between the ecosystems in Less Developed/Transition Regions (CZ, PL, PT) and More Developed Regions (IT, ES, SE) regarding industrial concentration, infrastructure maturity (especially for circularity), R&D focus, and policy frameworks.
- **Specialization:** Regions exhibit distinct strengths, offering potential for complementarity: SE leads in smart/sustainable R&D and EPR readiness; PT possesses a strong, integrated industrial base with technical textile expertise; IT (Prato) holds unique scaled capacity in mechanical wool recycling; ES leverages design and strong RTO/policy coordination; CZ has focused technical textile R&D (TUL); PL maintains a large fashion/apparel hub alongside modernizing industry.
- **Network Maturity:** Coordination mechanisms vary, with SE, ES, and PT showing more mature, dedicated platforms or clusters actively driving textile circularity compared to the others.

3.2 Common Critical Gaps Identified:

Despite regional differences, the benchmarking analysis in the initial mapping report revealed critical, shared weaknesses hindering the circular transition across *most or all* participating regions:

- **Separate Collection Failure:** Estimated separate collection rates remain drastically low across the consortium (often <15%, with PL and PT estimated <5%), far below EU averages and the requirements of the 2025 mandate. This is arguably the **most immediate shared bottleneck**.
- **Lack of Scaled Advanced Recycling:** Capacity for commercial-scale, economically viable advanced sorting of mixed textiles and subsequent high-value (fiber-to-fiber) recycling is largely absent regionally, with rates estimated at <1% across Europe. This necessitates reliance on export or lower-value downcycling/incineration/landfill.
- **Policy Implementation Hurdles:** While SE is advanced, other regions face significant challenges and uncertainties regarding the timely and effective implementation of national EPR schemes needed to fund collection/recycling infrastructure
- **Data Scarcity:** Reliable, granular data on regional textile waste flows, composition, and treatment fates remains scarce, hampering effective planning and monitoring.

3.3 Innovation Potential and Barriers:

The initial mapping also highlighted strong innovation potential anchored by regional RTOs, universities, and clusters (e.g., CITEVE/UMinho in PT, U Borås/RISE in SE, TUL in CZ, NTT in IT, Eurecat/Leitat in ES, ŁIT in PL). However, common barriers include translating research into widespread SME adoption, accessing pilot facilities for circularity testing, and securing finance, particularly for SMEs, to invest in green and digital technologies.

These baseline findings underscore the necessity for targeted interventions and interregional collaboration. The following sections will detail the specific needs articulated by stakeholders within this context and propose actions to address the identified gaps and leverage the diverse opportunities across the TEX-BREIN regions.

4. Regional Needs & Opportunities for Textile Transition

Detailed synthesis of stakeholder needs identified through interviews and engagement across the six regions, structured thematically:

- **Greener Manufacturing:** Needs related to sustainable materials (sourcing, cost, quality), water/energy efficiency, chemical management, waste valorization.
- **Digital Transition:** Needs concerning traceability (DPP), supply chain transparency, data management, smart manufacturing adoption (IoT, AI), digital skills.
- **Smarter Processes & Circular Models:** Needs for advanced sorting/recycling technologies, implementing reuse/repair models, developing circular design capabilities, accessing finance for circular innovation.
- Analysis of these needs from the Quadruple Helix perspectives (Industry – differentiating SME vs. Large, R&D, Government/Policy, Intermediaries/Civil Society), leveraging the persona insights.
- Identification of specific **opportunities** for innovation, collaboration (intra- and interregional), and investment arising from these needs (e.g., developing specific recycling solutions, creating digital platforms, joint training initiatives).
- Highlight **interregional opportunities** based on complementary strengths identified in D1.1 (e.g., connecting CZ/PT tech textile producers with SE/IT recycling R&D).

***Note**: For data protection reasons, the names of individual stakeholders are not used in the following text. Instead, they are identified by their area of focus. The project partners have access to the full list of names; however, since this deliverable is public, these data have been anonymized.*

4.1 Catalonia Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector

Executive Summary

This part synthesizes insights from three interviews with key stakeholders in the Region's textile sector: “Mechanical recycler”, “Spinner of recycled fibers” and „Technological Center”. The findings reveal a sector at a critical juncture, facing challenges from rising costs, international competition, and fragmented local value chains, particularly in spinning and intermediate processes. While sustainability is a recognized priority, its practical implementation is slow, hindered by high costs, reluctance to adopt recycled materials without legislative mandates, and a lack of infrastructure for advanced recycling. Digital technology adoption is low, primarily due to investment costs and resistance to change.

Key needs identified include flexible and supportive regulations, significant financial and technical support for SMEs to invest in green and digital technologies, and the preservation and development of specialized skills. Gaps in the innovation ecosystem, particularly a disconnect between R&I outputs and SME practical needs, and a lack of market demand for recycled products, were highlighted.

Major opportunities lie in leveraging existing regional knowledge, developing high-value-added recycled products, and embracing circular business models like leasing. Interregional collaboration, especially with more advanced EU regions, is seen as crucial for knowledge sharing and market access. Textile re-hubs are considered vital for closing material loops but require incentives.

Current regional policies and S3 strategies are perceived as insufficient or even counterproductive by some industry players, lacking practical tools for SMEs and sometimes creating financial burdens. Recommendations for S3 roadmaps and Deliverable D1.2 include: prioritizing investment in value chain gaps (e.g., spinning), fostering demand for circular products, developing SME-friendly support mechanisms for technology adoption, promoting interregional collaboration, and revising policies to be more facilitative and less burdensome. A stronger alignment between industry needs, R&I activities, and policy measures is essential for a successful transformation.

Introduction

The purpose of this report is to provide a consolidated analysis of the needs and opportunities within the Catalan textile and correlated sectors concerning the green, digital, and smart manufacturing transformation. The insights are derived from a qualitative analysis of three semi-structured interviews conducted with representatives from different segments of the textile value chain and innovation ecosystem: “Mechanical recycler”, “Spinner of recycled fibers”, and „Technological Center”. These interviews aimed to identify key needs, pinpoint innovation and collaboration opportunities, understand diverse perspectives from the quadruple helix, and gather insights to inform regional S3 roadmaps and Deliverable D1.2. The analysis synthesizes common themes and divergent viewpoints expressed by the interviewees across a range of topics outlined in the interview template.

Consolidated Current State and Challenges

- Main Sector Challenges:
  Across the interviews, a consistent theme was the significant pressure on the Region's textile sector. “Mechanical recycler” highlighted rising fixed costs and the difficulty of competing with foreign production, leading to the closure of industries at the end of the value chain and breaking the local productive chain. “Spinner of recycled fibers” echoed the concern about company closures within the value chain, emphasizing that the local market does not sufficiently demand technical recycled products, forcing sales to be international and in smaller production runs. „Technological Center” pointed to increasing competition from less regulated markets, necessary but restrictive environmental regulations, and high energy costs and dependencies as key factors affecting global competitiveness.
- Sustainability Issues (Waste, Circularity, Environmental Impact):
  All interviewees acknowledged the growing importance of sustainability, but practical implementation faces hurdles. “Mechanical recycler” stated that progress is slow, with many institutional requirements but a lack of "real work" or large-scale projects due to significantly higher costs and the non-mandatory nature of using recycled materials. They also noted that garment manufacturers often retain their post-industrial waste. “Spinner of recycled fibers” observed that the circular economy is not yet practically applied, with companies hesitant to use recycled raw materials due to concerns about property changes. „Technological Center” described

the pressure to reduce waste and transition to a circular economy as high, but identified a significant lack of infrastructure for advanced recycling.

- Digital Technology and Smart Manufacturing Adoption:
  The adoption of digital technologies and smart manufacturing is generally low. "Mechanical recycler" mentioned traceability tools like GRS and Fiber Tracer but noted they are not currently in demand. "Spinner of recycled fibers" explained that their carded spinning process is very manual, and upgrading machinery would require a very large investment. „Technological Center" characterized adoption as slow and fragmented, with main barriers being the initial investment costs and resistance to change within companies.
- Impact of Global Events:
  Recent global events have negatively impacted the sector. "Mechanical recycler" cited the impact of COVID-19, after which foreign countries developed their local markets, coupled with higher transport costs. "Spinner of recycled fibers" pointed out that certain links in the local processing chain are missing (e.g., for material mixing, dyeing, doubling). „Technological Center" confirmed that global events increase costs and delays, exposing the Region's dependence on foreign raw materials.

Key Needs and Gaps Identified

- Critical Needs for Green and Digital Transition:
  To facilitate the transition, "mechanical recycler" emphasized the need for flexible regulations, citing an example from Italy. "Spinner of recycled fibers" stressed the fundamental need for orders (demand) and investments. „Technological Center" identified access to affordable financing and accessible technologies for SMEs as critical.
- Skills and Knowledge Gaps (WP2 Alignment):
  There are concerns about the workforce. "Mechanical recycler" believes the knowledge and competencies exist but stressed the need not to lose them. "Spinner of recycled fibers" highlighted a significant issue: professionals who retire are not being replaced, and salaries in the sector are low, making it unattractive. „Technological Center" pointed to a need for specific training in advanced manufacturing and circular economy principles. These points directly align with the capacity building focus of WP2.

- Support Needed (Financial, Technical, Infrastructural, Policy-Related):
  A strong call for comprehensive support emerged. “Mechanical recycler” requires legislative and financial support to facilitate progress and investment. “Spinner of recycled fibers” suggested a more protective stance, advocating for vetoing competition that does not comply with EU regulations (e.g., through tariffs, import barriers). „Technological Center” called for a suite of measures including tax incentives, technical subsidies, financial support for applied innovation, and modern infrastructure.
- Gaps in the Innovation Ecosystem:
  The innovation ecosystem is perceived to have shortcomings. “Mechanical recycler” identified the main gap in spinning capacity and the ability to work with new fibers. “Spinner of recycled fibers” pointed to a lack of demand, especially at the national level, as a key gap. „Technological Center” identified a critical gap in the confidence of companies in ecosystem players who could help them navigate the upcoming changes.

Identified Opportunities and Potential

- Circular Economy and Advanced Manufacturing Opportunities:
  Despite challenges, opportunities are recognized. “Mechanical recycler” sees potential in the Region's existing knowledge and established links in the production chain. “Spinner of recycled fibers” believes opportunities will be significantly driven by legislation, once it becomes mandatory to use recycled content. „Technological Center” highlighted innovation in sustainable materials and advanced recycling systems as ways to strengthen European competitiveness.
- Interregional Collaboration:
  All interviewees saw value in looking beyond regional borders. “Mechanical recycler” suggested learning from Central and Northern European countries, which are more advanced. “Spinner of recycled fibers” emphasized the benefits of sharing best practices and informing EU companies about the availability of recycled raw materials from Catalonia, thereby giving visibility to local capabilities. „Technological Center” proposed technological exchange and joint projects in sustainability with other European clusters. These views align with WP3's focus on SME engagement and cross-border approaches.

- Potential for New Value Chains/Business Models:
  The development of new models is nascent but holds potential. “Mechanical recycler” stated that, for now, new value chains are not apparent and that legislation will largely define their emergence, noting the EU's large stock of post-consumer material. “Spinner of recycled fibers” sees potential in high value-added products and the recycling thereof. „Technological Center” suggested that the rise of functional textiles offers potential for business models based on leasing or post-consumer returns.
- Alignment of R&I with Industry Needs:
  There are mixed views on R&I alignment. “Mechanical recycler” feels R&I activities are aligned, but the leap from theoretical to industrial application is missing; if there are orders, the preparation is there. “Spinner of recycled fibers” expressed a need for technology and research centers to value SMEs more and align better with company needs, suggesting that advances made by companies in each country should be shared. „Technological Center” stressed that R&I must prioritize projects that address real industry needs, such as less energy-intensive manufacturing processes or new business models adapted to global sustainability criteria.
- Role of Textile Re-hubs:
  Re-hubs are seen as important. “Mechanical recycler” believes they play a key role because no single entity is 100% vertical in its operations. “Spinner of recycled fibers” pointed out the need to give visibility to what is being done in each region to generate synergies and optimize resources, citing a current lack of connection. „Technological Center” affirmed that re-hubs are key to closing the lifecycle of materials but require incentives to attract investment and business participation. This directly relates to WP4's focus on re-hub pilot cases.

Value Chain Perspectives

- Significant Needs and Opportunities for Improvement:
  Improving the value chain is paramount. “Mechanical recycler” referred back to their initial point about the broken productive chain as a key area for improvement. “Spinner of recycled fibers” highlighted the need for financing and support similar to what other regions in Spain receive. „Technological Center” emphasized the need to reduce dependence on imported materials and promote circularity through sustainable design from the outset.

- Collaboration Among Value Chain Actors:
  Enhanced collaboration is crucial. “Mechanical recycler” identified brands and buyers as key actors to initiate the circular process, but noted the problem that there is no compelling law yet. “Spinner of recycled fibers” proposed the creation of an EU hub to generate connections among stakeholders. „Technological Center” advocated for promoting and establishing exchange platforms that connect producers, brands, and recyclers to optimize material flows. These suggestions resonate with WP3's aim to improve the business climate and stakeholder network.

Policy and Strategy Insights

- Effectiveness of Current Regional Policies/S3:
  Feedback on current policies was largely critical. “Mechanical recycler” stated that policies do not facilitate anything; on the contrary, they use circularity as a pretext to collect more taxes. “Spinner of recycled fibers” felt that, in general, policies do not support the sector, and the productive sector is not valued at all. „Technological Center” offered a more nuanced view, suggesting that while well-intentioned, regional strategies lack practical tools for scaling green technologies in SMEs.
- Policy Changes and New Initiatives:
  Suggestions for policy improvements were clear. “Mechanical recycler” called for facilitation and incentives. “Spinner of recycled fibers” advocated for potentiating and providing more support to the industry, possibly through clusters, including budgets for members and support for creating new value chains. „Technological Center” recommended adapting recycling regulations to global competition, establishing minimum quotas for recycled materials, and reducing administrative barriers to innovations. These insights are valuable for WP5, which aims to influence regulators and policymakers.

Cross-Cutting Themes & Divergent Views

- Recurring Themes:
  Several themes resonated across the interviews:
  - **Impact of Legislation:** Legislation is seen as a double-edged sword – a potential driver for circularity if well-designed and supportive, but a hindrance if overly restrictive, inflexible, or perceived as a fiscal burden.

- **Need for Financial Support & Investment:** A critical enabler for adopting new technologies, modernizing infrastructure, and scaling circular practices, especially for SMEs.
- **Challenges from Foreign Competition:** Competition from regions with lower regulatory standards and costs undermines local efforts.
- **Fragmented Local Value Chain:** Significant gaps, particularly in spinning, dyeing, and other intermediate processes, force reliance on external partners and hinder local circularity.
- **Slow Adoption of Circularity:** Despite discussions and awareness, the actual uptake of circular materials and practices is slow, often due to cost, lack of demand, and technical challenges.
- **Importance of Collaboration & Visibility:** A need for better networking, shared learning, and visibility for regional capabilities, both within the Region and internationally.

Divergent Views (reflecting Quadruple Helix perspectives):

- **Skills and Knowledge:** While "Mechanical recycler" emphasized preserving existing knowledge, "Spinner of recycled fibers" pointed to a critical gap due to retiring professionals and low wages, and „Technological Center" highlighted the need for *new* skills in advanced manufacturing and circular economy. This shows a spectrum from knowledge retention to urgent reskilling/upskilling needs.
- **R&I Alignment:** "Mechanical recycler" felt R&I is theoretically aligned but needs industrial orders to translate into practice. "Spinner of recycled fibers" expressed a sentiment that SMEs are undervalued by R&I centers, calling for better alignment with practical business needs. „Technological Center" advocated for R&I to proactively prioritize projects addressing tangible industry problems. This reflects a potential disconnect between research agendas and immediate SME requirements.
- **Policy Perception:** The industry voices were more critical of current policies, viewing them as unhelpful or even detrimental. „Technological Center", while acknowledging good intentions, focused on the lack of practical implementation tools for SMEs. This difference in tone and focus likely reflects their distinct positions and interactions with the policy environment.

Actionable Insights & Recommendations for S3

Based on the synthesized interviews, the following actionable insights and recommendations are proposed for the Region's S3 roadmaps:

- **For S3 Roadmaps:**
  1. **Strengthen the Local Value Chain:** Prioritize funding and support for filling critical gaps, especially in **spinning of recycled and new sustainable fibers**, and other intermediate processes like specialized dyeing and finishing for circular materials.
  2. **Stimulate Demand for Circular Products:** Implement measures to increase demand for regionally produced recycled and sustainable textiles, possibly through public procurement preferences, consumer awareness campaigns, and incentives for brands adopting circular materials.
  3. **Develop SME-Focused Support Mechanisms:** Design financial and technical assistance programs that are easily accessible and tailored to the needs of SMEs for adopting **digital traceability tools, smart manufacturing practices, and green technologies**. This includes support for initial investment and de-risking innovation.
  4. **Foster Interregional and International Collaboration (WP3):** Actively support SMEs in connecting with EU clusters and partners for knowledge exchange, joint projects, and access to larger markets for recycled materials and products.
  5. **Revise and Adapt Regulations (WP5):** Advocate for and implement **flexible, supportive regulations** that incentivize circularity and innovation without imposing undue administrative or financial burdens. Consider measures like minimum recycled content quotas (as suggested by „Technological Center") and mechanisms to level the playing field against non-compliant foreign competition (as suggested by "Spinner of recycled fibers").
  6. **Invest in Skills and Capacity Building (WP2):** Develop targeted training programs addressing identified skills gaps, including advanced manufacturing, circular economy principles, and digital literacy for the textile workforce. Support initiatives to attract new talent to the sector.
  7. **Promote and Incentivize Textile Re-hubs (WP4):** Provide clear incentives and support for the development and operation of textile re-hubs, ensuring they are well-connected and visible to all stakeholders in the value chain.
  8. **Bridge R&I and Industry Needs:** Create stronger mechanisms for dialogue and co-creation between R&I centers and industry, particularly SMEs, to ensure research projects address real-world challenges and innovations are readily transferable.

Conclusion

The interviews with “Mechanical recycler”, “Spinner of recycled fibers”, and „Technological Center” provide valuable, albeit sometimes sobering, insights into the state of the Region's textile sector. While facing significant challenges related to costs, competition, and the practicalities of transitioning to a green and digital future, there is also a clear recognition of opportunities. The path forward requires a concerted effort from all stakeholders, underpinned by supportive and pragmatic policies, targeted investments, a commitment to skills development, and enhanced collaboration across the value chain and beyond. Addressing the identified needs and capitalizing on the potential outlined in this report will be crucial for the Region's textile industry to thrive in a more sustainable and competitive global landscape, directly informing the S3 strategy.

4.2 Norte (Portugal) Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector

Executive Summary

The Norte Region in Portugal, classified as a Less Developed Region (LDR) within the TEX-BREIN project, faces significant challenges in the circular textile economy, particularly concerning **advanced infrastructure** and **political support**. However, it has the potential to become a key player in the circular textile economy.

Key Findings:

- **Technological Gap:** There is a critical need for **efficient and automatic sorting processes** for textile waste based on its recycling potential. The mechanical recycling processes need improvements to be more efficient and less costly, particularly for the post-consumer textiles, and the chemical recycling is not yet scaled or fully effective. Overall installed sorting and recycling capacity falls short considering the expected growing waste volumes.
- **Skills Gap:** There is a lack of qualified skills in all steps of the textile process, particularly skills needed for the circular transition, such as expertise in circular design, eco-engineering, fiber science, and smart manufacturing.
- **Regulation and Market: Political support** is required to define regulations adapted to market needs and to provide **infrastructural and financial support**. The region sees an opportunity to reduce EU dependency on imported virgin raw materials by using recycled fibers.

Recommendations for Transformation

It is essential to accelerate the **local** and **interregional collaboration** for the development of infrastructures and research projects to promote textile circularity and leverage **RE-Hubs** as key bridges connecting the circular value chain. Policy adjustments, such as VAT exempting for second-hand goods, are suggested to incentivize reuse.

Introduction and Methodology

The purpose of this report is to provide a consolidated analysis of the needs and opportunities within the Portuguese textile sector and correlated sectors in the Norte Region, with a specific focus on the green, digital, and smart manufacturing transformation. The insights are derived from a **qualitative analysis of three semi-structured interviews** conducted in June 2025 with key Quadruple Helix stakeholders:

- **A textile RTO** (research in mechanical, chemical, and bio recycling, sorting, and accessories removal from textile wastes).
- **A Non-Profit Organization** (post-consumer textile collecting and sorting).
- **A Textile Recycling Company** (mechanical and chemical recycling processes for post-industrial and post-consumer textiles).

The interviews focused on the current state and challenges, needs and gaps, opportunities, value chain perspective, and policy/strategy, aiming to give relevant insights to the regional S3 roadmaps. This analyse reflects the collective input of the interviewed RTO researchers, non-profit collection manager, and recycling company manager and technician, highlighting shared points of view, as well as specific aspects related with the area of expertise of each of the interviewees.

Challenges

The main challenges refer to regulatory, material and market difficulties. The EU policies on textiles, like the end-of-waste criteria and extended producer responsibility, are unclear and not yet implemented, slowing down investment decisions. A particular reference was made to the customs codes, which have only one code (used textiles) to all different types of textiles that can be introduced in the circular value chain, not allowing to have discriminated data on those different types of textiles.

The textile material challenges include the products complexity, in particular the fibre blends and chemical additives that compromise the recyclability of those textiles. This complexity is even more evident in the technical textiles, making the sorting and processability harder. It was also highlighted the variability and low quality of post-consumer textiles, making reuse difficult. In addition, insufficient infrastructures and equipment's for

collecting and sorting and low consumers awareness on sorting were named as barriers for capturing usable textile waste.

The import of second-hand textiles from China saturates the global reuse market. Simultaneously, fast-fashion's throwaway model is increasing volumes of low-quality discards pushing more material into low-value recycling streams. The circular textiles value chain is still disconnected, without a holistic approach of the different types and characteristics of the textile wastes, from all sources (industrial, commercial, domestic) and the potential solutions.

Gaps

The following key gaps in the Norte Region were identified by the interviewees:

- **Technological gaps in sorting**: The collection points and sorting facilities lack scale, remaining largely manual. Lack of efficient sorting systems to route waste into the appropriate recycling streams
- **Technological gaps in recycling:** Mechanical recycling processes need improvements to be more efficient and less costly, particularly for the post-consumer textiles. Chemical recycling is not yet scaled or fully effective due in part to residual chemicals in textiles
- **Infrastructure constrains:** Overall installed sorting and recycling capacity falls short considering the expected growing waste volumes and the diversity of fibers used in the same product
- **Skills shortages:** There is a clear gap on expertise in circular design, eco-engineering, fiber science, and smart manufacturing to develop and/or adapt equipment and processes.

Opportunities

The Norte Region sees strong potential in developing circular solutions linked to the emergence of new industrial processes and business models.

- **Economic and market potential:** There is **great market potential** for textile recycled products and the development of new textile industries and businesses. Opportunities exist in reducing EU dependency on imported raw materials.
- **New business models:** Opportunities include the development of **new or improved businesses**, such as customized production, textile redesign, product-as-a-service,

second-hand sales, and repair-for-reuse. Also referred were the digital resale marketplaces and brand take-back schemes, to scale collection of used textiles, as well as brand led initiatives, such as taking back used garments and supporting repair and reuse.

- **Digital technologies:** The new digital technologies are critical enablers to improve the circular textile value chain. Smart technologies, like smart sensors in collection bins, automatic sorting, fibre tags, traceability systems, are key to improve efficiency and quality of reuse and recycling processes. Although the current high costs of these technologies can be a barrier.
- **RE-hubs and chain connection: RE-Hubs** are crucial for creating **bridges** between interested parties and contributing to **connecting the textile circular value chain**.
- **Proactive collaboration:** Collaboration is **essential** between relevant stakeholders, which may include shared infrastructure, such as joint sorting facilities serving multiple textile collectors, creating physical reuse spaces, like repair shops and swap events, and coordinated networks (stakeholder forum, ReHub, cluster), as a way to pool resources and know-how.

Policy

Implementing and modulating existing regulations, rather than creating new ones, was referred as a priority, to define how the circular value chain will operate. Key suggestions included a clarified and enforced extended producer responsibility scheme for textiles, clear end-of-waste criteria and differentiation of customs codes for used textiles to have specific data on different types of textiles. Fiscal measures were also recommended, including lowering eco-taxes (and VAT) on durable, recycled-content textiles and VAT exempting for second-hand goods, to incentivize reuse.

Actionable Insights & Recommendations for S3

Based on the identified needs and gaps in the Norte Region, the following actionable insights and recommendations are proposed for the regional S3 roadmaps (Regional Innovation Boosting Action Plan):

Funding & Investment Focus

1. **Infrastructural and Financial Support:** Establish **targeted financial and infrastructural mechanisms** to support the development of shared collection and automated sorting facilities and to enlarge existing textile recycling facilities and establish new ones, aligned with projected waste volumes.
2. **Investment in Digital Sorting:** Invest in the development and deployment of **advanced sensor and automated sorting systems** that can distinguish textiles based on their recycling potential, moving beyond basic container fill levels.
3. **Funding recycling R&D**: Support collaborative research projects to improve textile **mechanical recycling** efficiency and scale textile **chemical recycling** processes**.**
4. **Pursue funding:** Engage in EU and national funding calls (like joint projects, cascade funding) to pilot circular initiatives (new recycling processes, reuse schemes, circular business models).

Infrastructure and Skills Development

1. **Establish RE-hub Network:** Support the creation and development of **RE-Hubs** as **connecting bridges** for all parts of the circular textile value chain in the region, including linkages to international markets.
2. **Targeted Skills Training:** Implement **specialized training programs** focused on the critical skill gap, including **circular design**, **eco engineering, textile sorting** and textile **fiber experts**.
3. **Active Interregional Engagement:** Leverage the TEX-BREIN project to **strengthen interregional collaboration** and ensure market outlets for recycled fibers and products in European markets, compensating for the limited local market.

Policy & Strategy Adjustments

- **Market-Adapted Regulations:** Lobby for **political support** and regulatory bodies to define **regulations adapted to market needs**, particularly for EPR rules, end-of-waste criteria for textiles and customs/ trade codes to distinguish different waste streams.

- **Tax Incentives for Reuse:** Implement measures, such as **reduced VAT on recycled textiles** and **VAT exempting for second-hand goods**, to provide economic motivation for textile recycling and reuse.
- **Traceability Implementation:** Introduce policies mandating **textiles traceability** to enable more efficient sorting and raw material utilization throughout the value chain.

Conclusion

The insights gathered in the Norte Region indicate that this region, classified as a Less Developed Region (LDR) within the TEX-BREIN project, has the potential to become a key player in the circular textile economy but faces significant systemic and knowledge asymmetries.

The successful transformation hinges on overcoming the **technological gap** in efficient and automated textile sorting and in increasing the textile recycling capacity and addressing the **critical skill shortage**, particularly for textile fibers experts required for the spinning process of recycled materials. To achieve this, **political support** is needed to define market-adapted regulations and secure necessary financial and infrastructural backing. A suggested measure is **VAT exempting for second-hand goods** to incentivize reuse.

The effective implementation of the proposed action points and the reduction of regional asymmetries will depend on the Norte Region's ability to utilize **RE-Hubs** as **key bridges** connecting the circular value chain and engaging in **active interregional collaboration**. This collaboration is essential, specifically for ensuring market outlets for recycled fibers and products outside Portugal. The TEX-BREIN project seeks to transfer RE-hub models from more developed regions to LDRs, providing the Norte Region with a strategic opportunity to develop new industrial processes focused on textile recycling and reduce the EU's dependency on imported virgin raw materials.

4.3 Tuscany (Italy) Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector

This part synthesizes insights from interviews with three key stakeholders in the Italian textile sector, specifically in the Tuscany/Prato region: “Waste management company”, “Luxury knitwear company” and “Textile recycling machinery company”. The findings indicate a region that is already a benchmark for circularity but faces challenges in comprehensive textile waste management, the integration of advanced digital technologies, and the need for a supportive regulatory framework. Opportunities lie in developing new circular business models, fostering interregional collaboration, and investing in advanced recycling and digital solutions.

The purpose is to provide a consolidated analysis of the needs and opportunities within the Italian textile and correlated sectors, with a specific focus on the Tuscany/Prato region, concerning the green, digital, and smart manufacturing transformation. The insights are derived from a qualitative analysis of semi-structured interviews conducted with representatives from different segments of the textile value chain and innovation ecosystem. These interviews aimed to identify key needs, pinpoint innovation and collaboration opportunities, understand diverse perspectives from the quadruple helix, and gather insights to inform regional Smart Specialisation Strategies (S3) roadmaps.

Description of Key Italian Stakeholders

- “Waste management company” is the integrated waste management provider for central Tuscany, covering the provinces of Florence, Prato, and Pistoia, serving approximately 1.5 million residents. Formed in January 2023, “Waste management company” manages the full waste cycle (collection, transport, treatment, recycling, and disposal) with a mission to promote sustainability and environmental protection.
- “Luxury knitwear company” is an Italian luxury knitwear manufacturer, established in 1978 and headquartered in Prato. It specializes in high-quality cashmere garments, upholding the "Made in Italy" heritage. Company actively implements circular practices, recycling all textile waste, reclaiming steam water, generating about 60% of its energy via photovoltaic systems, and sourcing certified sustainable fibers like GOTS organic cotton and OEKO-TEX cashmere.

- "Textile recycling machinery company" is a family-run Italian manufacturer, operating since 1964 and headquartered in Campi Bisenzio (Florence). They specialize in textile recycling machinery, designing and producing a wide range of customizable machines and complete processing lines that reclaim fiber from various textile wastes. They also operate a technical laboratory for clients to test and produce fiber samples.

Consolidated Current State and Challenges

Main Sector Challenges:

- "Luxury knitwear company" highlights the main challenge as **combining artisanal knitwear tradition with environmental sustainability requirements and the adoption of digital technologies** in the production process.
- "Waste management company" faces key challenges in **providing a better system for textile waste collection and management** in the Prato district. This includes intercepting illegally dumped or mixed residual waste, maximizing the valorization of both post-consumer and pre-consumer scraps, increasing reuse and recycling rates, avoiding landfill and incineration, and educating both citizens and textile companies on proper waste disposal.

Critical Needs for Green and Digital Transition:

- "Waste management company" identifies **infrastructural and technological gaps** in textile waste management within the "Waste management company" -managed area and the entire Tuscany region concerning post-consumer waste. These gaps are expected to be addressed with the creation of the **Textile Hub, planned to be operational by the end of 2026**. There is also a significant **lack of legislation**, particularly regarding national Extended Producer Responsibility (EPR) and harmonized End-of-Waste (EoW) regulations for textiles.
- "Luxury knitwear company" sees opportunities for more sustainable and innovative practices through **developing partnerships with start-ups or research centers to access bio-based or innovative materials** and "smart" yarns. Furthermore, they emphasize the need for **implementing and adopting machine learning (ML) and Artificial Intelligence (AI) for specific activities such as garment design**, tracking via Radio-Frequency Identification (RFID) in the production chain, using and

developing scanners and custom software for archiving samples and prototypes, and employing augmented reality (AR) during the sample design phase.

Skills and Knowledge Gaps:

- While "Luxury knitwear company" does not explicitly state skills gaps, its identified needs for advanced digital technologies (ML, AI, RFID, AR) imply a requirement for new and specialized skills within the workforce. "Textile recycling machinery company" foresees **growing investment in skills development** as crucial for the district's future competitiveness.

Interregional Collaboration:

- "Luxury knitwear company" views the **greatest opportunity in collaborating with spinning mills to develop new circular business models** within the Prato textile district, while noting that other specialized knitwear competencies might be found outside the district.
- "Waste management company" has signed a **Memorandum of Understanding with other district stakeholders** to implement the goals of "Next Generation Prato" in relation to the creation of the Textile Recycling Hub. Additionally, "Waste management company" actively **collaborates with various actors through multiple European projects** focused on the textile sector and the promotion of circular economy models and solutions.
- "Textile recycling machinery company" envisions the future of the local textile industry to involve **active collaboration among businesses, research centers, and public institutions** as key to addressing future challenges and ensuring long-term competitiveness.

Role of Textile Re-hubs:

- "Waste management company" expects the **Textile Hub, planned to be operational by the end of 2026**, to significantly address infrastructural and technological gaps. Once operational, "Waste management company" will manage around **13,000 tons/year of pre-consumer textile waste** from Prato's textile companies and supply companies with textile materials (End-of-Waste) ready for recycling and valorization.
- "Textile recycling machinery company" already recognizes Prato as a **European benchmark for circularity and sustainable textile production** due to its deep-

rooted industrial tradition and early commitment to recycling practices. They anticipate the district will further strengthen this position by **integrating circular economy principles across every stage of the textile value chain**, from eco-design and responsible sourcing to advanced recycling and regeneration technologies.

R&I Alignment:

- "Luxury knitwear company" is actively analyzing, evaluating, and implementing sustainable and innovative practices, and sees opportunities in **partnerships with start-ups or research centers to access bio-based or innovative materials** and "smart" yarns, as well as digital solutions for garment design and tracking. "Textile recycling machinery company" commitments to providing advanced recycling systems and technical expertise further underscores the importance of R&I.

Policy Perception:

- "Luxury knitwear company" provided "No comment" on the effectiveness of current regional policies.
- "Waste management company" participates in the Prato Textile District roundtable, **advocating for regulatory harmonization and institutional engagement** in managing Europe's largest textile district. They emphasize the need for synergistic actions and partnerships with district companies to close the loop of reuse and recycling, and envision creating new brands to reintroduce products derived from reuse/recycling back into the market. They also explicitly highlight the lack of national EPR and harmonized EoW regulations. "Textile recycling machinery company" notes that investment in green technologies, digital solutions, and skills development needs to be **supported by active collaboration among businesses, research centers, and public institutions**.

Actionable Insights & Recommendations for S3

Based on the synthesized interviews, the following actionable insights and recommendations are proposed for the region's S3 roadmaps and for inclusion in Deliverable D1.2:

- **Accelerate and Optimize Textile Waste Management Infrastructure**: Prioritize the rapid and effective establishment and full operationalization of the planned Textile Hub in Tuscany. Ensure it develops comprehensive capabilities for collection, sorting, valorization of both pre- and post-consumer waste, and the efficient supply of End-of-Waste materials for recycling.
- **Advocate for Robust and Harmonized Regulatory Frameworks**: Intensify efforts to influence national and EU policymakers for the swift implementation of national Extended Producer Responsibility (EPR) schemes and harmonized End-of-Waste (EoW) regulations for textiles. This will provide a clear and consistent legal foundation crucial for scaling circular practices and investment.
- **Boost Innovation in Materials, Digitalization, and Smart Manufacturing**: Promote and financially incentivize partnerships between textile companies (especially SMEs), start-ups, and research and technology organizations (RTOs). Focus on developing and adopting bio-based/innovative materials, "smart" yarns, and cutting-edge digital technologies such as Machine Learning (ML), Artificial Intelligence (AI) for design, RFID for traceability, and Augmented Reality (AR) for prototyping.
- **Strengthen Interregional and Intra-District Collaboration**: Foster more intensive collaboration initiatives within the Prato textile district, particularly between knitwear manufacturers and spinning mills for new business model development. Simultaneously, leverage interregional and European projects to share best practices, knowledge, and technologies, especially from and to other textile regions.
- **Invest in Targeted Skills Development and Capacity Building**: Develop and implement specific training programs focusing on advanced manufacturing technologies, circular economy principles, and the new digital tools identified as crucial for the sector's transformation. This is essential to address evolving workforce needs and ensure the effective adoption of innovations.

- **Promote Circular Business Models and Market Demand**: Support the development of new brands and market mechanisms that reintroduce products derived from reuse and recycling, thereby stimulating demand for circular textile products and closing the loop effectively.

Conclusion

The interviews with “Waste management company”, “Luxury knitwear company” and “Textile recycling machinery company” provide valuable insights into the dynamic state of the Italian textile sector in Tuscany/Prato. While the region is a recognized leader in circularity, addressing challenges related to waste management infrastructure, regulatory gaps, and advanced digital adoption is critical. A concerted, multi-stakeholder effort, supported by targeted policies, strategic investments, and enhanced collaboration, will be fundamental for the region's textile industry to further strengthen its position and thrive in a sustainable and competitive global landscape.

4.4. Lodz Region (Poland) Insights Report: Green, Digital, and Smart Manufacturing Transformation in Textile Sector

This part synthesizes insights from interviews with key stakeholders in the Polish textile sector, specifically an SME textile entrepreneur, an R&D institute, and a high technical school in the Łódź Region. The findings highlight a sector actively pursuing circularity, with academia and R&D institutes playing a vital role in promoting sustainable textile solutions. **However, significant structural challenges hinder progress, most notably the severe lack of adequate textile recycling infrastructure, particularly for sorting mixed fabrics, and substantial financial barriers for Small and Medium-sized Enterprises (SMEs)** to invest in crucial recycling machinery and digital tracking technologies. Slow industry adoption of research outcomes and limited, inconsistent availability of recyclable raw materials are also critical pain points. There is a clear ambition for future collaboration with international consortia to advance circularity and a call for targeted policy support and accessible financing to accelerate the region's transition into a European hub for circular textiles.

The purpose of this report is to provide a consolidated analysis of the needs and opportunities within the Polish textile sector in the Łódź Region concerning the green, digital, and smart manufacturing transformation. The insights are derived from a qualitative analysis of semi-structured interviews conducted with representatives from an SME textile manufacturing enterprise, an R&D institute, and a lecturer/scientist from a high technical school. These interviews aimed to identify critical needs, pinpoint innovation and collaboration opportunities, understand diverse perspectives from the quadruple helix, and gather insights to inform regional Smart Specialisation Strategies (S3) roadmaps and Deliverable D1.2.

Key Findings:

Current State and Main Sector Challenges:

- The SME respondent noted that the Łódź region, and Poland more broadly, **"lacks adequate infrastructure for textile recycling, especially for the sorting of mixed fabrics"**.
- **Financial barriers** are significant, as the **"high costs of recycling machinery and digital tracking technologies remain unaffordable for SMEs,"** and "public subsidies exist but are limited".

- **Operational difficulties** include "limited and inconsistent availability of recyclable raw materials," complicating production planning for companies incorporating regenerated fibers.
- The R&D institute highlighted "**slow Industry Adoption**" as a persistent pain point in scaling research to commercial use, describing it as "The gap between research outcomes and real-world uptake".
- The R&D institute also mentioned "**Funding Limitations**" as a challenge for securing support for long-term projects.

Critical Needs for Green and Digital Transition:

- A fundamental need identified is for "**efficient solutions for textile waste processing**".
- There is a need for the "**development of alternative bio-based and recycled fibers**".
- The SME expressed a future ambition to collaborate with "**providers of digital traceability solutions (e.g., digital product passports)**".
- The SME's conclusion explicitly states the need for "**accessible financing, stronger waste collection infrastructure, and consumer education**".

Skills and Knowledge Gaps:

- The R&D institute emphasizes "preparing highly qualified specialists in the fields of technology, engineering, and science".
- The high technical school plays an "active role in promoting circular economy principles in textiles".
- The R&D institute's role includes "bridging the gap between academic research and industrial application", which is hindered by slow industry adoption. This aligns with WP2's capacity building focus by highlighting the need for better knowledge transfer and uptake.

Interregional Collaboration:

- The SME expressed future ambitions for collaboration with "**International consortia advancing textile circularity and closed-loop innovations**".

- The TEX-BREIN project itself explicitly aims to "reduce asymmetries between the less developed regions (Norte, Lodzkie and Severovychod) and the more developed (Catalonia, Tuscany and Västra Götaland) by mapping and benchmarking the innovation pivots and by engaging companies in cooperation for the preparation of business cases". It will transfer knowledge and capacities in textile circularity from developed to less developed regions. This aligns with WP3's focus on fostering new collaborative projects and cross-border approaches among SMEs.

Role of Textile Re-hubs:

- The R&D institute directly contributes to the circular textile economy by "Providing efficient solutions for textile waste processing".
- The SME is already "testing fabric recycling methods to assess technical feasibility" and "incorporating regenerated fibers into production". They also run "take-back programs for used textile products".
- The identified **"Infrastructure gaps"** in the Łódź region, particularly the lack of adequate textile recycling for mixed fabrics, underscore the critical need for re-hubs.
- The TEX-BREIN project's portfolio of business cases will include three related to the design of textile recycling hubs in less developed regions, with Łódzkie being one of them. The SME's defined pilot investment projects "will be mandatorily connected to the activities of the pilot hubs of WP4, as SMEs will be the core part of the new re-hubs, at least in the less developed regions". This directly relates to WP4's objective of defining textile re-hub pilot cases and facilitating knowledge transfer.

Actionable Insights & Recommendations for S3:

Based on the synthesized interviews, the following actionable insights and recommendations are proposed for the regional S3 roadmaps:

- **Invest in and Establish Comprehensive Textile Recycling Infrastructure:** Prioritize the development of adequate infrastructure for textile waste collection and processing, with a particular focus on **advanced sorting capabilities for mixed fabrics** in the Łódź region and Poland.
- **Provide Accessible Financial Support for SMEs:** Implement targeted financial support mechanisms, such as adjusted subsidies and grants, to help SMEs overcome

the **high costs of investing in recycling machinery and digital tracking technologies**.

- **Promote Digital Traceability Solutions:** Support the adoption and implementation of digital traceability solutions, like **digital product passports**, to enhance transparency and efficiency in the textile value chain and facilitate recycling.
- **Strengthen Academic-Industrial Linkages:** Develop stronger programs and platforms to **bridge the gap between academic research outcomes and industrial application**, facilitating faster uptake of sustainable textile innovations by SMEs. Encourage R&D institutes to collaborate directly with companies, as the SME already does with Łódź University of Technology.
- **Foster Interregional Collaboration for Advanced Circularity:** Actively participate in and leverage European initiatives like TEX-BREIN to **transfer knowledge and capacities from more developed regions** concerning textile circularity and the establishment of larger, well-functioning recycling facilities and closed-loop innovations.
- **Implement Consumer Education Initiatives:** Develop and fund campaigns to increase consumer awareness and demand for circular textile products, as this is a crucial component of accelerating the transition.

Conclusion

The interviews with Polish stakeholders reveal a textile sector in the Łódź Region that is committed to the green and digital transition but is significantly hampered by foundational infrastructure gaps and financial constraints, particularly for its numerous SMEs. The active involvement of R&D and technical schools is a strong asset, but the challenge lies in scaling innovations and ensuring widespread industry adoption. The urgent need for **robust textile recycling infrastructure, targeted financial aid for SMEs, and enhanced digital capabilities** stands out prominently. These findings are highly relevant for the TEX-BREIN project, directly informing its work packages related to capacity building (WP2), investment project ideas (WP3), and especially the development of re-hub pilot cases (WP4) in less developed regions like Łódź. Addressing these identified needs through concerted efforts, policy adjustments, and strong interregional collaboration will be crucial for the Polish textile industry to evolve towards a more sustainable and competitive future.

4.5 Västra Götaland (Sweden): Insights Report: Green, Digital, and Smart Manufacturing Transformation in the Region's Textile Sector

This part synthesizes insights from interviews with key stakeholders in the Swedish textile sector. The findings indicate a sector that, while currently less affected by some global supply chain disruptions (apart from past Covid-related yarn delays), faces significant challenges in its green and digital transition. **Critical needs include the establishment of textile recycling plants and simplified reporting systems for small and medium-sized enterprises (SMEs).** There is a clear call for either local or larger European recycling facilities, potentially specialized by textile type, highlighting a need for interregional cooperation in developing this infrastructure. Knowledge gaps primarily revolve around how smaller companies can effectively navigate and implement sustainability requirements and reporting.

The insights are derived from a qualitative analysis of semi-structured interviews conducted with representatives from key segments, which aimed to identify critical needs, pinpoint innovation and collaboration opportunities, understand diverse perspectives from the quadruple helix, and gather insights to inform regional Smart Specialisation Strategies (S3) roadmaps.

Key Findings:

Impact of Global Events:

- One interviewee stated that they are "not affected that much" by recent global events currently, but did recall **"extremely delayed" yarn deliveries during the Covid pandemic**. Another stakeholder also noted that recent global events were "not a problem for us".

Critical Needs for Green and Digital Transition:

- A prominent need identified is for **"Recycling plants for textile waste"**.
- There is a strong demand for **"Support for small companies to manage all reporting in a simple way"** and a call for **"Adjusted reporting system for small companies"**.
- Stakeholders expressed the need for Sweden to consider **"how we can establish textile recycling locally, or how Europe can work towards setting up larger, well-**

functioning recycling facilities," with an emphasis on **"textile recycling stations that are dedicated to different types of textile purposes"**.

Skills and Knowledge Gaps:

- For smaller companies, there is a challenge in "getting recommendations of what to focus on and reporting system/documents adjusted for us". This suggests a need for specific training and guidelines in simplified regulatory compliance and strategic focus for the green and digital transition, aligning with WP2's capacity building focus.

Interregional Collaboration:

- The idea that "Europe can work towards setting up larger, well-functioning recycling facilities" implicitly suggests a need for interregional collaboration. This aligns with WP3's focus on fostering new collaborative projects and cross-border approaches among SMEs.

Role of Textile Re-hubs:

- The sources directly point to the critical need for **"Recycling plants for textile waste"** and the importance of **"establishing textile recycling locally, or how Europe can work towards setting up larger, well-functioning recycling facilities"**.
- It is also highlighted that these facilities should ideally be **"dedicated to different types of textile purposes"**. This directly relates to WP4's objective of defining textile re-hub pilot cases and facilitating knowledge transfer from more developed regions.

Actionable Insights & Recommendations for S3:

Based on the synthesized interviews, the following actionable insights and recommendations are proposed for the regional S3 roadmaps:

- **Develop Simplified Reporting Systems for SMEs:** Prioritize the creation and dissemination of **adjusted and simplified reporting systems and guidelines** specifically tailored for small and medium-sized textile companies to ease their compliance with green and digital transition requirements.
- **Invest in and Establish Textile Recycling Infrastructure:** Support and incentivize the **establishment of textile recycling plants and re-hubs**. This should include exploring both localized solutions and participation in larger European facilities, potentially focusing on **specialization for different textile waste streams**.

- **Foster European-Level Collaboration for Recycling:** Promote and facilitate interregional cooperation (aligned with WP3) for the **development and implementation of large-scale, efficient textile recycling solutions** across Europe.
- **Address Skills and Knowledge Gaps in SME Transition:** Implement capacity-building activities (aligned with WP2) that offer **clear, practical recommendations and specific training** to SMEs on strategic focus for the green and digital transition and on effective navigation of reporting requirements.

Conclusion

The interviews with Swedish stakeholders provide valuable insights into the specific challenges and opportunities within the region's textile sector. The urgent need for **textile recycling infrastructure and simplified, targeted support for SMEs in managing the green and digital transition** stands out prominently. These findings are highly relevant for the TEX-BREIN project, directly informing its work packages related to capacity building, investment project ideas, and especially the development of re-hub pilot cases. Addressing these identified needs through concerted efforts and interregional collaboration will be crucial for the Swedish textile industry to evolve towards a more sustainable and competitive future.

4.6 Severovýchod region (Czechia): Insights Report: Green, Digital, and Smart Manufacturing Transformation in the Textile Sector

The Czech textile sector (specifically the Northeast Region, classified as a Less Developed Region – LDR) is at a critical juncture in its circular economy transition. It urgently requires systemic solutions for the **long-term financing of reuse/upcycling infrastructure** and **innovative processing methods for complex industrial waste**.

A key finding is the **fundamental lack of systemic and political support** for the creation and operation of community centers (RE-hubs), which are perceived as crucial nodes for awareness, redistribution, and local production. Stable operational funding, independent of non-systemic project calls, is currently non-existent.

While sorting and social enterprises report the **economic non-viability** of textile collection and sorting due to low purchase prices and declining demand, which is expected to persist until **Extended Producer Responsibility (EPR)** is implemented, manufacturing SMEs struggle with the **local disposal of technical textiles, blends, and coated fabrics**. For these, local processing capacities are missing, and they often end up in landfills. Furthermore, strict regulations (such as MDR and REACH) significantly restrict the use of recyclates in segments like medical devices.

Successful progress requires **anchoring reuse/upcycling in regional strategies (S3)**, **systemic funding** for reuse centers as a public service, and **targeted partnership** between academia, industry, and local RE-hubs to develop practical solutions for difficult materials.

1. Introduction

This report provides a consolidated analysis of the needs and opportunities within the textile and related sectors in the Czech Northeast Region, focusing on the circular transformation.

The insights are derived from a **qualitative analysis of questionnaires** completed by representatives of key Quadruple Helix segments, including:

- **Non-Profit Organizations (NPOs) and Reuse Centers,**
- **Small and Medium Enterprises (SMEs),**
- **Municipalities,**
- **Sorters and Recyclers,**
- **Academic Sector**

The objective of the analysis is to identify key needs, specify innovation gaps, and inform the regional S3 strategy

Value Chain Perspectives - Significant Needs and Opportunities for Improvement

Improving the value chain requires addressing three main issues: the economic stability of reuse, the processing of industrial waste, and systemic anchoring:

Segment	Need / Problem	Opportunity
Reuse & NPOs	**Financial Instability:** Dependence on non-systemic grants; reliance on private/credit resources to cover costs early in the year.	Creation of a stable "**reuse industry**" as a unified sector with long-term, systemic public support.
SMEs - Industry	**Complex Waste:** Tons annually of technical, coated, or blended textiles for which **no local processor exists**.	**Technological Innovation** for processing multi-component, highly elastic, or coated composite materials, possibly through targeted financial support.
Sorters	**Economic Loss:** Low purchase prices and rising costs for collection/sorting; the sector is currently **loss-making** until EPR is in place.	**Accelerated EPR implementation** for textiles to finance collection and sorting and setting minimum quotas for recyclate use in public procurement.
Academia	**Awareness and Talent:** Slight decline in interest in technical fields and a shortage of interdisciplinary experts (combining textile, chemical, and environmental knowledge).	Leveraging the new Bachelor's Program (*Sustainability, Recycling and Ecodesign*) and **supporting PhD students** and industry scholarship programs.
Municipalities	**Financial and Legislative Uncertainty:** Collection fees became payable after 1/1/2025 without price regulation; difficulty finding buyers for waste code 200111 (textile materials).	Involvement in the creation of **RE-hubs** as an effective solution for non-reusable textiles and advocating for national awareness campaigns.

Collaboration among Value Chain Actors

Collaboration is essential for translating circular economy theory into practical application.

- **Role of RE-hubs:** They are viewed as **key infrastructure points** with the potential to integrate awareness, education, local redesign/upcycling, SMEs and recyclers view them positively as **connecting links** between manufacturers, research, and recycling. Conversely, some SMEs and municipalities are unaware of their specific benefits for their operations.
- **Link with Research:** There is strong interest in **embedding research in the field** (reuse workshops, collection points) to generate solutions with practical impact. University actively collaborates with companies on thesis topics, lifespan evaluation, and sustainable solutions (e.g., the EcoEco project). University seeks better coordination with businesses and public administration to facilitate efficient innovation transfer.
- **Public Administration:** Municipalities perceive a lack of clear vision for waste management, despite their role being deemed **crucial**. Public administration must **formally recognize recycling/reuse centers as a public service** and actively support the establishment of infrastructure.

Actionable Insights & Recommendations for S3

Based on the synthesis of the questionnaires, the following recommendations are proposed for regional strategies (S3) and for implementation within the TEX-BREIN project:

Policy & Strategy Adjustments

- **Systemic Anchoring of Recycling/Reuse/Upcycling:** It is crucial to formally **embed the activities of circular centers and community workshops into strategic city and regional documents** (Waste Management Plans, climate strategies) and perceive them as a public service essential for addressing the climate and economic crises.
- **Accelerated EPR Implementation for Textiles:** To ensure the long-term stability of the sorting and reuse sector, the **introduction of Extended Producer Responsibility (EPR) is critical**, allowing for the financing of reuse/recycling center operations and the stabilization of collection systems.

- **Removal of Legislative Barriers for Reuse:** Introduce **clear legal conditions for working with used materials**, their legal redistribution, and the removal of material surpluses from the public sector from the waste category, thereby prioritizing reuse over disposal.

Funding & Investment Focus

- **Operational Financial Support for RE-hubs:** Replace short-term project financing with **multi-year operational support** for the basic functions of reuse centers and community workshops.
- **Targeted SME Support for Technological Innovation:** Provide financial tools (grants, consulting) for the **implementation of technologies to recycle difficult industrial waste** (technical and blended textiles) and for piloting new solutions in practice.
- **Educational Scholarships and Research Funding:** Financially support **company scholarship programs** and doctoral studies to increase the attractiveness of technical textile fields.

Infrastructure and Skills Development

- **Support the Establishment of RE-hubs as Regional Motors:** Actively support the creation and development of circular hubs (e.g., in Hradec Králové), which should serve as **business incubators** for local recycling/redesign/upcycling.
- **Harmonization of Research and Practice:** Promote **closer collaboration between Universities and field actors** (reuse and recycling workshops, companies) so that research generates solutions with practical applicability, especially in the field of recyclates and hard-to-recycle materials.
- **Creation of a Reuse Network and Methodologies:** Develop an **online tool and methodology for working with recycling/reuse materials for schools and educators**. Develop the "reuse industry" as an integrated sector that systematically extends textile life cycles.

Conclusion

The Czech ecosystem questionnaires indicate that successful circular transformation requires **balancing the focus on recycling/reuse/upcycling** (primarily addressed by NPOs) **with strategic investments in recycling** (necessary for SMEs and unusable waste). The greatest challenge is overcoming **institutional and financial barriers** that impede the development of a robust reuse industry.

The implementation of the recommendations above, particularly the systemic anchoring of reuse/RE-hubs and the acceleration of EPR, is essential for reducing the asymmetries of the Northeast Region (LDR) and for preparing the pilot RE-hub case within the TEX-BREIN project.

5. STRATEGIC ALIGNMENT WITH REGIONAL INNOVATION PRIORITIES AND RECOMMENDATIONS FOR BOOSTING REGIONAL INNOVATION ECOSYSTEMS

This report synthesizes the key needs and opportunities identified in the six regions (CZ, IT, ES, PL, PT, SE) involved in the TEX-BREIN project.

Insights were derived from a qualitative analysis of semi-structured interviews with key Quadruple Helix actors (SMEs, NPOs, Recyclers/Sorters, Academia, Public Administration), aimed at identifying innovation gaps and opportunities in the green, digital, and smart manufacturing transformation. The TEX-BREIN project focuses on **building innovation capacity in textile ecosystems** and **reducing asymmetries** between LDRs and MDRs by transferring textile recycling hub (RE-hub) models.

5.1. Value Chain Perspectives and Regional Challenges

Significant Needs and Opportunities for Improvement (Value Chain Gaps)

Regional ecosystems identified specific gaps and hurdles preventing the full implementation of circular principles:

Region (Classification)	Key Needs and Obstacles	Opportunities
Severovýchod (CZ) (LDR)	Lack of **systemic support and long-term financing for RE-hubs** (recycling/reuse/upcycling). **Legislative and regulatory barriers** (MDR, REACH) restrict the use of recyclates in SMEs. Lack of processors for **complex industrial waste** (technical and blended textiles).	Systemic anchoring of reuse as a **public service**. Utilization of RE-hubs as nodes for education, redesign, and research linkage.
Łódzkie (PL) (LDR)	**Inadequate infrastructure** for collection and especially **sorting of mixed fabrics**. **High costs** for digital technology and recycling machinery are unaffordable for SMEs. Limited and inconsistent availability of recyclable raw materials.	Partnership with MDRs for RE-hub knowledge transfer. Targeted financial support for SME technological investments.

Norte (PT) (LDR)	Overall installed sorting and recycling capacity falls short considering the expected growing waste volumes. Lack of efficient and automated sorting systems. Need of infrastructural and financial support improve textile mechanical recycling efficiency and scale textile chemical recycling. Clear gap on expertise in circular design, eco-engineering, fiber science, and smart manufacturing	Great market potential for textile recycled products. Development of new textile industries in textile recycling and circular businesses models. RE-Hubs for creating bridges between interested parties connecting the textile circular value chain
Catalonia (ES) (MDR)	**Fragmentation of the local value chain** (especially recycled fiber spinning and specialized finishing processes). Slow sustainability implementation due to **high costs and market reluctance** to adopt recyclates.	Support for filling critical gaps in the local chain. Stimulation of **demand for circular products** (public procurement).
Tuscany/Prato (IT) (MDR)	**Infrastructural and technological gaps** for post-consumer waste collection and processing. **Lack of national EPR and harmonized EoW** regulations. Challenges in integrating advanced digital technologies (ML/AI/RFID).	Creation of a **Textile Hub** (planned for late 2026) to address infrastructure gaps. Development of **new circular business models** and partnerships for innovative materials.
Västra Götaland (SE) (MDR)	Critical need for **local or larger specialized European recycling facilities**. Knowledge gaps and need for **simplified reporting systems** for SMEs.	Support for the creation of RE-hubs/recycling facilities. Upskilling and knowledge sharing on implementing sustainability.

Collaboration and the Role of RE-hubs

- **Role of RE-hubs:** RE-hubs are viewed in LDRs (CZ, PL) as **key infrastructure nodes** that must integrate awareness, redistribution, local recycling/redesign/upcycling (CZ), and serve as the core of new value chains (PT, PL, SE). Successful MDR models, such as the planned **Textile Hub in Prato** (IT), act as reference points for transfer to LDRs.
- **Academia and R&I Alignment:** There is a need for **stronger linkage between research and practice** (CZ). Research activities should focus on the practical application of recyclates and difficult-to-process materials (PL). MDR regions (IT) are already actively seeking partnerships with startups for bio-based materials and digital solutions.

- **Interregional Collaboration:** MDRs (ES, IT, SE) are critical for **transferring RE-hub models and knowledge** to LDRs (CZ, PL, PT). MDRs hold capacity in R&D and processing, while LDRs provide new opportunities for recycling capacity and testing new business models.

5.2 Alignment with RIS3 Strategies & Recommendations for S3

Consistency of Conclusions with RIS3 Strategies

The conclusions and recommendations laid out in demonstrate **high consistency** with the existing RIS3 frameworks of the involved regions. The project was specifically designed to address sectoral gaps and contribute directly to the refinement of S3 roadmaps.

A. Alignment in Priority Areas (Sectoral Consistency)

All participating regions, whether More Developed Regions (MDRs) or Less Developed Regions (LDRs), formally identify the textile sector, fashion, or related advanced materials/manufacturing as a priority area within their RIS3 strategies.

- **MDRs (IT, ES, SE):** Regions like Tuscany, Catalonia, and Västra Götaland include textiles/fashion or technical textiles as strength areas. For example, Västra Götaland's RIS3 vision emphasizes moving towards a **fossil-independent and circular society**, with focus areas specifically covering *Circular business models*. This perfectly matches the D1.2 focus on innovation in circularity and RE-hubs.
- **LDRs (CZ, PL, PT):** These regions anchor the project in existing specializations, such as the *Modern textile and fashion industry* in Łódź and the focus on *New textile materials* and *Advanced materials based on textile structures* in the Czech Northeast regions (Hradec Králové/Pardubice).

B. Alignment in Addressed Challenges (Thematic Consistency)

The core recommendations directly address the functional and systemic gaps identified within the RIS3 context:

1. **Circular Economy and Infrastructure:** Most RIS3 documents, particularly the newer iterations (e.g., RIS3CAT 2030 in Catalonia), prioritize the **Ecological Transformation**. The Catalonian strategy explicitly lists the need to **drastically reduce textile waste and boost recycling infrastructure**. This directly validates

projects's primary recommendation for **investment in advanced sorting infrastructure** and the creation of RE-hubs.

2. **SME Digital/Green Transition:** RIS3 universally targets improved competitiveness and innovation performance in SMEs. Deliverable recommendations—such as creating **simplified reporting systems for SMEs** (SE), providing **targeted financial support** (PL, CZ, PT), and boosting the adoption of **advanced digital technologies** (IT, ES, PT)—are specific action points that directly enable the green and digital shift mandated by regional S3 objectives.
3. **Policy and Systemic Gaps:** Where RIS3 documents in LDRs currently offer only marginal coverage of circular economy topics (e.g., Pardubice), Deliverable supplies immediate, actionable policy inputs. The demand for **systemic anchoring of reuse centers as a public service** and the **acceleration of EPR/EoW harmonization** provides the concrete political and regulatory reforms necessary to meet future S3 goals regarding waste management and sustainable development.

Recommendations aim to reduce regional asymmetries and strengthen textile ecosystems, aligning with TEX-BREIN's focus on S3 priorities.

I. Policy & Strategy Adjustments

- **Accelerate EPR and EoW (All Regions):** Intensify efforts to promote **national EPR schemes** for textiles and harmonized **End-of-Waste (EoW) regulations** at the EU and member state levels (IT, CZ, PT).
- **Strategic Anchoring of Reuse (CZ, PT, PL):** Formally **embed reuse and RE-hubs** in regional and municipal strategic documents (S3, Waste Management Plans) and recognize them as a **public service**.
- **SME Simplification (SE):** Develop and distribute **simplified reporting systems and guidelines** for SMEs to ease compliance with green and digital requirements.
- **S3 Alignment (All Regions):** Complement regional S3 priorities to more strongly support the circular transition of textiles, including **supporting education** in sustainability and circular economy.

II. Funding & Investment Focus

- **Operational Funding for RE-hubs (CZ, PL):** Replace project grants with **multi-year systemic operational financing** for the core functions of recycling/reuse/upcycling centers (CZ).
- **Support for Technological Investments (PL, CZ, PT):** Establish **targeted financial instruments and subsidies** for SMEs to overcome the high costs of purchasing advanced recycling (for mixed textiles) and digital technologies.
- **Demand Stimulation (ES, IT):** Implement measures to increase demand for regionally produced recycled textiles, such as through **preferential public procurement** (ES).

III. Infrastructure and Skills Development

- **RE-hub Development (LDRs):** Prioritize **investment in collection and advanced sorting infrastructure**, focusing on establishing pilot RE-hubs in LDRs (CZ, PL, PT).
- **Digital Transformation (IT, ES, PT):** Finance partnerships between SMEs and R&D centers focused on **adopting advanced digital solutions** (AI/ML for design and RFID for traceability) to enhance value chain integration.
- **Capacity Building (All Regions):** Develop and implement specific **training programs (Capacity Building)** focused on digital competencies, circular economy principles, and specialized skills required for RE-hub operations (e.g., "reuse change facilitators" in CZ).

6. CONCLUSIONS AND STRATEGIC OUTLOOK

This report successfully fulfils its main purpose: **translating the foundational mapping and in-depth needs analysis derived from the involved ecosystems into a cohesive and actionable strategy**. This process moved beyond merely identifying the existing state ('what is') to defining the necessary steps ('what needs to be done') to accelerate the green and digital twin transition in the European textile sector. The findings synthesized here, drawn from extensive stakeholder engagement and policy dialogue, provide a concrete roadmap to boost regional innovation capacity and guide policy development.

6.1 Summary of Key Recommended Actions

To foster integrated, circular, and resilient value chains, the analysis points to several critical and actionable recommendations for the regional textile innovation ecosystems:

1. **Investment in Core Infrastructure:** There is a critical and widespread need for significant investment in **collection and advanced sorting infrastructure**. This includes prioritizing the establishment of adequate textile waste collection and processing facilities (referred by PT), particularly focusing on sophisticated sorting capabilities for mixed fabrics, especially noted in the Łódź Region (PL).
2. **Policy and Regulatory Alignment:** It is essential to intensify efforts to **accelerate the adoption of national Extended Producer Responsibility (EPR) schemes** and ensure harmonized **End-of-Waste (EoW) regulations** at both the EU and member state levels (notably recommended for IT, PT and CZ).
3. **Systemic Support for Circularity:** Strategies must formally embed **reuse and RE-hubs** into regional and municipal documents, such as S3 and Waste Management Plans. Crucially, reuse centers and RE-hubs should be recognized as a **public service**, requiring systemic, multi-year **operational funding** to replace reliance on project grants (especially critical for LDRs like CZ and PL).
4. **Targeted SME Support:** To facilitate compliance with green and digital requirements, specific measures are needed, such as the development and distribution of **simplified reporting systems and guidelines for SMEs** (a key recommendation based on findings from SE).

5. **R&I Linkage:** A stronger linkage between academic research and industrial practice is required, focusing R&I activities on the practical application of recyclates and the processing of difficult-to-handle materials.

The summary of recommendations detailed below is essential for **building integrated, circular, and resilient value chains** in the textile industry. These actions address asymmetries between Less Developed Regions (LDRs) and More Developed Regions (MDRs) by facilitating knowledge transfer and tackling critical regulatory and infrastructural bottlenecks identified in this analysis.

	Concrete Actionable Recommendations (D1.2)	Prioritization / Regional Context	Contribution to Circular Value Chains
I. Policy & Strategy Adjustments			
Action 1.1	**Accelerate EPR and EoW Implementation:** Intensify efforts to promote national Extended Producer Responsibility (EPR) schemes for textiles and harmonize End-of-Waste (EoW) regulations at the EU and member state levels.	**All Regions, prioritized for IT, PT and CZ** (due to regulatory gaps and delays).	**Ensures financial stability** necessary for textile waste collection, sorting, and management infrastructure.
Action 1.2	**Systemic Anchoring of Reuse/RE-hubs:** Formally embed reuse and RE-hubs in regional and municipal strategic documents (S3, Waste Management Plans) and recognize them as a **public service**.	**LDRs (CZ, PL, PT)**, where long-term operational support is critically lacking.	Strengthens the **low-tech segment of the circular chain** (reuse/upcycling) and provides crucial institutional legitimacy.
Action 1.3	**SME Reporting Simplification:** Develop and distribute **simplified reporting systems and guidelines** specifically tailored for SMEs to ease compliance with green and digital requirements.	**MDR (SE)** and **SMEs across all regions** (addressing knowledge gaps and reducing administrative burdens).	Accelerates SME engagement in the **digital and green transition** by removing administrative hurdles.

Action 1.4	**Tax Incentives and Demand Stimulation:** Introduce tax incentives for reuse (e.g., **VAT exempting for second-hand goods** in PT) and stimulate demand for circular products (e.g., preferential **public procurement** in ES).	**PT** (Taxation) and **ES** (Market Stimulation).	**Increases the market viability** of recycled materials and products, overcoming market reluctance to adopt recyclates.
II. Funding & Investment Focus			
Action 2.1	**Operational Funding for RE-hubs:** Replace reliance on project grants with multi-year **systemic operational financing** for the core functions of reuse/upcycling centers.	**LDRs (CZ, PL)**, where funding for reuse capacity depends on non-systemic grants.	**Ensures long-term resilience** and continuity of essential circular infrastructure.
Action 2.2	**Targeted SME Financial Support:** Establish targeted financial instruments and subsidies for SMEs to overcome the **high costs of purchasing advanced recycling machinery** and essential digital tracking technologies.	**LDRs (PL, CZ)**, where high technology costs are prohibitive for SMEs.	Facilitates **SME adoption of green and digital solutions**, strengthening the industrial base against competition.
Action 2.3	**Support R&D Digital Partnerships:** Financially incentivize partnerships between SMEs and RTOs/start-ups focused on **implementing advanced digital solutions** (ML/AI for design, RFID for traceability).	**MDRs (IT, ES)**, aiming to accelerate the transfer of cutting-edge digital technologies into industrial practice.	Enhances **transparency and traceability** in the supply chain, essential for the Digital Product Passport (DPP).

III. Infrastructure & Technology Support			
Action 3.1	**Priority Investment in Sorting Infrastructure:** Prioritize massive investment in the development of collection and **advanced sorting infrastructure**, especially for mixed fabrics.	**LDR (PL)** (due to inadequate infrastructure) and **all regions** as this is the shared bottleneck (Separate Collection Failure).	Overcomes the primary material bottleneck by providing **quality feedstock** for high-value recycling.
Action 3.2	**Develop Pilot RE-hubs:** Support the definition and development of **pilot RE-hubs in LDRs** (WP4 objective), leveraging model transfer from MDRs (IT, ES, SE).	**LDRs (CZ, PL, PT)**, leveraging MDR expertise (e.g., Prato's planned Textile Hub).	**Establishes regional capacity** for waste processing and supports the creation of **new circular business models**.
Action 3.3	**Technology for Complex Waste:** Promote technological innovation focused on **processing difficult, complex industrial waste** (e.g., technical, coated, or blended textiles) where local capacity is absent.	**LDR (CZ)**, specifically for technical textile producers struggling with local disposal options.	Reduces **landfilling/incineration** of specialized industrial waste, enhancing the sector's sustainability profile.
IV. Skills & Capacity Building			
Action 4.1	**Capacity Building Program (WP2):** Implement the dedicated **Capacity Building program (WP2)** focusing on digital competencies, circular economy principles, and **specialized skills needed for RE-hub operations** (e.g., textile fiber experts, advanced manufacturing).	**All Regions**, with priority on transferring knowledge and skills to LDRs.	**Upskills the workforce** and innovation intermediaries, ensuring effective adoption of green and digital solutions.
Action 4.2	**Talent Support and Recruitment:** Establish programs to **support talent** (e.g., company scholarships	**LDR (CZ, PT)** and **MDR (ES)**, targeting retention and	**Strengthens human capital** for sustainable development and ensures continuity of

	and doctoral studies) and address critical skill shortages caused by retiring professionals and the sector's low appeal.	recruitment in technical fields.	essential technical know-how.
V. Network & Collaboration Facilitation			
Action 5.1	**Interregional RE-hub Knowledge Transfer:** Leverage TEX-BREIN (WP3, WP4) to actively transfer knowledge regarding RE-hub models and **cross-sectoral partnerships** from MDRs (IT, ES, SE) to LDRs (CZ, PL, PT).	**LDRs (CZ, PL, PT)** as receivers, using MDRs (IT, ES, SE) as best-practice references.	**Reduces innovation asymmetries** and accelerates the implementation of proven circular solutions across Europe.
Action 5.2	**Bridge R&I and Industry (SME) Needs:** Create stronger mechanisms for dialogue and **co-creation between R&I centers and SMEs**, ensuring research generates readily transferable, practical innovations (e.g., in recyclates and hard-to-process materials).	**All Regions**, addressing the disconnect between academic research and industrial implementation (e.g., ES, CZ, PL).	**Accelerates the industrial uptake of innovation** (the leap from theoretical to industrial application) and ensures R&D addresses real-world problems.
Action 5.3	**Establish Material Flow Optimization Platforms:** Implement digital and physical **exchange platforms (matchmaking)** connecting producers, brands, and recyclers to optimize material flows and **increase visibility** of regional capacities.	**ES** (Proposals for flow optimization) and **PT** (Need to reach market across Europe).	**Optimizes and interconnects regional value chains**, ensuring that recycled feedstock finds sufficient demand beyond the local market.

6.2 The Role of Interregional Collaboration (TEX-BREIN Facilitation)

Interregional collaboration, actively facilitated by the TEX-BREIN project, is deemed **critical for addressing systemic challenges** and reducing innovation asymmetries across Europe. The project brings together partners from three Less Developed Regions (LDR: Severovýchod/CZ, Norte/PT, Łódzkie/PL) and three More Developed Regions (MDR: Tuscany/IT, Catalonia/ES, Västra Götaland/SE).

This collaboration enables the **transfer of knowledge and capacities in textile circularity** (especially recycling hub models) from MDRs to LDRs. While MDRs contribute established expertise in R&D and processing, LDRs offer new opportunities for establishing essential recycling capacity and piloting novel business models. Effective collaboration is recognized as a necessity because disruptive changes cannot be achieved by individual stakeholders or regions acting in isolation.

6.3 Links to Subsequent TEX-BREIN Activities

The findings and recommendations serve as the foundation and direct input for the subsequent phases of the TEX-BREIN project:

- **WP2 (Capacity Building):** The identified needs—particularly concerning digital competencies, circular economy principles, and specialized skills for RE-hub operations—directly inform the definition and implementation of the comprehensive capacity building programme.
- **WP3 (Portfolio of Investment Project Ideas):** The prioritized needs and identified opportunities guide the generation of a portfolio consisting of at least **17 collaborative or individual SME project ideas**. These ideas will focus on innovation in the green and digital transition and are intended to be prepared for submission to future I3 funding opportunities.
- **WP4 (Re-hubs Pilot Cases):** The regional needs assessment, specifically detailing the requirements of the LDRs, is crucial for shaping the model definitions and technical/economic viability analysis of the **three textile re-hub pilot cases** foreseen in the less developed regions.

6.4 Concluding Statement on Impact

The robust implementation of these actions will significantly contribute to the **sustainable and competitive future of the European textile sector**. By accelerating investment in essential circular infrastructure, strengthening the technical and systemic capacity of SMEs and support organizations, and embedding circularity within regional policies, TEX-BREIN fosters the creation of resilient, circular, and highly interconnected European value chains. The outcome is expected to lead to enhanced profitability for textile SMEs, the development of sustainable business models, and ultimately, a reduction in textile waste generation across participating regions.