



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

WP2 Portuguese National Report



Co-funded by
the European Union

Project acronym:	ADDTEX
Project full title:	Advancing industrial digital and green innovations in the advanced textile industry through innovation in learning and training
Grant agreement no.:	101056303 — ADDTEX — ERASMUS-EDU-2021-PI-ALL-INNO
Responsible partner for deliverable:	CITEVE & TUS
Contributing partners:	—
Author(s):	CITEVE
Target Group(s):	Institution
Distribution level:	Partnership
Total number of pages:	24
Version:	Final
Language	English
Reviewed by:	Peer review
Status:	Final
Delivery date:	20.12.2022

Version control:

Number	Date	Description
1	20.12.2022	Final

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or European Education and Culture Executive Agency (EACEA). Neither the European Union nor the granting authority can be held responsible for them.”

Contents

Contents	3
1. Introduction	4
2. Technologies / innovation /documents /tools.....	5
2.1.1 Green transition	5
2.1.2 Digital transition	7
2.1.3 Smart transition	9
3. Existing Initiatives (Projects/strategies/documents/tools).....	10
4. Impact of the Green, Digital and Smart processes in the industry	13
4.1.1 Green	14
4.1.2 Digital	15
4.1.3 Smart.....	15
5. Initial and further education on advanced textiles	17
6. Conclusions	19
7. Annexes.....	20

1. Introduction

The research and development activities carried out by CITEVE, are focused on the textile and clothing sector. The Textile and Clothing Industries are two of the oldest industries in Portugal and represent one of the largest and most important national business sectors. In national level, the North of Portugal concentrates most of these industries. In March 2020, in Portugal there were 3463 textile companies and 8480 clothing industries in operation¹.

CITEVE carried out a detailed analysis of the sector regarding:

- Relevant trends in the field of advanced materials with respect to green, smart and digital knowledge.
- Existing green, smart, technological and digital knowledge in active vocational education curricula in initial and further education.
- Specific needs at the level of the most emerging skills that result in occupations.
- Impact of COVID19 in terms of skills and adoption of new working methodologies.

Regarding the research methodology, a quantitative and qualitative methodology was adopted, between August and November, through desk and field research, as well as a living lab session.

We started by collecting pertinent information on the sector's trends regarding the preparation for the green, digital and smart transition, as well as understanding the existing training offer in the different areas. In parallel, we started the Meetup and the field research with companies, VET and HEI.

With three face-to-face sessions and one online session, it was possible to involve a total of **39 companies, 6 VET and 6 HEI**, distributed as follows:

- **Meetup** - held in two sessions (i) one in presence (07.10.2022) with 4 companies, and 2 VET and 2 HEI, ii) one online (20.10.2022) with 12 companies).
- The **field research** sessions took place on the same days of the Meetup with the same participants. Holding the Meetup and the field research on the same day allowed to gather in a holistic way crucial information for the next phase of the project, the training development.
- In November we held the **Living Lab** that gathered 7 companies, 2 VET and 2 HEI to share the results achieved in the desk and field research and to identify the main contents that companies would like to see addressed in training offer, as well as to understand the challenges that Education entities face in preparing training offer in green, digital and smart.

This report is divided into six chapters in which we present the main results achieved in the different phases of the desk and field research. With chapter one being the introduction and chapter six the conclusion.

In chapter two we present the main technologies/ projects/ innovations or challenges identified and explored in collaborative sessions with companies. With a table for each of the areas - green, digital, smart, we highlight the processes that are impacted by the technology/innovation/changes.

The results achieved in the desk research regarding national projects or strategies with a focus on the advanced materials targeted on green, smart, digital knowledge and impact of COVID 19 on the adoption of new working methodologies in the Advanced Textiles industry are presented in chapter three.

Chapter four talks about what green, digital and smart innovation means for companies, and where process innovation is implemented. A list is also presented with a proposal of the themes that companies and educational institutions would like to see addressed in a training offer. For this analysis the companies' functional areas were the basis of analysis.

Identification of strategies, documents, programs, tools, projects at EU, national and regional level with a focus on the advanced materials targeted on green, smart, digital knowledge and impact of COVID 19 in the area of education in VET and HEI is the main content of chapter five.

¹ INE, 2020 (Statistics Portugal)

2. Technologies / innovation /documents /tools

The differentiation and innovation that is increasingly present in the textile and clothing industries in Portugal, makes this sector a pioneer and an international reference.

More than ever the technology present in the sector has allowed the creation of high added value products and opened doors to innovations from nanotechnology in fabrics to software that allows the enhancement and automation of production.

In our research we try to focus on which technologies/challenges and innovations are present in the sector or will influence it in the coming years.

The following tables list the main technologies/innovations/challenges for each of the three areas: Green, Digital and Smart.

2.1.1 Green transition

Table 1. Green

Technology/innovation/Changes	Description	Processes impacted by the technology/innovation/changes	Examples (links..)
Texboost – Circular economy	Development of sustainable textile structures, with eco-design and multifunctionality, based on the valuation of waste from other industries, is inserted in the new paradigm of the Circular Economy.	Coated textile solutions, through the use of waste and by-products of: vegetable origin industrial operations, such as the tanning industry, natural leather cutting (for indoor automotive) and EVA (for shoe components) dairy industry - with new multifunctional properties combined with design and special fashion effects.	https://tinyurl.com/j292h8t4
Cork.a.Tex-Yarn: Yarn coated with cork additives	The "Cork.a.Tex-Yarn: yarn coated with cork additives" project is the result of a long journey already undertaken by Têxteis Penedo, Sedacor, CITEVE and the Faculty of Engineering of the University of Porto, with the aim of developing innovative and high performance products that simultaneously incorporate the properties of textile substrates and the functional benefits of cork.	Recyclable and 100% natural, cork is an intrinsically sustainable resource that is both renewable and biodegradable. The strategy of this project is based on the knowledge that textiles, during their life cycle, have a huge impact on the environment, aiming to design textiles that are both softer and more resistant, offering better protection against the various elements and with an extended life span.	https://tinyurl.com/2ph527n7

Technology/innovation/Changes	Description	Processes impacted by the technology/innovation/changes	Examples (links..)
Fiber4Fiber	<p>Initiative promoted by the Portuguese business group, Altri, through Caima, in collaboration with two entities of the National Scientific System: CeNTI and CITEVE.</p> <p>Fiber4Fiber project intent to develop optimized dissolving pulps, from Portuguese Eucalyptus globulus trees, to produce man-made cellulosic fibres – Lyocell and Viscose, that can be traced along the value chain.</p>	<p>This traceability will make it possible to distinguish products with sustainable origin from others similar that come from less responsible management sources, making it crucial to leverage the use of these fibres in increasingly demanding applications.</p> <p>These pulps will also be used to develop innovative functionalized lyocell fibres, to be marketed as premium products, as textile fibres and technical yarns.</p>	<p>https://tinyurl.com/5n7pcrk</p>
Fibrenamics Green - Platform for the development of innovative products based on waste	<p>A sustainable innovation project aimed at the incorporation and recovery of waste from various industries for the development of innovative products.</p> <p>Fibrenamics Green is being developed by the Fibrenamics International Platform of the University of Minho, in partnership with the Centre for Waste Recovery, With the main mission of waste recovery as a source of value creation for product development through the incorporation of design, engineering and creativity, resulting from involvement and university-company synergies.</p>	<p>Fibrenamics Green intends to aggregate in a common space the various players of the entire value chain of the waste generation and recovery process, enhancing the transfer of interdisciplinary and multisectoral knowledge, in the development of products based on waste, driven by scientific and technological knowledge.</p>	<p>https://tinyurl.com/4hndf6ju</p>

2.1.2 Digital transition

Table 2. Digital

Technology/innovation/Changes	Description	Processes impacted by the technology/ innovation/ Changes	Examples (links..)
Mind Technology	Software highly specialized equipment for the development of high quality fashion products at competitive prices and with production flexibility, satisfying its customers who seek creative and personalized design: - MindCUT - Cutting room: automatic placement based on pattern recognition, adaptive cutting control and part selection. - MindGEST - Integrated Product and Process Data Management for production planning and control. Cost evaluation, documentation and reporting.	It combines MindCUT Studio software with the best digital cutters from Zünd, thus offering an ideal cutting solution, flexible and adapted to an increasingly demanding clothing industry: - Capture, Recognition and Automatic Nesting - Automatic Cut - Parts Picking	https://tinyurl.com/ybt8thjx
Meta Real	Riopele company – meta-collection. Riopele is deepening its efforts to digital transition and is unveiling its first-ever collection in the Metaverse. This initiative will enable “the customers, suppliers and partners of Riopele to experience the fabrics in the digital world”	With this technology, which falls within the framework of the project designed to digitalise the samples and provide virtual prototypes of products, Riopele is placing all of its tools in the Metaverse to enable its customers to fully analyse the collection, verify their functionalities and visually experience.	https://tinyurl.com/2p88k85z
Automated real-time inspection for Circular Knitting Machines	Portuguese company Smartex has developed the first automated fabric inspection system for Circular Knitting Machines. Advanced camera vision system that reduces defective production to close to 0% in Circular Knitting Machines, including lycra faults, yarn thickness, holes, needle defects, and more.	Defects are detected & automatically recorded on the X Y roll map, so their downstream impact in the supply chain can be minimized. Detects recurring defects & stops the machine before it's too late. This technology eliminates textile waste during the manufacturing process.	https://tinyurl.com/bdfdwthe

Technology/innovation/ Changes	Description	Processes impacted by the technology/ innovation/ Changes	Examples (links..)
	<p>The system is able to create a roadmap of possible types and coordinates of defects and offer insights about the efficiency of machines and percentage of defective production.</p>		
<p>Texboost - Digitization and dematerialization prototype fabrics and clothing</p>	<p>Aims to create new products, processes or services, innovative and technologically advanced, driving the entire value chain of T&C industries to areas with scientific and technological skills in the sense of Digitization and Dematerialization. The aim is to develop solutions applied to textile dematerialisation (textile samples, modeling and prototyping of technical clothing) through the use of technologies and information tools.</p>	<p>The innovative application of Information and Communication Technologies (TICs) are included in accordance with two main strategic orientations:</p> <ol style="list-style-type: none"> 1. dematerialization of samples and sample plants, through an algorithm capable of learning from the history of textile data, and able to predict and optimize variables / parameters useful for decision-making processes in textile production. 2. dematerialized modeling (motion capture) of sports clothing (performance) through studies of the sportsman and sportswoman biomechanics, relating with the properties of the textiles to be selected for each zone of the clothing articles to be developed (comfort mapping) and for the validation of the sensors to include in the suits, as well as to choose the places where they will be integrated. 	<p>https://tinyurl.com/j292h8t4</p>

2.1.3 Smart transition

Table 3. Smart

Technology/innovation/Changes	Description	Processes impacted by the technology/innovation/Changes	Examples (links..)
HelpInTex Multifunctional and Intelligent Mat Solutions	Multifunctional and intelligent mat solutions. Detect and communicate the presence or movement through a fully integrated sensor system completely integrated in the mat's textile structure, operating as an active remote monitoring system capable of detect and communicate/alert the presence and/or presence of movements inside the dwelling (or any given division). Consortium composed by António Salgado company, CITEVE and CeNTI.	The innovative solutions envisaged in HelpInTex are part of the important and strategic market for textiles – as well as a security method, particularly in crime against private property and health care.	https://tinyurl.com/3m3feay7
IHeatex Multifunctional Felt and Intelligent Hybridization Project	New multifunctional, intelligent hybridization three-dimensional structures and architectures with active moisture and heating management properties, whose developments are directed to two typologies of felted products for application in home textiles and hotels: bath articles and kitchen articles. Consortium composed by J.F. Almeida company, CITEVE and CeNTI.	This project promotes significant advances, in particular in spinning, weaving and finishing technologies.	https://tinyurl.com/2p99p5rf
ACAMS II Adaptative Camouflage for the Souldier II	Integrate several active and passive adaptation mechanisms into a textile based soldier camouflage system. This system addresses several wavelength bands, such as visual, infrared as well as radar. Military needs on sensing, fire power, mobility and endurance are considered.	Optimization is achieved through both well-established and new methods to capture the adaptive properties. The reduction in detection range and hence the increase in survivability will be assessed using well-established methods and new methods to capture the adaptive properties.	https://tinyurl.com/2jtj6xwd https://tinyurl.com/45zz7423

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

- Identification of projects and documents at national and regional level with a focus on the advanced materials targeted on green, smart, digital knowledge and impact of COVID 19 on the adoption of new working methodologies in the Advanced Textiles industry.

The Portuguese Recovery and Resilience Plan (RRP)² is a national programme, with an implementation period until 2026, which will implement a set of reforms and investments that will enable the country to recover sustained economic growth, reinforcing the objective of convergence with Europe during the next decade.

Within the national RRP there are different axes of intervention that will have an impact at the level of the textile and clothing sectors, namely regarding business capitalisation and innovation, qualifications and skills, industry decarbonisation, sustainable bio-economy and digital transition. It is aligned with the six relevant pillars of the European 2030 strategy and there are measures foreseen in the 3 dimensions: i. Resilience, ii. Climate Transition and iii. Digital Transition.

The Portuguese RRP invests 16.6 billion eur in national recovery, with 3.7 billion eur going towards digital objectives. Reforms and measures support digital inclusion, the digitalisation of businesses and key public sectors, and lifelong learning throughout education phases and systems.

CITEVE coordinates the BE@T project³, which brings together around 55 partners with complementary skills (15 non-SME companies, 17 SME companies and 21 entities of the national Scientific and Technological System). This project is organised into 10 Initiatives and 59 Measures to be implemented in a planned period of 4 years (2022-2026) and presents an overall investment of around 132.5 million euros distributed between research and development activities, productive innovation, training and communication and internationalisation actions. It also presents an integrated strategy, bringing together the knowledge from industry and education with the integration of Higher Education and VET providers in the Textile and Clothing area. The project presents 4 strategic pillars: i. biomaterial, ii. circularity, iii. sustainability, iv. society. In the sustainability pillar there are concrete measures for the capacitation of the education and training system, the training of professionals in sustainability, eco-design and eco-engineering and the transfer of knowledge.

Also, the Mobilising Agendas/ Alliances for Reindustrialisation and Green for Business Innovation under the RRP create investment opportunities and implementation capacities for the development of projects that transform the specialisation profile of the Portuguese economy, encouraging higher value-added and knowledge-intensive activities, oriented towards international markets and the creation of skilled jobs.

CITEVE coordinates the Mobilising Agenda for business innovation Giatex: Intelligent Water Management in the textile and clothing industry⁴. This project aims to address the challenges faced by textile finishing companies in terms of intensive water consumption. It aims to develop a set of tools that allow companies to: 1. Reduce the specific water consumption (use of less intensive finishing technologies and adoption of treatment technologies that allow water reuse). 2. Support the decision on the final destination of water (through the integration of monitoring and process control systems and a new support tool for water management).

CITEVE also coordinates the TEXP@CT - Innovation pact for the digitalisation of the Textile and Clothing sector Mobilising Agenda⁵. The project will develop a set of innovative solutions, designed to address the specific challenges of the textile and clothing sector, towards the necessary digitalization shift. The project includes R&D activities, the development of industrial demonstrator pilots and the strengthening of digital skills of the sector's workforce, with expected results not only on the entities participating in the project but committed to generating relevant impact on the overall Portuguese sector, also on the ICT and Advanced Manufacturing Technology sectors.

The mobilising project STVgoDIGITAL⁶: Digitalisation of the value chain of the Textile and Clothing Sector, is a structuring project of the Portuguese Textile Cluster, which aims to include a set of R&D initiatives, with the central involvement of

² <https://tinyurl.com/ydaskaea>

³ <https://tinyurl.com/2ds29ape>

⁴ <https://tinyurl.com/bddbrha4>

⁵ <https://tinyurl.com/4ktnrxrb>

⁶ <https://tinyurl.com/3s896eu2>

companies in the Textile and Clothing Sector and other complementary sectors that enhance the adoption and transition to the new paradigm of Industry 4.0 and the digital transition, with emphasis on information and communication. The STVgoDIGITAL project identifies 5 themes and the solutions for: -Textile sustainable and circular 4.0 ID; Supply Chain 4.0; Fashion Ecosystem 4.0; Worker 4.0; Artificial Intelligence for ITV 4.0.

The iTechStyle Green Circle - sustainability showcase⁷, an initiative of CITEVE in partnership with ASM - Associação Selectiva Moda, was launched during Modtíssimo in 2018 (the oldest textile show in the Iberian Peninsula and the only one in Portugal dedicated to the Textile and Clothing Industry) and acts as a showcase of the capacity of Portuguese textile and clothing companies, to produce innovative items in the area of sustainability and circular economy.

The iTechStyle Green Circle allows the wide dissemination and promotion of the national textile and clothing industry, as a reference in innovative articles in sustainability and circular economy.

The Portuguese Government has approved the process of recognition of the Digital Innovation Hubs⁸, which aims to create a National Network of Digital Innovation Hubs, where the Fashion Hubs are integrated, in articulation with companies and other R&D and innovation entities. The Interface Centers (CIT)⁹ promote the connection between higher education institutions and companies.

Within the scope of entrepreneurship for students who finish higher education but do not have the financial capacity, the Business Angels' Program works as a fundamental mechanism for the labour market. Also in this scope, the national project Think Industry i4.0 promotes entrepreneurship and the attraction of young people to the industry.

The Portuguese T&C industry proved to be an example of resilience during the COVID-19 pandemic due to its clusters, flexibility, investment in research and development (R&D).

The following phenomena can be listed as the most obvious results of the pandemic¹⁰:

- the abrupt and sharp decrease in consumption;
- the abrupt economic polarization in society;
- the selective impact on shopping habits;
- the happening of the "retail apocalypse" in Europe;
- the interruption of Omnicanality integration;
- concentration of commerce on digital platforms.

The "Pandemic forces companies to process innovation"¹¹ report presents *the first results on business innovation for the period 2018-2020, based on the Community Innovation Survey (CIS) - a biennial survey and the responsibility of the General Directorate of Education and Science Statistics (DGEEC). Results are presented concerning: innovation activities, innovation with environmental benefits, innovation cooperation, innovation expenditure, turnover resulting from the introduction of new or improved products and strategies on the economic performance of enterprises.*

In the 2018-2020 triennium expenditure-generating innovation activities expanded, being reported in 48.0% of companies, and this expansion was mainly due to process innovation, observed in 42.7% of companies. There is strong evidence that this increase in process innovation is largely associated with the impact of the COVID-19 pandemic, namely the implementation of teleworking and consequent investment in technology and equipment to enable it, the adjustment of communication channels (including the implementation of online sales) and generally the adaptation of processes and procedures related to the adoption of teleworking and non-face-to-face contacts to ensure business continuity.

It was among companies with 250 or more people in service that the highest percentage of business innovation was observed (79.8%).

⁷ <https://tinyurl.com/bderhpkp>

⁸ <https://tinyurl.com/2r495x2k>

⁹ <https://tinyurl.com/536mwm7r>

¹⁰ Agis, D.; Vaz, P.; (2021). *ITV 2030 Vision and strategies - Contribution to a strategic plan for the Portuguese textile and clothing sector for 2030*. Edition ATP - Portuguese Textile and Clothing Association.

¹¹ <https://tinyurl.com/2s4f9u7w>

Compared to the period 2016-2018, Industry and energy recorded the largest reduction in the proportion of companies with product innovation (-4.6 p.p.).

Between 2018 and 2020, 49.7% of companies introduced innovations with some kind of environmental benefit, regardless of the degree of contribution to environmental protection.

In 2020, the total expenditure on innovation activities reached €2736 million, up 5.3% on 2018, representing about 1% of the total turnover of companies (0.8% in 2018), highlighting companies in the Information and communication sector that presented an expenditure on innovation corresponding to 4.0% of total turnover.

The impact of the new Industrial Revolution on employment and the labor market: amplified effects with COVID 19 Report¹² introduce considerations and literature review on changes in employment and labor markets, possibly accelerated by the pandemic, and possible impacts on social protection systems, especially in the context of social security contributory regimes.

The author believes that the current Fourth Industrial Revolution (IR) will have important employment consequences.

With beginning in the transition of the millennium, has been marked by the revolution of artificial intelligence (AI) and robotization and is a consequence of the revolution immediately previous, especially the development of the 'internet of things' and 'big data'.

It highlights six effects of this IR:

- i) the destruction of jobs, even in part compensated by the creation of new - qualified and linked to the development of these new technologies*
- ii) pressure for lower wages*
- iii) the work will be marked by an increased dose of instability - less lasting*
- iv) less overworked work - higher prevalence of teleworking; part-time or related work*
- v) influence on migratory movements, creating the so-called forms of migration/virtual immigration*
- vi) increased precariousness and erosion of the very notion of work.*

The report concluded by highlighting how the pandemic (COVID-19) has accelerated or amplified some of the impacts of this revolution: from the very beginning, the widespread use of telework.

¹² <https://tinyurl.com/bdfu5jvf>

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

- What does innovation relevant to green mean for companies and where is innovation in the processes implemented? What target impacts need to be achieved?

Essentially companies mentioned that all processes associated with reducing and saving resources are considered essential and sources of innovation.

They gave as examples the implementation of solar panels and water reduction.

It was mentioned as an example: Natural materials inclusion to overcome the increased demand for PVC free, oil-derivatives free interior and awareness of harmful leather processing. These materials have an increased bio content maintaining high performance and reduced carbon footprint. It can be used in all interior applications where flexible materials are used and processed by cut & sew or thermoforming/compression molding processes.

The importance of traceability at all stages of production and the use of bio-based materials was also emphasised.

It was also reinforced that it was essential to update the training paths and training offer, so that there was training aligned with the needs of companies in terms of green transition. Although there is already training in this area, namely in terms of legislation, it is not yet the necessary one, as it is urgent to prepare technicians with more transversal skills, namely legislation, technologies, eco-engineering and design for sustainability.

- What does innovation relevant to smart mean for companies and where is innovation in the processes implemented? What target impacts need to be achieved?

The companies associated examples of smart and digital innovation, considering that the same are interconnected.

The integration of automation, informatisation and digitalisation of the entire process, whether the connection to suppliers, to clients or in the internal restructuring of the companies. They consider it would help the companies to be faster and reduce waste (energy, water, raw materials) as well as it would help to satisfy the customers, demonstrating the quality of their work/brand.

- What does innovation relevant to digital mean for companies and where is innovation in the processes implemented? What target impacts need to be achieved?

Technological transformation, customisation, traceability, connectivity and efficiency.

It was mentioned, the investment in digital commerce, with many companies basing a good part of their sales on the online system.

They highlighted digital innovation in the continuous improvement of products and services, automation of processes and the possibility of cost reduction.

The main results achieved in the field research and living lab with regard to companies' experience and training and qualification needs are compiled in the following tables.

4.1.1 Green

Table 4. Green

Functional areas of the company	Technology/innovation/Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Strategic management	Energy restructuring (Biomass, solar panels,...). Choosing greener machines and processes.	Energy-efficient technologies in industry. Factory structure. Maintenance of new technologies. Monitoring software. Planning and organisation to create efficiency productive energy.	Maintenance. Planning and organisation. Ecological, sustainability and circularity criteria Sustainable energy. Recycling. LCA studies, carbon footprint and environmental declaration. Eco-efficiency in the value chain. More eco-efficient production processes. Digitisation. Automation. Sustainable functionalisation by process.
Raw material purchasing sector	Regulation / Legislation. Recycling of materials.	Recycling's impact on the environment. Internal improvements. Sustainable fibres and materials (origin, characteristics, composition, other technical specifications).	Traceability. Regulation. Eco design. Recycling materials. Product composition. Fibres and textile structures (more sustainable). Choice of sustainable materials.
Quality	New processes.	Legislation / regulation.	European legislation. Eco-labels. GOTS/OCS. GRC/RCS. Material quality and durability.

4.1.2 Digital

Table 5. Digital

Functional areas of the company	Technology/innovation/changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Management	ERP.	Data analysts. Building basic/semi-basic forecasting models. Know the whole process of the company (may be who works with the quality process).	Technical knowledge (materials, processes, technologies). Choice of hardware for digital transformation (cybersecurity, ...).
Production area (mainly seamstresses)	Sensors. Defect analysis. Maintenance: preventive and corrective. Open-end sewing machines (More automatic processes).	Digital basic skills. Basic machine programming and maintenance.	Basic data analysis. Basic processing information (quantitative data).
Marketing Communication	CRM / google analytics. Demographics data. Meta verse. Digital Showroom. Marketing influencer/Best practices.	Data analysis. Marketing skills / Fashion – B2C. Photo/video/digital showroom.	Choice of hardware for digital transformation (cybersecurity, ...).
Design and product development	CAD / 3D. Prototyping.	3D. Raw materials knowledge (library import). Technical knowledge.	Virtual prototyping. 3D. Digitisation. Automation.

4.1.3 Smart

Table 6. Smart

Functional areas of the company	Technology/innovation/changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Strategic management	Innovation. Strategic planning.	Innovation management. Digital literacy.	New business models. Workshops. Case studies. Good practices. Benchmark. International missions.
Design and product engineering	3D design and pattern making. Additive manufacturing Smart textiles / nanotechnology.	Design for sustainability. Digital Design and Modeling. Nanotechnology and Microelectronics. New generation artificial fibres. Monomaterials.	Design for sustainability. Modelling and 3D prototyping. Smart manufacturing. Design (technical design skills). New generation artificial fibres. Monomaterials.

Functional areas of the company	Technology/innovation/changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
Shop floor	AR/VR. AI/ML. Industrial processes. Process/product engineering.	Ability to analyse data. Operations management/optimization. Technological/textile/clothing knowledge.	Technological potentialities and barriers. Digitisation. Automation. Specific knowledge in textile/clothing business.
IT	AR/VR. AI/ML. Big data. BI. IoT.	Data science. Data engineering. Big data. AR/VR. New technologies.	Specific knowledge in textile/clothing business. On job training. Contents related with all knowledge needed (AR/VR,...).

5. Initial and further education on advanced textiles

- Identification of strategies, documents, programmes, tools (i.e. systems of qualification, educational platforms, ...), projects at EU, national and regional level with a focus on the advanced materials targeted on green, smart, digital knowledge and impact of COVID 19 in the area of education in VET and HEI

The technological, social, and cultural evolution has brought challenges not only to industries, but also to the creation of training solutions aligned with the industry's needs.

Considered one of the most polluting sectors, and despite the advances made by companies to invest and innovate in the implementation of eco-efficient design principles, the truth is that a large percentage of companies still have many difficulties and a lack of knowledge about tools, materials and processes that help them implement eco-design principles in their products.

The majority of Portuguese companies are micro, small and medium-sized and it is within these that there is a more urgent need to invest in the adoption of intelligent production, in the upskilling or reskilling of the workforce, and to promote a mindset that accelerates the development of new strategies.

One of the objectives of the Portuguese Roadmap Action Plan for a more resilient, sustainable and fair Europe is Vocational Education and Training (VET) to support the transition to a digital and greener economy. According to Eurostat, around 40% of Portuguese secondary school students participate in VET courses. The VET courses of the National Qualifications System lead to a double certification: a school and a professional certification.

The government plan to support the digital transition aims to create a knowledge-focused economy and society, where productivity growth is supported by Innovation and highly qualified people¹³.

Portugal has the most qualified generation ever, but the labour market is constantly changing.

Absorbing national talent, which generates wealth, is only possible with a more robust and innovative economy.

Higher Education has an essential role to support the country's growth in the face of the challenges of climate transition and the ageing of the population. In this sense, education needs to keep up with the evolution of the market to ensure that the competences it claims for are guaranteed in the programmes¹⁴.

During the field research and Living lab companies highlighted the lack of in-house knowledge and skills regarding new digital tools, as well as advanced textile materials. At the same time, the difficulty felt in attracting young people to the sector was also emphasised.

In the collaborative sessions held with companies, VET and HEI the following occupations most impacted by new technologies/challenges were essentially highlighted:

- Green:
 - Technology/innovation/changes: Digital tools and platforms enabling sustainability and circularity.
 - Occupations/profiles impacted by the technology: Sustainability Technicians, Quality Technicians, Planning Technicians.
 - Technology/innovation/changes: Recycled production from raw materials to intermediates and final products.
 - Occupations/profiles impacted by the technology: Designers, Innovation and Product Development Technicians, Planning Technicians, Purchasing Technicians, Timeline Analyst, Supply chain Analyst.
- Digital
 - Technology/innovation/changes: 3D Design.

¹³ Cedefop, *O sistema de educação e formação profissional em Portugal: descrição sumária*, Publications Office, 2021, <https://data.europa.eu/doi/10.2801/359964>

¹⁴ Partnership with Renascença radio and Fundação Francisco Manuel dos Santos. (2022, julho 19). *Desafios do Ensino Superior em Portugal*. Da capa à contracapa – podcast. <https://tinyurl.com/4w8r5e89>

Occupations/profiles impacted by the technology: Designers, Clothing CAD Pattern Maker, Graphic designers.

Technology/innovation/changes: AI, ML, AR and VR in design and prototyping.

Occupations/profiles impacted by the technology: Designers, Computer technicians, Marketing Technicians, Innovation and Product Development Technicians, Digital Marketing Professional.

- Smart

Technology/innovation/changes: Sensors and electronic circuits in e-textile materials.

Occupations/profiles impacted by the technology: Innovation and Product Development Technicians.

Technology/innovation/changes: Quality control

Occupations/profiles impacted by the technology: Quality Technician.

In terms of vocational education and training, the National Qualifications Framework presents almost 30 qualifications for the textile and clothing sector, which are being reviewed in order to adapt the training offer to the current needs of the industry.

The update of the CNQ (National Qualification Framework) aims to carry out diagnostic studies of skills and competences needs, of sectoral scope, as well as the design of the respective competence benchmarks and recognition instruments, validation and certification of professional skills (RVCC Professional).

The CNQ is a tool for the strategic management of non-degree qualifications - levels 2, 4 and 5 of the National Qualifications Framework (NQF) - and for the regulation of their dual certification modalities and recognition processes, validation and certification of skills that exist in Portugal under the National Qualification System. Among its objectives, the production of skills and competences critical to the competitiveness and modernisation of the economy and to the personal and social development of people and the development of a readable and flexible qualifications framework that favors the comparability of qualifications to national and international level.

At this point, the state of the art is being conducted, to integrate the most emergent profiles, skills and competences to the industry. This diagnostic phase is taking place in the same period as the mapping of needs within the scope of the ADDTEX project, which has allowed the achievement of transversal results that are useful for both studies.

Customised training is increasingly in demand and of growing importance. It develops skills in a direct and effective way, focusing only on the essentials of the knowledge to be acquired.

Companies are increasingly open to financing training for their employees when it comes to a bespoke training offer, as they know they will get a return on their investment. The acquisition of adequate technical and practical knowledge translates into productive gains, but also motivational ones.

In terms of training offer, it is possible to find an intermediate level offer in VET entities aimed at middle and senior management of companies through short duration programmes and bespoke training.

At the higher education level, focused on middle and senior management of companies, as well as on new graduates, there are few post-graduate courses available.

The bespoke training offer can cover some of the skills gaps identified by companies, however, there are still gaps in terms of technical training for the most emerging areas associated with industry 4.0, design for circularity and eco-engineering.

As far as vocational and higher training is concerned, there is a long journey to be made and it is urgent to rethink curricula as well as methodologies. The revision and updating of the national qualifications' framework will allow the integration of new qualifications and training paths that better respond to the labour market.

Attached is a list of courses available for the sector focusing on the digital, smart and green transition.

6. Conclusions

Technological evolution and scientific advances have triggered significant advances in both productive processes and management mechanisms.

The last three years, due to the COVID19 pandemic, the acceleration towards a digital, green and smart transition has gained new impulse, requiring a prompt reaction from industries.

The transition becomes a reality in the immediate present, with a greater openness to change.

The growing concerns related to climate change have led to significant changes in production processes, with the introduction of sustainable mechanisms throughout the value chain, not only in terms of productive development, but also, for example, in the creation of digital platforms for the launch of collections.

The Portuguese textile and clothing sector represents a significant weight in terms of employment and turnover, however, we have witnessed a decrease in the capacity to attract young talent, both by companies and by education and training promoters.

Changes in the labour market have generated new demands, both in terms of work processes and raw materials, and in terms of skills and employment trends. Reducing the gap between the supply of training and the demand for skills becomes therefore crucial, as it is essential to reform and project education and training programmes that are able to keep up with the advancement of industry and society.

Industry is aware that this shift to the paradigm of a climate-neutral, resource-efficient, circular, digitalised and robotised economy is mandatory. However, there are difficulties in its implementation, with strong references to the cost associated with the reform of certain processes and equipment on the one hand, and the lack of in-house and market skills on the other hand.

The creation of new jobs, which promote change or even the extinction of others, is a reality assumed but difficult to implement.

The Sustainability, Quality and Planning Technicians, as well as Designers, Innovation and Product Development Technicians, Planning and Purchasing Technicians, Timeline Analyst and Supply chain Analyst were outstanding qualifications as priorities for the implementation of digital tools and platforms enabling sustainability and circularity, as well also for the recycled production from raw materials to intermediates and final products.

Regarding digital technologies such as 3D, AI, ML, AR and VR in design and prototyping the occupations most focused on by companies were Designers, Clothing CAD Pattern Maker, Graphic designers, Computer technicians, Marketing Technicians, Innovation and Product Development Technicians and Digital Marketing Professional.

The occupations of Innovation and Product Development Technicians and Quality Technicians were highlighted by companies in the field of technologies and innovations for the smart transition.

Despite the existing training offer, in the short term the response is still slow, which requires a continuous effort between industry and academia to find a balance between supply and demand, as well as to build offers that encourage and retain people in the industry.

This desk and field research shows a training offer that still does not fully respond to the needs felt by the sector for the smooth implementation of a digital, green and smart transition. The companies highlighted as essential to have training contents that reach the whole industry chain. Training experienced and junior employees will enable the creation of sustainable products and processes, in line with the industrial trend towards digitalisation and circularity. For companies, it is essential that those who are trained are better prepared for the development of production optimisation projects, problem solving, both in the technological and development areas, in order to integrate eco-design and eco-efficiency philosophies.

7. Annexes

Country	Title of resource	Type of resource	Level	Education level	Area	Curricula title	Main topics	Education Level	Websites	Contact (where relevant)
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Green	Sustainable Procurement	Sustainability and sustainable procurement National Strategy for Ecological Public Procurement (ENCPE) 2020 ISO 20400 2017 Sustainable Procurement	VET professional	https://tinyurl.com/mv5rj3zy	academia@citeve.pt
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Green	Ecological, sustainable and circular textile fibres	Ecological, sustainability and circularity criteria Fiber types and examples of ecological, sustainable and circular solutions Methodologies and tools for assessment and communication of environmental impact, level of sustainability and circularity The importance of traceability LCA studies, carbon footprint and environmental statement - scope and objectives	VET professional	https://tinyurl.com/yckmufx9	academia@citeve.pt
Portugal	Fast Track Training	Other	National	n.a. (although more)	Green	SDG - Sustainable Development Goals	The origin and importance of the SDGs Define priorities and	VET professional	https://tinyurl.com/f67mk575	academia@citeve.pt

Country	Title of resource	Type of resource	Level	Education level	Area	Curricula title	Main topics	Education Level	Websites	Contact (where relevant)
				oriented to middle and senior managers in the textile sector)			objectives Integrate the SDGs in the company's strategy Reporting and reporting performance on SDGs			
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Green	Good Sustainability Practices - STeP by OEKO-TEX®	Good sustainability practices based on the modules of the STeP by OEKO-TEX® framework	VET professional	https://tinyurl.com/ykuzshen	academia@citeve.pt
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Green	Sustainable Textile Finishing	Main technologies associated with eco-preparation more ecofriendly dyes more sustainable dyeing technologies and processes more environmentally sustainable pastes and stamping chemicals main eco-friendly stamping and pre-treatment technologies more ecofriendly textile coating products textile coatings with incorporation of waste from different industries criteria for selecting chemicals for certification of sustainable products	VET professional	https://tinyurl.com/y82s999s	academia@citeve.pt

Country	Title of resource	Type of resource	Level	Education level	Area	Curricula title	Main topics	Education Level	Websites	Contact (where relevant)
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Digital	Data Analysis in the Textile Sector	Analysis of Sources of Data Data import Data inspection Descriptive analyses Improving the quality of data Data exploitation Data visualization Introduction to predictive approaches	VET professional	https://tinyurl.com/mryjzdc5	academia@citeve.pt
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Green	Communication for Sustainability in Fashion	Communication for Sustainability in Fashion New Age Factors and Trends New materials and life cycles Sustainable Thinking and Design Certifications, tools and key indicators New economies and new business models Product strategy, content marketing and customer communication Greenwashing	VET professional	https://tinyurl.com/ycknw66	academia@citeve.pt
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Green	New Materials and Textile Solutions for Sport	Properties/functionalities of textiles with application in the field of sport Trends and challenges New Materials (fibers/yarns and textile structures) and textile solutions for the field of Sport Performance evaluation	VET professional	https://tinyurl.com/mry54tu8	academia@citeve.pt

Country	Title of resource	Type of resource	Level	Education level	Area	Curricula title	Main topics	Education Level	Websites	Contact (where relevant)
Portugal	Fast Track Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Green	GOTS/OCS and GRS/RCS Certification Requirements	GOTS (Global Organic Textile Standard)/OCS (Organic Content Standard) GRS (Global Recycled Standard)/RCS (Recycled Claim Standard)	VET professional	https://tinyurl.com/2tjp94br	academia@citeve.pt
Portugal	Modular Training	Other	National	n.a. (although more oriented to middle and senior managers in the textile sector)	Digital	CAD - Computer Aided Modelling	Analyse the technical data sheet or technical sketches. Techniques and methods of creating details, details and basic patterns using the CAD system. Techniques and methods of transformation of basic patterns using CAD system. Garment projects. Techniques in the execution of design, transformation, grading and execution of cutting plans, according to the pre defined specifications, using the CAD system.	VET professional	https://tinyurl.com/n36hdwww	
Portugal	Post-graduation	Other	National	HEI professional	Green	Circular and sustainable water design	Blue Economy, Sustainability, Maritime Transport, Shipbuilding, Food Biotechnology and Nautical Documentary.	HEI professional	https://tinyurl.com/4k79f53f	
Portugal	Erasmus +	Project	EU	HEI initial	Green	Progressive sustainability in fashion	Progressive Sustainability in Fashion: Design and Product Development in the Context of Material	HEI initial	https://tinyurl.com/52753u2b	

Country	Title of resource	Type of resource	Level	Education level	Area	Curricula title	Main topics	Education Level	Websites	Contact (where relevant)
							Culture; Possibilities within circular economy strategies in the Fashion Design universe: circular design, extension of the garment life cycle and communication towards circularity.			
Portugal	Post-graduation	Other	National	HEI professional	Green	Postgraduate Diploma in Innovation for Sustainable & Regenerative Business	Sustainable and Regenerative Businesses', focused on circular business solutions and not violating social and environmental boundaries, driven by technology and disruptive innovation.	HEI professional	https://tinyurl.com/37txda jr	