AddTex

Advancing industrial digital and green innovations in the advanced textile industry through innovation in learning and training

WP2 Spanish National Report

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1. Introduction

An analysis of the Spanish textile educational and companies training was performed for the WP2 of the ADDTEX project by AEI Tèxtils and Universitat Politècnica de Catalunya. The desk research has been developed at national level. The field research and the direct contact with the VET and HEIs and companies has been done mainly at regional level of Catalonia since is the region of Spain where most of the advanced textile companies are concentrated, and also our area of action.

1.1 Organisation of the industry desk and field research

A collaborative session / workshop was held on 18th October 2022 to identify the needs of the companies and be able to prepare this report. As AEI Tèxtils works in the advanced textiles materials sector, the 7 companies that participated in the session are specifically from this sector. It must be considered when answers are examined.

The workshop included, first, an explanation of the project and its objectives. The session followed with a collaborative task using the tool Miro. After discussing the results together, the participants were asked to fill a short form to gather all the important information.

1.2 Organisation of the VET and HEI desk and field research

In the case of the VET and HEI research, an online session was carried out where the project was introduced and following, the session continued in a workshop in which was discussed the current situation within the framework of the advanced textile industry, and in particular from the point of view of education, the main innovation challenges, difficulties, opportunities and strengths to face the challenges generated by COVID-19, transition green and digital transition. The most relevant skills that students must have mainly related to innovation (materials, processes, products), the digital and green transition were identified. Also, the priority topics for the initial and ongoing training of current and future employees in the advanced textiles sector as well as the innovative work-based learning (WBL) methodologies implemented were identified. This online session was performed on 18th of November 2022.

The participants from VETs participating on the field research education where from different parts of Catalonia and all of them teachers on textile engineering with a total of 6 participants from 4 different VET. In the case of HEI, there are only 2 universities since are the only two public HEIs in Spain which teach Textile Engineering Degrees and Master Degrees.

1.3 Organization of the Living Lab session

While the first workshop for the field research was carried out separately between the industry and the VET and HEI, in the second stage it was performed together in an open Living Lab. The 14th of December, an open Living Lab for industry and VET and HEI participating on the previous meetings was carried out in the UPC installations. The Living Lab was in-person form and the discussion about these transitions, future challenge and the continuous evolution and necessities of the textile industry was deepened.

2. Technologies / innovation /documents /tools

In this chapter, the technologies and tools identified as the most important technological changes that will affect the textile industry in the region are exposed. The results summarised in the tables of the chapters 2.1, 2.2 and 2.3 referred to green, digital and smart transitions, respectively, are the combination of the analysis of the feedback received by the Spanish industry, together with the VET and HEI collaborating.

The main challenges identified after this research for the green transition were focused in the identification and remediation of the environmental issues, trough well-known issues of the textile industry, such as water consumption and contamination, or the use of new tools, such as LCA (Life Cycle Assessment). Moreover, alternative and biobased materials and processes are attracting the interest. Improvement of the recycling of textiles materials represent a constant challenge and the interest is increasing with the application of the new EU normative starting the next 2025. Regarding the digital transition, the future challenges will be associated to personalized and less material consumption techniques, like 3D printing, and the digitalization of all the textile industry, enhancing the tracking process and the control over all the associated process and materials. This digitalization is expected to improve the decision making, reduce and optimize process and material consumption, reduce waste, help to obtain a better data recollecting for LCA, and being a helpful instrument for the identification and recycling of the textiles at its end-life stage. The challenges appreciated in the smart transition are related to the integration of electronic devices, washable ones being a milestone, and textiles with different and improved functions.

2.1 Green transition

Table 1. Green

Technology/ innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
Water reduced processes	Water contamination is one of the main problematics in the textile industry. Cleaning, bleaching, finishing, dyeing and printing processes, for example, are one of the most consuming industrial processes. It is mandatory to reduce the water consumption and its contamination.	Finishing, dyeing and printing process	Levi's Waterless Nylstar Eco Programs Tejidos Royo DESTINTCOT
Bio-based and recycled materials	New greener materials, from renewable sources and recycled compounds, must be developed to achieve the textile actual and future demand. Moreover, these		Recover Fiber Repreve Hilaturas Arnau

	materials must be also improved to reduce the environmental impact, mainly in case of existing materials, or for the design of advanced materials.		
Enzymatic treatments	Enzymes are applied in a large variety of industrial processes due to its highly specific, efficient, non-toxic, and eco-friendly behavior. In the textile industry, it's interesting is increasing fast.	Fabrics finishing, desizing, dyeing, recycling process, water treatments in textile effluents	Biokatal
Life Cycle Assessment (LCA) (and other Life Cycle analysis)	The Life Cycle Assessment (LCA) is the analysis of all the environmental impacts associated to a product or a process. In these cycles are included inputs such as materials, energy, transport, and outputs like gas emissions, water treatments, by-products. The use of an LCA allow determining and improving in a sustainable point of view parameters, process or materials in a process or product. However, their use is still incipient in industry. Moreover, the recollection of the data and the production of the inventories (Life Cycle Inventories) is expensive. Nonetheless, the inclusion and revision of BAT (Best Avalaible Techniques) has been done after the analysis of LCA.	All the process, including the reuse, recycle and end of life behavior.	MIDWOR Ferre Yarns

2.2 Digital transition

Table 2. Digital

Technology/ innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
3D Printing	Additive manufacturing allows the production of new personalized materials while reducing the cost and the waste of common manufacturing process. In textile industry, the technique is still incipient. Materials and Additive techniques must evolve for the textile industry.	Fabrics manufacturing, garments production.	Zer Collection
Tracking systems for textiles	Tracking systems allows following all the steps and materials in a product by using Blockchain or similar technologies. The use of this information could lead to a better management of the distribution or the recycling of the components in the textile products and byproducts.	All the textile chain: from materials to end life.	https://retexcycle.com/ Trick
Artificial intelligence	Artificial Intelligence could analyze, execute, predict or conclude. Besides, and	All the production chain	Gnoss IndesIA

for production and quality departments in industry	parallel to the software design, it is necessary to include and manage the system. These technologies are a helpful instrument but require a constant update and manage of the data.		

2.3 Smart transition

Table 3. Smart

Technology/ innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
Smart textiles	Manufacturing of textiles with sensors integrated could led to improvements in different fields such as medicine, where detection of illness could be early and fast with no invasive methodologies. Nonetheless, the integration of these sensors, electronic devices and conductive filaments is still a challenge. Another important milestone is the separation and recycling of these products.	Raw materials production, product manufacture, recycling.	Ekatom® sensor SensingTex STAR - AITEX SmartX and spanhish founded projects
Functional Textiles	These textiles are produced with the objective to have additional properties and applications than the common uses. Development in manufacture processes, finishing, recycling is necessary for these textiles.	Raw materials production, product manufacture, recycling	Eurecat Bionoxgroup CEBIOTEX
Washable sensors on textiles	One of the challenges in smart textiles is the development of washable sensors. Wearable smart textiles are designed to monitoring different parameters of our life and improve it thought the analysis of these data. However, one of the main inconvenient is the sanitizing process of these materials.	Raw materials production, product manufacture	Gow trainer - Weartech

3. Existing Initiatives (Projects/strategies/documents/tools)

3.1 National and Regional programs

3.1.1 Circular economy plans

Circular Fashion Agreement

In Catalonia, each person consumes between 21.5 and 26 kg of clothes annually, but only 12% is collected selectively. Most of it ends up in landfills or is incinerated. In an attempt to reverse this situation, the Circular Fashion Agreement has been presented, a voluntary agreement to which 55 companies and entities in the sector have joined. This initiative is one of the circular economy pilot actions chosen by the European Union within the Interreg Europe CircE project. The project promotes durable clothes and cleaner production by increasing the durability and the percentage of recycled materials into fabrics; reduce and eliminate harmful materials; and implemented new business models and efficient production strategies.

Work is already underway on pilot projects to promote the collection of second-hand clothing and its reuse, as well as to improve the selective collection systems for textile waste and the development of the local textile recycling industry.

https://web.gencat.cat/ca/actualitat/detall/Arrenca-el-Pacte-per-a-la-Moda-Circular

España circular 2030

It is estimated that Spain needs more than two and a half times its surface to supply the needs of its economy. In addition, to the environmental impacts that this entails, data demonstrate the inefficiency of the model and the aggravated dependence on the outside, which they make Spanish economy more vulnerable and less competitive. To respond to this situation, this Spanish Circular Economy Strategy has been drawn up. Spain Circular 2030 lays the foundations to promote a new model of production and consumption in which the value of products, materials and resources are maintained in the economy for the maximum possible time, in which the generation of waste is reduced to a minimum and advantage for the ones that cannot be avoided is taken. The Strategy thus contributes to Spain's efforts to achieve a sustainable economy, decarbonized, efficient in the use of the resources.

The Circular Economy Strategy is endowed with a transversal character and aspires to become it a frame of reference for all public administrations, companies and citizens. Planning and monitoring is carried out special for certain economic sectors: construction and demolition, agro-food, industry in general set, consumer goods, tourism and **textiles and clothing**.

In this context, the Strategy establishes strategic guidelines in the form of a decalogue and is marked a series of objectives for the year 2030:

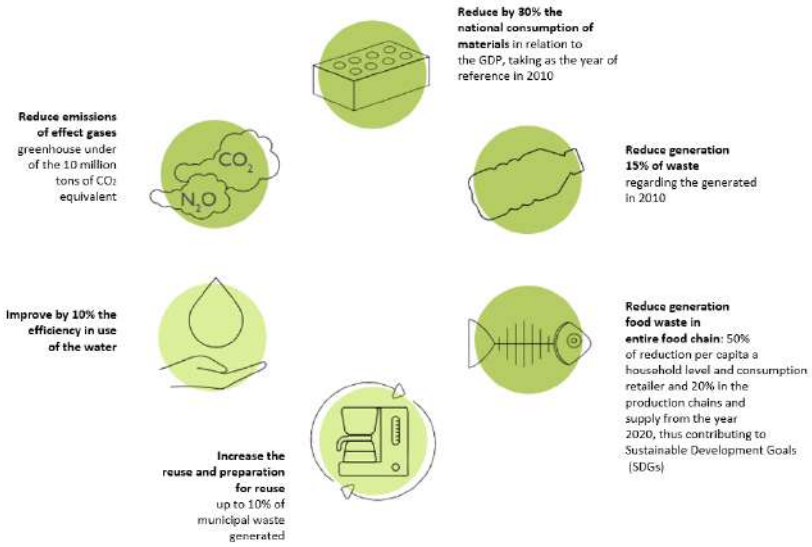


Figure 1. *España circular* objectives for 2030.

The action lines on which the policies and instruments of the Circular Economy Strategy and their corresponding plans will focus are: Production; Consumption; Waste Management; Secondary raw materials; and Water reuse and purification.

Source: https://www.miteco.gob.es/es/calidad-y-evaluacion-ambiental/temas/economia-circular/espanacircular2030_def1_tcm30-509532_mod_tcm30-509532.pdf

Recovery, transformation and resilience plan

The objective of the plan is to promote the modernization and productivity of the Spanish ecosystem industry-services, through the digitization of the value chain, the boost in productivity, the competitiveness and the improvement of the energy efficiency of the key strategic sectors in the ecological transition and digital transformation. Manufacturing industry represents 12.3% of Gross Added Value of the Spanish economy, a lower percentage than the countries of our surroundings. It supposes an element of vulnerability.

In the Recovery, transformation and resilience plan, we can find the **Plan to support the implementation of waste regulations and the promotion of the circular economy,** whose objective is to facilitate the deployment of the circular economy in Spain. The actions contemplated are very diverse and range, from the implementation of separate collection of different fractions such as **textiles**, the improvement of the existing systems, construction of specific facilities for the treatment of those different materials and the recycling of other waste streams The investment will also pay special attention to the development of digitalization tools for environmental management and to the promotion of the circular economy in the company's field.

Source: https://planderecuperacion.gob.es/politicas-y-componentes/componente-12-politica-industrial-espana-2030

3.1.2 Implementation of S3 strategies

RIS3CAT 2030

Research and innovation strategies for intelligent specialization (RIS3) have been a key element of the Europe 2020 strategy, for one smart, sustainable and inclusive growth. With the objective to make knowledge and innovation a priority, in the financial framework 2014-2020, the European Union (EU) asked governments to prepare RIS3. In the case of Catalonia, this strategy is specified in the RIS3CAT, the Research and Innovation Strategy for intelligent specialization of Catalonia, which the Government approved in 2014 for the period 2014-2020, which has promoted projects worth 936 million euros, executed by 563 entities.

The RIS3 consists of transformative agendas, which have innovation and knowledge as drivers for a greener, digital, resilient and fair socio-economic model.

The preparation of the RIS3CAT 2014-2020 was based on a SWOT analysis of the Catalan economy, as well as the sectoral key areas and existing technological capabilities. In these analyses, three major transformative vectors were identified for the Catalan economy to face successfully the great social and economic challenges of the 21st century:

- The first transformative vector that was identified is the inheritance of the Catalan industrial tradition —lead, in the 19th century, by the **textile**, chemical and metallurgical sectors, which have evolved emphasizing competitive factors such as innovation, technology, design and professional training.
- The second vector focuses on the well-being of people in areas related to food, health, leisure or lifestyle.
- The third vector is the clear commitment to transform the Catalan economy into green economy.

Following RIS3CAT 2014-2020, RIS3CAT 2021-2027 will promote, in Catalonia, shared research and innovation agendas that contribute to the green economy, improving people's quality of life, enhancing the industrial transition and transforming production and consumption models to make them more sustainable and inclusive.

Source: https://eapc.blog.gencat.cat/2020/05/26/ris3cat-2021-2027-and-transformative-innovation-policy-tatiana-fernandez-and-alberto-pezzi/

3.2 Projects from public research centers and entities

Name	**GALACTICA**
Description	GALACTICA project aims to support the creation of new industrial value chains around textile and aerospace sectors based on advanced manufacturing. The vision is to drive cross-sectoral innovation to boost new market opportunities, revenues and improve productivity.

	GALACTICA will facilitate the uptake of advanced manufacturing technologies as part of the digital transition of the textile and aerospace industries.
Link	https://galacticaproject.eu/

Name	**CLAMTEX**
Description	CLAMTEX main objective is to strengthen cluster management excellence of the participating European clusters to boost their specialized innovation eco-system by facilitating the cross-sectoral and cross-regional collaboration to facilitate the uptake of digitalization within and beyond the partnership with the implementation of ClusterXchange pilot scheme.
Link	https://www.clamtex.eu/

Name	**PACTEX**
Description	The objective of the project is to establish synergies between the companies of AEI Tèxtils and the ones of the Packaging Cluster to promote the effective use of material resources between them, by reducing industrial waste at source, reusing products, improving recyclability and recovering waste. Initially, a detailed identification of the type of material resources and waste generated by companies in both sectors will be carried out. Once this initial diagnosis has been made, a series of proposals for improvement and innovative measures (technological and/or non-technological) will be proposed to be adopted by companies in order to reuse material resources and reduce their generation of industrial waste. Likewise, an evaluation of the technical, economic and environmental feasibility of each of the proposed proposals and measures will be carried out. Finally, a selection of the most appropriate proposals and measures will be made to test the photo and demonstrate that they are technically, economically and environmentally viable. The results of the project, as well as all the proposals for improvement and innovative measures proposed, will be collected in a Sector Guide.
Link	https://www.textils.cat/en/project/pactex-project/

Name	**ECODISTEX**
Description	ECODISTEX promotes the use of environmental criteria in the different stages of design, production, distribution, use and recycling of final products within the technical textile sector with the goal to reduce and mitigate the environmental impact during the whole life cycle.
Link	https://www.textils.cat/en/project/ecodistex-project/

Name	**CIRCULARTECH**
Description	CIRCULARTECH is a project at Catalan level, promoted by AEI Tèxtils and Leitat Technological Center, which aims to develop a sectoral analysis to be able to identify what are the barriers in the sector to implement actions that promote the 'circular economy (EC), as well as identifying specific EC actions applicable to the specificity of the technical textiles sector in order to facilitate its implementation by these companies.
Link	https://www.textils.cat/circulartech/

Name	**CIRCULAR.TEXTILS.CAT**
Description	CIRCULAR.Tèxtils.CAT was born with the aim of developing a sectoral study to promote the circular economy in the advanced textile materials sector of Catalonia, giving new outlets to the waste it generates. The main action of the project is to create a database of textile waste generated in the sector, by several companies associated with the AEI Tèxtils cluster. The project represents an improvement for companies manufacturing advanced textile materials in Catalonia, as new opportunities will be generated for them to contribute to the

	reduction of the environmental impact of the sector. Likewise, it will also have a positive impact on fashion and home companies that will have access to sustainable and high value-added raw materials with technical properties.
Link	https://circular.textils.cat/

Name	**TEXSOSPACK**
Description	TEXSOSPACK is promoted by AEI TÈXTILS and the Packaging Cluster. The project aims to develop a study to promote the implementation of sustainable packaging in the advanced textile materials sector. As a starting point, an analysis of the state of the art of sustainable packaging in various sectors will be carried out and several companies from the AEI TÈXTILS cluster will be consulted, in order to obtain a collection of the main packaging challenges and define the most common and priority. An intercluster session was organized between companies in the textile and packaging sector in order to expose the challenges and, through a working dynamic, propose solutions. Finally, with all the information generated, a study was drawn up that aims to be a guide on how to implement sustainable packaging in companies in the advanced textile materials sector.
Link	https://www.textils.cat/texsospack/

Name	**RECYBUILDMAT**
Description	RECYBUILDMAT is a project developed by the group TECTEX of the UPC. The project aims to develop to develop and characterize sustainable building materials based on cement or lime matrix and additives from agricultural by products reinforced with nonwoven fabrics produced from textile waste designed to be applied on thin or sandwich panels for their application in ventilated façades, pavements and reinforcement of masonry structures. The project comprehends from the recovery and characterization of textile waste, the preparation of the non-woven structures suitable to be able to use as reinforcement in cement materials and the analysis of the environmental impact of these materials.
Link	RECYBUILDMAT-UPC

Name	**RECYWASTEX**
Description	RECYWASTEX is another project developed by the group TECTEX of the UPC focused in the recyclability of municipal textile waste. The textile waste estimated in Spain annually is around one thousand tons. From this quantity, the reuse and recycled part represents around 12% of the total waste collected differentially. The rest is thrown in the unseparated waste recollection, landfilled or incinerated. However, the new EU policy in 2025 require having a separate fraction for the textile. Thus, the one thousand tons will be collected and an effort in its recycling must be done. In this context, this project aims to: 1.The development of recycling processes for the textile wastes found in municipal solid waste sorting plants; 2.The development of technological solutions to improve the quality of the fibres obtained from the shredding process; 3.The development of a new system for separation of the shortest fibres using fluid-dynamic techniques.
Link	Website in process - https://serveistic.upc.edu/ca/genweb/el-servei/portfolio

Name	**CEBIOTEX**
Description	CEBIOTEX started as a collaboration between the UPC and the hospital Sant Joan de Déu in Barcelona and, since 2015, it is a successful case of UPC's spin-off. The project consisted in the development of a surgical drug delivery membrane for cancer patients. The membrane is biobased and biodegradable, and it is added after the surgery of a tumour removal. The membrane releases high dosages of a chemotherapy drug where the cancer was located and avoids the spread and propagation of new carcinogens cells after the surgery. The technology has been patented in EU, USA and China and the membranes are in the second phase of the clinical test.
Link	https://www.cebiotex.com/en/

Name	CISUTAC
Description	CISUTAC (Circular and Sustainable Textiles and Clothing) is a Horizon Europe funded project leaded by the Centexbel and with the Spanish participation of TEXFOR (textile industry confederation). The project aims to eliminate the bottlenecks in textile industry to improve the circularity of textiles in Europe. Thus, it will improve the sustainability and the circularity of the industry while reducing the environmental impact. The participants of the projects will found alternative uses for cotton and polyester fibres, which represents the 90% of the global production, and parallelly, analyse and solve the circularity of certain products: working uniforms, personal protective equipment and general fashion clothes.
Link	https://www.cebiotex.com/en/

3.3 Project from private companies

Name of the project	Disruptive and environmentally friendly data transmitter tape for the aeronautic industry
Description	Aims to develop a data transmitter tape for aeronautic applications with decreased weight and simplified designs to transmit information between the different sensors and the control units.
Beneficiary	Cintas y pasamanería S.A. (CINPASA) (https://cinpasa.com/)
Framework	Galactica pioneer projects, 1st call

Name of the project	Development of disruptive lightweight and flame-retardant fabrics for aeronautics applications
Description	Aims to develop and validate a minimum viable product of a new low-weight fabric for aerospace applications based on flame retardant polypropylene fabrics.
Beneficiary	Etisilk, S.A. (https://texsilk.eu/)
Framework	Galactica pioneer projects, 1st call

Name of the project	Active cooling textile system to prevent heat-stress in outdoor workers
Description	Extreme heat can lead to heat-stress-related complications and death, namely in outdoor workers such as construction workers, farmers, and those working in the mail and package delivery. To optimize the body temperature, a cooling system would be helpful to be integrated into clothes worn by people at risk.
Beneficiary	E. Cima (www.ecima.com) ITP (https://itp-gmbh.de/)
Framework	Galactica orbital projects, 1st call

Name of the project	rCF
Description	Thanks to the knowledge in weaving technologies and subsequent processes, Texfire Textils Tècnics S.L (Texfire) has been able to take a step forward in sustainable solutions, developing the first high drapability fabric made with 100% recycled carbon fibers. Texfire has been working on this development for more than 2 years, and has achieved the fabric in a laboratory loom (TRL4). The current challenge is to scale up the production to a pilot plant, define consolidation parameters, study mechanical properties to introduce this innovation on the market getting up to TRL7 result, validating the product in a real environment.

Beneficiary	Texfire Tèxtils Tècnics, S.L. (https://texfire.net/es/)
Framework	Galactica pioneer projects, 2nd call

Name of the project	RFID-Shelving-Systems
Description	With the present project, Maccion aims to come up with a novel and disruptive approach lying on RFID tracking technologies that will reduce item-level inventories and lead times by 25%, leading to dramatic improves in the textile supply chain management. Maccion will develop a project that consists of developing a smart-shelving system based on tracking in real-time the location of items and goods in zones and locations. The solution should be enabled by the combination of the most advanced tracking technologies – RFID tags with geolocation (GPS) capabilities, RFID readers and antennas and a track and trace software module with AI to filter out mislabeled reads that can collect, interpret, and communicate data to a captor and that can be stored into the ERP already installed in the company. So far, we have tested our system at a lab scale reaching a TRL4. With this project, we aim to assess the best suited RFID technologies, evolve our track and trace algorithms and integrate all the system into a TRL6.
Beneficiary	Maccion (https://www.maccion.com/)
Framework	Galactica pioneer projects, 2nd call

Name of the project	SMART-TEXTILE-SORTING
Description	Currently, efficient solutions for textile waste sorting and cleaning are missing in the textile value chain. Textile waste sorting is currently performed often manually. This is not technically nor economically viable yet as it faces, among other challenges, the difficulty of separating complex fiber blends (most post-consumer textile waste is composed by a mix of fibers), high costs due to the initial, labor-intensive manual sorting process, which lacks efficiency and poor price parity with virgin fabrics. As such, recycled content from post-consumer sources remains low, and higher-grade applications competitive with virgin fibers are not possible yet. To address these needs, Triturats La Canya (a textile recycling company) comes up with novel approach that lies in the implementation of a semi-automated sorting solution - based Near-infrared Spectroscopy (NIR) or AI/computer vision – that will assist and maximize workers efficiency that will be 2x more productive (in number of pieces sorted per hour, based on color and composition), allowing to reach an impressive sorting accuracy of more than 95%.
Beneficiary	Triturats La Canya, S.A. (https://trituratslacanya.com/)
Framework	Galactica pioneer projects, 2nd call

Name of the project	RTracking4Textile
Description	An important aspect of the management of a warehouse is related to keeping track of the location of the items and correctly handling the checkouts of the products. Today, Radio-frequency identification (RFID) is the alternative to barcodes and is perceived as more accurate and efficient in tracking the flow of items and finished goods. Nonetheless, despite RFID is already well spread in retail use-cases in the textile sector, it is not yet commonly used to optimize the production processes in a warehouse. The use of IoT technologies for tracking and trace is still underexploited in the textile sector causing huge inefficiencies. The implementation of deep leaning/AI is also needed to prevent duplicated or incorrect tag readings and increase accuracy. At Fello (textile company) we want to change this status quo by bringing to reality an advanced RFID tracking to manage

	a textile warehouse in real-time, capable to bring down stockouts by 30%. Through the present Pioneer project, Fello aims to develop a minimum viable process that consists in developing an IoT system that ensures the track and trace in real time of items in zones and locations. The solution will rely on advanced tracking RFID technology and a track and trace software module with AI that can collect, interpret (and filter out false positive reads), and communicate data to a captor and that can be stored into the ERP already installed in the company. So far, we have tested our system at a lab scale reaching a TRL4. With this project we aim to assess the best suited RFID technologies, evolve our track and trace algorithms and integrate all the system into a first functional MVP at TRL6 (technology demonstrated in relevant environment).
Beneficiary	Generos de punto FELLO, S.A. (https://fellosportswear.com/)
Framework	Galactica pioneer projects, 2nd call

Name of the project	RealTime-Shmacs
Description	In modern aircraft, structures such as wings and landing gears need to be permanently monitored because they are made of composite materials, complex in its nature. Additionally, those structures are exposed to several failures and structural damages. Novel solutions based on smart monitoring systems that would enable real-time in-service load monitoring and damage detection of aircraft structures should be envisaged. Conventionally, electric strain gauges are used, but they are usually wired to copper that is not viable because does not provide optimal bandwidth and data transmission capabilities, it is heavy and offers poor resistance as it is affected by electromagnetic interference. Novel fiber optic sensors are needed to monitor structure deformations, load monitoring, and center of gravity estimation – in Real-Time! Among possible solutions for structure health monitoring, fiber optical sensors, especially those based on fiber Bragg gratings (FBGs), are a promising technology due to their distinctive advantages which include higher sensitivity and are immune to electro-magnetic interference. However, these technologies present yet several drawbacks regarding sensor performance, accuracy and stability, due to the fact the fiber optics is directly attached to the aircraft structures. In this project – CINPASA (textile company developing textile tapes) and OPTRAL (advanced manufacturing partner, responsible for providing advanced fiber optics sensor solutions and fiber optics terminations) – will partner up to develop a smart textile tape with embedded fiber optics solutions wither higher accuracy and flexibility for applications in structural health monitoring of composite aeronautic structures, considering both the use of multi-point/distributed sensors. Furthermore, due to reduced weight and maintenance of the optic fiber tapes, the aircraft companies will save up to 5% in fuel and operational costs.
Beneficiary	Cintas y pasamanería S.A. (CINPASA) (https://cinpasa.com/)
Framework	Galactica orbital projects, 2nd call

4. Impact of the Green, Digital and Smart processes in the industry

To describe the specific needs of the companies related to the most emerging skills in a realistic way, the companies were asked about it during the T2.3 industry field research workshop and in depth discussed during the Living Lab with VET and HEI carried out in December 2022, from the T2.5 task, with UPC.

The subject was raised in the roundtable of the workshop and then the participant companies were asked to fill the SWOT analysis with the help of the cluster members that guided the session. The results are graphically summarized in the following figure:

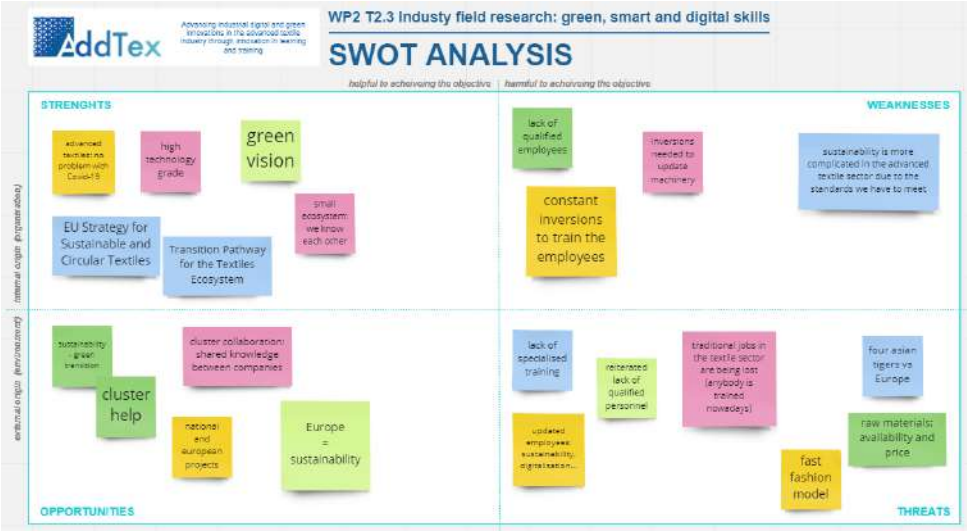


Figure 2. SWOT analysis carried out during the workshop session with the companies.

The main threats and weakness identified by the companies related with the analysed transitions (green, digital and smart) are linked to the lack of qualified personal, which requires a constant investment for the training of the employees, while at the same time the training is not easily available. In addition, the specialized personal is being retired and, mainly in traditional technologies, is difficult to replace. an economical point of view, it is difficult to compete with Asian producers in terms of cost productions, materials availability and price and the textile sustainable standards marked by the companies and the EU. Nonetheless, and besides the high standards required by the EU community, there are lot of opportunities in the textile industry, as Europe is consolidating sustainability as a necessity and strengthening this vision by European strategies, national and European projects, enhancing industries and cluster collaborations, and encouraging the improvements in technology. One interesting conclusion also from this SWOT analysis is that advanced textiles, a growing market in the EU, were not affected by the COVID-19 pandemic. Thus, no regression has being observed during the pandemic and the next years.

The results obtained by the desk and the field research allow us to accurately define the skills needed to occupy different jobs in the textile industry. The skills are summarized in the chapters below regarding three different

positions: Textile engineer, Manager and Technician/ Operators. The effect of these skills in the analysed transitions will be discusses.

4.1 Textile engineer

The sum of the skills of the Textile engineer position defined are shown in Table 4:

Table 4. Textile engineer skills.

TEXTILE ENGINEER 	• Know-how on textile technologies and materials • Smart textiles • Integration of electronics • Data management (from product and from production process) • Energy efficiency and sustainability - ability to identify weak points in sustainable design, energy consumption and processing • LCA assessment, data gathering, automatization • Emerging technologies AI and blockchain for textile traceability and sustainability passports

Textile engineers must have a key role in the green, digital and smart transitions, as they are going to be responsible for the implementation of the new and sustainable methodologies, production techniques and processes or materials. Thus, textile engineers must have a general and continuously learning knowledge of green processes and materials; smart materials and electronics integration; emerging digital technologies such as Blockchain. Moreover, it is desirable a depth knowledge in LCA and AI. The knowledge is identified and summarized in Table 5, indicating the priorities in training that need to be addressed.

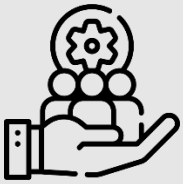
Table 5. Textile Engineer knowledge identification for green, digital and smart transitions.

Functional areas of the company	Technology/innovation/ Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Production, Logistics, Quality and Waste management departments	Green procedures	Raw materials, Biobased and sustainable colorants and auxiliary materials, Emerging sustainable processes, BAT (Best Available Techniques) application and implementation. Recycling procedures and materials. Ecodesign	Emerging techniques and materials, BAT's, Recycling, Process optimization. Ecodesign
	Smart materials	Smart materials, Woven and nonwoven textiles, electronics, sensors	Electronics, sensors
	Digital	Digital technologies	AI and Blockchain. Data management
	LCA	LCA software, LCI preparation. Report interpretation	Report interpretation and LCI preparation

4.2 Manager

Manager position must be in contact with textile engineers and operators/technicians. They are the link between them. The skills defined for this position related with the green, digital and smart transitions are summarized in Table 6:

Table 6. Manager skills.

MANAGER 	• Data management (from product, from production, from resources), use of AI for decision making • Environmental impact, LCA, policies, trends, and carbon offset measures • Green Logistics • Traceability and blockchain management, how to get ready for product digital passport • Smart textiles materials • Agile management, resolution of conflict • Adaptability for VUCA and fast changing environment • Smart decision making

As previously mentioned, managers are the link between the textile engineers and technicians and operators. Thus, they must have a general and applicate knowledge in the technologies and innovations implemented, as they need to communicate with the engineers and understand the issues detected, solve them and transfer all the necessary learning to the technicians. Data management, AI and LCA, environmental policies, regulations and trends, ecolabels and green logistic knowledge is desirable for this position. In addition, managers must be people with a high adaptability, as industry and regulations are in a continuous change, agile, smart in management, and decision-making. The necessities in knowledge identified for this position are reported in Table 7.

Table 7. Manager knowledge identification for green, digital and smart transitions.

Functional areas of the company	Technology/innovation/ Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Production, Logistics, Quality and Waste management departments	Green Logistics	Sustainable transport and logistic systems	New developments in logistic management and transports
	LCA	LCA software, LCI preparation. Report interpretation	Report interpretation and LCI preparation
	Environmental regulations, Ecolabels, Recyclability	Environmental regulations and policies	Changes and new environmental regulations and policies
	Smart textiles materials	Smart materials, Woven and nonwoven textiles, electronics, sensors	Raw materials, electronics, sensors, applications
	Digital	Digital technologies	AI and Blockchain. Data management

4.3 Technicians and Operators

The skills defined for technicians and operators position related with the green, digital and smart transitions are summarized in Table 8:

Table 8. Technician and operator skills.

TECHNICIANS / OPERATORS	
	• Production process know-how • Interaction and data visualization tools (dashboards) • Process control • Environmental impact at process level, interaction, data gathering, • ERP management and data input • Highly specialized for optimized production

Technicians and operators are the persons who in fact implement and work with the processes and new technologies. They must learn and understand the processes; manage and interaction with data tools and software; and detect issues during the production and how to manage them. Moreover, it is desirable that this profile is specialized in production optimization. The identified knowledge for this position is described below in Table 9.

Table 9. Technician/Operators knowledge identification for green, digital and smart transitions.

Functional areas of the company	Technology/innovation/ Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Production and logistics	Process optimization	Process optimization and BAT's technologies	Process optimization and BAT's technologies
	LCA	Report interpretation	Report interpretation. Issues detection
	Smart textiles materials	Production techniques, raw materials	Raw materials, production methodologies, electronics
	Digital	Digital technologies	Data management, input data, software interaction

5. Initial and further education on advanced textiles

The analysis of the first workshop with VETs and HEIs and the in-person Living Lab between companies and VET/HEI reported a large gap between the VET education and companies, while in the case of HEI, these advanced textiles are already considered in the educational curriculum.

The VET curriculum is common for all the Spain regions and are available and published in the BOE (Boletín Oficial del Estado). There is a total of 9 careers devoted to textile industry in Spain, but only 6 of them are taught in Catalonia. These VET programmes are divided in two degrees: Formació Superior de Grau Mitjà (auxiliary technicians) and Formació Superior de Grau Superior (technicians). Besides, the presence of smart, green and digital technologies in these educational programmes is scarce, for smart technologies could be considered inexistent and mainly devoted to well implemented and already working technologies in companies.

On the other hand, HEI in Spain have already a higher presence of the proposed technologies in their curriculum. In the HEI educational stage, there is a unique official and public bachelor's degree in Spain, the Bachelor's degree in Textile Technology and Design from Universitat Politècnica de Catalunya (UPC), while in the case of master degrees there are different public and private programmes. The public and official ones are: Master's degree in Textile Design and Technology from UPC; and the Master's Degree in Textile Engineering and the Erasmus Mundus Master of Science in Textile Engineering from Universitat Politècnica de València (UPV). In the bachelor's degree, these technologies are taught in different courses such as: Colouring Agents and Auxiliary Materials (green); Materials for Textile Design (smart); or Integral Development of Textile Products (digital). Regarding the Master Degrees. On the other hand, in the Master 's degrees, there are courses totally devoted to these technologies. Some examples are:

- Smart Textiles (UPC and UPV)
- Sustainability in the textile industry (UPC)
- Designing sustainable textiles (UPV)
- Tools for Data Processing in the Textile Industry (UPV)
- Textile production in the industry 4.0 (UPC)

Nonetheless, and besides the differences between VET and HEI, both educational institutions agree on the future challenges of the companies and the need of training in these new technologies identified. In the green transition, the need for greener process, such as enzymatic treatments, recyclability and new sustainable materials were the main challenge identified for the becoming years. Knowledge in environmental impacts and regulations will be also required. Regarding the digital transition, the HEI and VET were totally in agreement with the challenge being the data analysis and software for AI and tracking systems. These technologies are continuously implemented in the companies. Finally, smart transition challenges for VET and HEI are led by the manufacture of functional textile and textiles with integrated

sensors for fields such as medicine. Nonetheless, while the future challenges of all the analysed transitions were in agreement for VET and HEI, its future implementation in the curricula was not. The participants of the VET and HEI meet up and Living Lab exposed the need of specialized professionals and a continuous learning process. In the case of HEI, university professors are more used and closer to the innovation and constant learning is a natural process. Moreover, the implementation in the curricula is easy as these curricula are revised in short-time periods. Nonetheless, the case of VET is the opposite case. VET professors must do a constant effort to learn about these techniques and there are scarce technological programs for it. The VET participants commented the lack of learning programs for VET teachers, as the offered nowadays are mainly devoted to pedagogy. Moreover, the accessibility to materials, software and techniques associated to these transitions are scarce, as the government budget for these institutions does not usually complete this necessity. These educational centres are planned to teach the basics knowledge of the industry and not the innovations. Thus, only well-stablished technologies and process are included in the curricula. In this sense, an effort must be done to increase teachers technical training programs, improve accessibility and teaching about new digital technologies and enhance the collaboration between industry and VET to achieve the appropriate skills of these future technician and operators.

Finally, another challenge was identified by all participants. For almost all the proposed innovations and technologies of the transitions identified, a basic knowledge in different fields such as chemistry, biology, electronics or mechanics, will be additionally necessary for the training. Although these basic courses are covered in the secondary school and, in HEI, during the first year of the bachelor's degree, perhaps, a deeper knowledge will be necessary. Nevertheless, the time is a critical factor and enlarging these basic courses is beyond dispute. Thus, the behaviour, and interest of the students will be a key factor to achieve this necessary knowledge. It will be necessary to attract students to these courses and continuously motivate the students to facilitate their effort regarding this basic knowledge that must be learned by themself, and avoid the dropout.

6. Conclusions

This national report summarises the Spanish situation of textile education and industry, how the green, smart and digital transition are being carried out, and the future challenges.

The field and desk research demonstrate a compromise between European, National and regional governments towards these transitions, promoting different circular plans and funding. From the industry point of view, the situation is open to different opportunities for a field that has not shown a regression during the pandemic[1] and it is constantly evolving. However, there is a lack of specialized employees and, due to this lack, an additional inversion is necessary for his training. Three different jobs position (textile engineer, manager and technician/operator), with the required skills and training to face successfully these transitions, are defined in this report. In all the cases, training associated to data management, smart materials production, and green processes or LCA interpretation are desired. Additionally, the companies are fully aware of the importance of sustainability, nowadays, in the textile sector. Therefore, they put a lot of efforts trying to adapt their processes and products, improving constantly, and analysing its environmental impact. Digital transition is following the same path, but it is more difficult for the companies to adapt to it. Nonetheless, this transition is being supported by national and European government. The presence of smart textiles is growing up fast in the national level and, although its presence is still reduced in comparison with other technologies and products, companies are open to this transition challenges.

On the other hand, the field and desk research of VET and HEI demonstrated the gap between industries and the Spanish education system. The gap is reduced in HEI, where the curricula could be modified easily and there are full courses devoted to green, digital and smart technologies. However, in the case of VET the situation is opposite to HEI. The analysed transitions are scarcely present in the curricula and there is a lack of accessibility of these centres to the new technologies and innovations in terms of materials, software, or professors training. Thus, to achieve the industry demands it will be necessary to improve the accessibility and the resources of the education centres, increase the offer to teachers training programs to enhance the continuous learning of these professors regarding the new technologies, and promote the collaboration between industry and education centres. Nonetheless, another milestone is commented related to students. A need for basic knowledge is necessary to obtain the desired skills related with the green, digital and smart transitions, but it could not be taught in the curricula. Thus, an effort by students will be necessary. In this sense, the attraction of these students to the textile courses and the continuous motivation is another milestone.

[1] The consulted companies are from the technical textile subsector, which have not been affected in the same way as the fashion one during the pandemic.