AddTex

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

WP2 Czech 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):	CLUTEX
Target Group(s):	Institution
Distribution level:	Partnership
Total number of pages:	19
Version:	Final
Language	English
Reviewed by:	Peer review
Status:	Final
Delivery date:	06.01.2023

Version control:

Number	Date	Description
1	06.01.2023	Final

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Contents

1. Introduction

The textile industry in the Czech Republic (CR) maintains an important position despite its decreasing in the past (between 2004 and 2021 a decrease of 51%). However, the slowdown was accompanied by restructuring and a focus on the technical textiles segment, which has the potential for higher added value and applications in several areas with specific needs - as an example automotive, healthcare, social personal services, construction, agriculture, special clothing, etc. The specific needs of these sectors led to the ever-higher demand for knowledge in the field of electrical engineering, physics, chemistry, biology, IT technology, and their reflection into new functional materials, technologies, etc., i.e. the development of **multidisciplinarity**. The perspective specialization of the Czech textile industry are nanofibers and nanotechnologies.

A significant presence of the textile industry in the CR remains in the NUTS II Northeast, as well as South Bohemian and South Moravian regions. These regions specialize in the textile industry as part of their RIS 3 strategies. High relevance is the solution of the **circular textile industry** because the CR is among the **10 largest producers of textile waste** (Italy, Germany, France, Belgium, Poland, the Czechia, the Netherlands, Portugal, Spain and Austria), and dominates in the production of textile waste per inhabitant (12 kg compared to the EU average of 5 kg/inhabitant).

Gap analysis processing procedure:

- **Desk research at the EU and national level** - industry, VET and HEI education, WBL methods and COVID impact
  - we studied essential strategic EU documents and studies relevant to our topics in twin transition during July to September. Advanced textile materials require advanced knowledge, so we also studied the relevant research and innovation trends set by ETP, as well as RIS3 specializations. This this part was directed to the smart topic. An EU report was prepared. A subcontract was carried out for desk research in the national HEI education section, the result of which is a report. The author is the textile faculty of the Technical University in Libberec - the only textile faculty in the Czech Republic.

- **Meetup and industry field research**
  - **MeetUp** was held in presence on 4th October 2022 with 9 companies, 3 VET and 1 HEI**, industry field research** took place on the same day. There was a discussion on the results of the desk research, companies expressed their view on the weak and strong sides of the advances textile industry, identified the main challenges and threats. At the same time, they formulated the knowledge that these challenges require. The SWOT analyse was developed.

- **VET and HEI field research**
  - the education field research was held online on 21st November 2022, 3 VET and 1 HEI took part in this session. We discussed results of desk research and current offer of educational modules, WET education methods and the reflection of COVID. Representatives of education expressed a great interest in deepening cooperation with companies and a detailed discussion about the needs of the company in connection with the twin transition and the need for advanced knowledge and skills

- **Living Lab**
  - Joint meeting on 23th November gathered 7 companies (10 represenatives), 2 VET (4 representatives) and 1 HEI (3 representatives) 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. Each of the chapters represents one of the phases of finding out information to determine the gaps, which will be the focus of further project activities.

From identifying the main trends and challenges that companies must respond to, to mapping existing projects and activities, i.e. what knowledge companies have, to identifying the current education offer, identifying gaps, identifying barriers and schools' needs. The output is the main topics that are proposed for the upcoming MOOC course as well as other tools for the development of knowledge and skills in companies.

2. Technologies / innovation /documents /tools

The technologies and tools identified as the most important technological changes that will affect the textile industry in the region are exposed in this chapter. 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 global trends, strategic framework and feedback received by the Czech industry, together with the VET and HEI collaborating.

Companies perceive the trend of sustainable development as the main challenge, they consider digital technologies as a means that can significantly contribute to green goals.However, all the companies involved also emphasized problems in the area of energy intensity and disproportionate cost increases. They often mentioned, for example, that connected with eco-design and product planning with regard to environmental aspects, it must also be connected with modeling the energy intensity of production processes. The area of advanced textile materials must therefore be closely linked with the area of advanced textile engineering and production technologies.

Particular technologies/innovation/changes are presented, if possible, in the sequence of the circular model

2.1 Green transition

Technology/ innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
Life Cycle Assessment (LCA) (and other Life Cycle analysis)	The essential part of the circle economy, analysis of all the environmental impacts associated to a product or a process. In these cycles are included inputs such as materials, energy, transport, communication with the customer, sales, end-of-life phase of the product and its recycling, waste as a resource for further production. This process takes into account outputs like greenhouse gas emissions, water treatments, chemicals by-products. This methodology is still incipient in industry.	All the process, including the reuse, recycle and end of life behavior.	https://cordis.europa.eu/project/id/628 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022D2508&qid=1671517820694
Ecodesign	Ecodesign is a systematic process of designing and developing a product and manufacturing processes, which, in addition to classic features such as functionality, economy, energy and virgin resources, safety, ergonomics, technical feasibility, aesthetics, etc., places great emphasis on achieving a minimum negative impact of the product on the environment, from the point of view of its entire life cycle	All the process, including the reuse, recycle and end of life behavior.	http://www.ecosign-project.eu/wp-content/uploads/2018/09/TEXTILE_UNIT08_EN_lecture.pdf
Water reduced processes	Water consumption and contamination is one of the main problematics in the textile industry. Many textile processes, such as cleaning, bleaching, finishing, dyeing and printing are one of the most consuming industrial processes.	Cleaning, dyeing, printing, finishing,… processes	https://cordis.europa.eu/project/id/642494
PFAS chemicals, microplastics	Perfluorinated substances are a significant burden on the environment because they are difficult to degrade	Design of product, use of the product, its maintenance (e.g. washing) recycling of waste	https://sustainfashion.info/the-use-of-perfluoroalkyl-and-polyfluoroalkyl-substances-pfas-in-textiles/

			https://www.gore-tex.com/sustainability/protect-the-planet/reduce-chemical-impacts
Collecting and recycling technology	Compulsory collection of textiles will be introduced from 2025, it is necessary to develop sorting lines, recycling technologies, efficient sorting of textiles according to composition, color, or other attributes	Waste as a resource	https://www.fibersort.com/
Clothing as a service	a business model that allows you to return the clothing after it has been worn to the seller (manufacturer), who then recycles the clothing (material), has a greater overview of the material, recycling is facilitated	Waste as a resource	https://mudjeans.eu/

2.2 Digital transition

Technology/ innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
Digital collaboration plaformes	Digital environment for Factories 4.0 collaboration and the development of business models in cross-industry business in a circular economy environment	All processes of circular economy	https://www.digiprime.eu/project/
Virtual design of garments	CAD/CAM, AI software tools for 3D modelling of apparels, fashion	Design of product, production, communicazion with customer	http://www.inventex.eu/en/oferta/inventex-fds-virtual-garment-and-textile-designing-tool/
Machine learning	Technology enabling defect detection, quality control of product, print, pattern, also train to accept defects within a certain error range. After feeding it numerous good, bad, and acceptable patterns, it will be able to distinguish completely bad knit patterns from very slightly incorrect but still acceptable patterns.	Production	https://metait.cz/snizujeme-chybovost-jersey/
Blockchain	The technology is a special type of distributed database storing an ever-expanding number of records that are protected against unauthorized intervention both from the outside and from the involved subjects themselves. Possibilities for a tracking system of textiles are being explored,	Traceability of product, digital passport of product	https://www.trick-project.eu/

2.3 Smart transition

Technology/ innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
Smart textiles	Textiles enabling the integration of electronic functions, now a current topic of autonomous charging of these systems - especially solar cells and their connection with flexible storage systems	Utility value of textile, product manufacture, recycling	https://www.applycon.cz/index.php/produkty/nositelna-elektronika/
Recycling of mixed materials	Recapture of raw materials from non-reusable products (primarily from textile fibers, not from PET bottles)	Raw materials production, product manufacture, recycling	Worn Again https://wornagain.co.uk/ FIB FAB https://cordis.europa.eu/article/id/300714-renewable-durable-clothes-are-a-fibfab-fit-for-a-green-future
Biobased fibers	Design of bio-based polyamides and polyesters from renewable feedstocks rather than crude oil, and manufacture greener and structurally improved fibers and films. We also intend to showcase the use of our bio-based ingredients in a wide array of mass-produced consumer products across multiple markets, such as construction, automotive, packaging, garments, carpets and textiles.	Raw materials	https://www.effective-project.eu/The-Project/
Nanomaterials	Nanofibers with diameters in the nanometer range. Nanofibers can be generated from different polymers and therefore have different physical properties and application potential – health, environment, filtration, decontamination, industry, air cleaning, energy storage	Utility value of textile, product manufacture, recycling	https://www.contipro.cz/portfolio/4SPIN-zarizeni-pro-nanotechnologie?cpnb_method=cpnbCookiesDeclined

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

3.1 Strategies, studies, tools

Strategy of the textile and clothing industry until 2025
http://www.atok.cz/folders/Strategie_TOP_do_roku_2025.pdf

The Association of the Textile and Clothing Industry is professional organization, a member of the Europan textile platform, has an established ATOK platform for the circular economy, is a member of the EURATEX confederation and involved in its working groups for the circular economy, traceability and for perfluoroalkyl chemical substances (PFAS). This strategy review development scenarios, recommending focus on development of advanced technologies and unique products and the active, consistent processing of European and non-European markets, emphasize social responsibility and long-term sustainability both in relation to the regions in which it operates and to the supply destinations. as problems defined mostly collectively. Focus on technical textiles, gradual transition to smart textiles, which creates the need for a higher proportion of R&D, higher added value of upgrading the skills of workers

Foresight of research trends in the Czech textile and clothing industry and regional innovation S3 activities
https://ctpt.cz/img_webimg/img_editor/soubory/Foresight_vyzkumnych_trendu_CTPT.pdf
ČTPT – Česká technologická platforma pro textil (The Czech Technological Platform for Textiles)

Trends, their impacts, opportunity for companies and research were definedrends affecting the textile and clothing industry (TCI). Subsequently, relevant research topics were proposed for the cooperation of research and companies.
In the area of advanced materials and the area of green and digital technologies and processes, the focus is on:
Green: dematerialization, recyclability of raw materials, circular models, minimization of raw material consumption, waste processing, repeated use of water, materials, chemicals, reduction of energy intensity, climate protection – reduction of production of greenhouse gases and pollutants, biomaterials,
Digital: digital technology in prototyping, virtual modeling, digitization of production processes, e-commerce, integration of communication, monitoring and "smart" responsive elements into textile substrates; data processing, dematerialization, linking with the user sphere and professional maintenance; personalization
Smart products: e-textiles changing their utility properties based on external stimuli measured by surrounding sensors, wearable electronics, functional materials, composite structures, composite materials

Research and Innovation Strategy for Smart Specialization
https://www.ris3.cz/en

In terms of advanced textile materials, the focus is as follows: intelligent materials, nanomaterials, biomaterials, metal, composite, polymer, textile and other materials), New non-wovens and smart textiles, smart apparel with sensing functions, Advanced fiber-based materials including hybrid textile structures, multifunctional textile structures, structures capable of generating energy, structures with integration of sensors and other electronic ones elements, nanofibrous scaffolds for the growth of microorganisms and cells for broad-spectrum applications, new filter materials and technologies, biotechnology in relation to textile structures (e.g. substitution of chemical processes, creation of functional properties of textiles, use of enzymes, use of biopolymer and biomass, replacement of fossil materials, Photonics and micro/nanoelectronics in connection with textile structures and fibers (transmission of electrical impulses, integration of sensors, provision of data communication options), etc.
RIS3 also responds to social challenges, in the form of so-called missions. Advanced textile industry and advanced textile materials will find application especially within the mission "Efficiency of material, energy and emissions the demands of the economy". This mission is of critical importance for both green and digital transformation

Digital Czechia - Strategy of coordinated and comprehensive digitization of the Czech Republic 2018+
https://www.digitalnicesko.cz/

"Digital Czechia" is a set of concepts and implementation plans ensuring the prerequisites for the long-term prosperity of the Czech Republic in the environment of the ongoing digital transformation
Supporting the development of artificial intelligence in various sectors of the economy, high-performance computing, open data sources, new technologies and innovative business models
Promoting interoperability between sectors and the adoption of digital technologies across sectors of the company

One of the concrete impacts of this strategy is the creation of a **network of european digital innovation hubs in Czechia-** https://digital-strategy.ec.europa.eu/en/activities/edihs, which will help SMEs with digital transformation

Waste Management Plan 2015 – 2024

https://www.mzp.cz/C1257458002F0DC7/cz/plan_odpadoveho_hospodarstvi_aj/$FILE/OODP-WMP_CZ_translation-20151008.pdf

The plan focuses on the prioritization of waste management methods according to the waste management hierarchy and the fulfillment of European goals in all areas of waste management.
A detailed analysis of waste streams was carried out for **textiles**.
Weaknesses were identified insufficient

- separate concentration of textile waste
- consideration of long-term functionality, repairability or recyclability of products in their design and production
- information on substances of concern and their potential presence in recycled materials and products made from recycled materials
- level of innovation in all parts of the economic and life cycle of products
- Lack of respect for the hierarchy of waste management
- Prioritizing cheaper technologies for waste treatment at lower levels of the waste management hierarchy

Opportunity was identified as:

- Material ecodesign
- Increasing the intensity and quality of awareness and education in the area of the circular economy
- Innovation in the field of more efficient processing of raw materials, materials and waste
- Development of material recycling
- Development of thermal depolymerization technologies and subsequent physical-chemical recycling of waste
- Digitization in the monitoring of material flows
- Digitization in monitoring the content of substances in waste
- Development of capacities, projects and platforms for the reuse of things
- Green public procurement with an emphasis on the circular economy
- Support for environmental labeling and the EMAS environmental management and audit system

Threats:

- Increasing presence of microplastics from waste in the environment
- The presence of dangerous and suspicious substances in waste recyclates

Project SS02030008 Center for Environmental Research: Analysis of textile waste flows in the Czech Republic

https://www.cenia.cz/wp-content/uploads/2022/08/ZP-PZ_abstrakt_Shtukaturova_CJ.pdf

Two main streams were identified, namely industrial textile waste and textile waste from households. The results showed that in the production of industrial there was no significant increase in textile waste: in 2010, the amount of industrial textile waste was 70,405 tons and in 2019 87,840 tons. The opposite situation is with textile waste from households: in 2019, production was 37,393 tons and compared to 2010, it is almost ten times higher. In addition long-term analysis of mixed municipal waste (MSW) samples showed that the samples contained around 7% of different types of used textile products that could be suitable for recycling.
Surprisingly, according to the MFA, based on official data, mainly more complex textile waste is recycled from households, while more homogeneous industrial textile waste with a known composition is more common landfill or incinerate. Our results confirm that the **Czech Republic is not well prepared for compliance of the ambitious recycling targets** of the Action Plan in connection with textile waste for reasons constantly increasing volumes of this type of waste and hard-to-find official statistics on its production, the lack of recycling technologies and the obsolescence of the waste collection system

National network of European Digital Innovation Hubs

https://digital-strategy.ec.europa.eu/en/activities/edihs

The EDIH network was established in the Czech Republic - these are independent entities or coordinated groups of entities (consortia) with complementary expertise and a non-profit goal that support the digital transformation of enterprises and public sector organizations at the regional level. They are supposed to provide services to entrepreneurs

precisely in the field of digitization. These are technologies, training, testing, various prototype solutions. Furthermore, information on the market situation or various business models. The goal is for workplaces in individual European countries to become technology contact centers. They are supposed to provide digitization services to entrepreneurs in the given regions

COVID 19 and its impact on business

https://amsp.cz/wp-content/uploads/2021/03/Ipsos-pro-AMSP_Covid-a-Zm%C4%9Bny-v-podnik%C3%A1n%C3%AD_FINAL-_TZ.pdf

The main goal of the research was to find out how business entities perceive changes in their business in the context of a pandemic situation. Questionnaire survey, 188 enterprises, collection took place 1 - 15 February 2021
2 out of 3 small and medium-sized enterprises have been negatively affected by the situation surrounding Covid-19. Most often due to a decrease in orders or the need to interrupt/reduce activities. 3 out of 10 companies had to tap into financial reserves due to the situation. Same ratio companies postponed investments due to the pandemic. A moderate majority (55%) of negatively affected businesses expecedt that the recovery from the crisis will be theirs will take more than a year. 24% subjects have significantly expanded their homeoffice, half of subjects feel increase pressure to digitalize, this applies primarily to companies, new technologies have helped many not to fall to the bottom. 3 out of 10 companies speed up the digitization process due to COVID-19. 2/3 of the subjects said that the crisis has not affected the digitalization process. The situation surrounding Covid-19 has clearly rapidly accelerated the use of communication platforms such as Zoom, Teams, Webex, Google Meet, etc. It has also accelerated the online version of certain services and products in the field of education and the consumer market. On the other hand, it is evident from the survey that companies have been working with digitization for a long time, and the pace of digitization, for example in production, is not directly dependent on unexpected external factors. Services, on the other hand, offer an explanation that they achieved a relatively high degree of digitization even before the covid era

3.2 Projects

Name	**EXTRATEX - European framework for cross-sectoral innovation in the fields of textiles-transport-sustainability and excellence for industrial clusters**
Area	**Green**, advanced materials
Description	The project brings together clusters from various strategic sectors of European industry with a high potential for cooperation. Namely, it concerns the fields of textiles, transport and sustainable materials, plastics, it also deals with connections with COVID.
Link	https://extratex.eu-vri.eu/

Name	**RESET – Research Center of Excellence in Textile Industry**
Area	**Green**
Description	RESET addresses 6 key themes: Recycling in textile and waste disposal, Water consumption and energy saving, sustainable company organisations, New sustainable chemistry, including reduction of chemical substances, Smart textiles and new ways of production, Eco-creativity, natural fibres, short value chains, New materials and new application
Link	https://projects2014-2020.interregeurope.eu/reset/

Name	**ENTeR – Expert Network for Textile Recycling**
Area	**Green**
Description	ENTeR has developed a system capable of enhancing the value of industrial textile waste based on the characterization and classification of their properties and using an online platform (M3P) for the matching of “materials and waste”. Project realized - 9 pilot cases - 5 training modules - Textile waste database - Strategic Agenda and Action Plan
Link	https://www.interreg-central.eu/Content.Node/3.html

Name	DiGi Prime – Digital Manufacturing Platform for Connected Circular Smart Factories
Area	Digital
Description	Project develops the concept of a circular economy digital platform in order to create circular business models based on the data-enhanced recovery and reuse of functions and materials. Project activities contains for instance the Product Avatar tool, which is a software solution that allows different actors to manage the information related to a real Product during its ongoing lifecycle. The actors that interact with the Product information can have different roles and can be working in different companies. Through the Product Avatar it is possible to search all the information already saved in the platform, related to a specific object.
Link	https://www.digiprime.eu/

Name	TRICK – Empower Circular Economomy with Blochchain Data Traceability
Area	Digital
Description	Project supports the adoption, tracing and demonstration of **sustainable approaches** by means of an **innovative and circular product information management system** based on **Blockchain** and able to provide stakeholders of the supply chains and final consumers with all the relevant data needed to implement end of waste practices and aware purchasing choices.
Link	https://www.trick-project.eu/

Name	Better Factory - Grow your manufacturing business' — 'Better Factory'
Area	Digital
Description	In the frame of project is a RAMP (Robotics Automation Marketplace), free and open IoT (FIWARE) platform available, it is running on state-of-the-art servers with access to cloud storage and computing, enabling connection to robots, sensors, cameras, AR/VR and other equipment. RAMP will provide a 3D simulation tool to create a Digital Twin for virtual testing, a team building space for online collaboration between other digital services.
Link	https://betterfactory.eu/

Name	BETITEX - Development of sustainable textiles against bugs
Area	Smart
Description	Project which aims to obtain textile materials protecting humans against ticks and bedbugs.
Link	http://www.betitex.eu/

Name	NANOFASE - Nanomaterial Fate and Speciation in the Environment
Area	Smart
Description	Project is aimed at prediction of environmental distribution, concentration and form (speciation) of nanomaterials, to allow early assessment of potential environmental and human exposure and risks, to facilitate safe product design and to include these aspects in nano regulation.
Link	http://www.nanofase.eu/

Name	BleNaBis - Blends of Natural and Biosynthethic fibres for eco-efficient yarns
Area	Smart
Description	BleNaBis deals with research into the possibilities of applying renewable fiber sources - fibers from oilseed stalks (waste from the production of a nutritional source), bio-polyamide and their mixtures for the production of yarns intended for interior textiles. The aim is to ensure the usability of renewable fibrous biodegradable materials as a replacement for synthetics from fossil sources and thereby reduce environmental burdens.
Link	https://starfos.tacr.cz/cs/project/EG15_007_0001812

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?

Industry field research was the main source for finding innovations relevant to green, digital and smart processes. Representatives of the companies identified the main strengths and weaknesses, challenges and threats, and a SWOT analysis was created during the session.
The area of green transformation was seen as key sphere. The companies have declared their interest in production with a low impact on the environment, but at the same time they name the legislation related to the Green Deal and the Strategy for the sustainable textile industry as a key part of their further activity. They named as the main focus areas following:

- **Legislative** – new requirements appear, small sub-divisions do not have the capacity to monitor everything and apply it professionally
- Knowledge about the **lifespan of materials** - they are interested in a course that would focus on information on how to assess the lifespan of materials, how to increase it, and what decreases it
- **Biodegradability and compostability** – use of the properties of textiles only for a specified period of time, prerequisites for the degradability of materials without negative impact on the environment
- **Recyclability** – information about what properties a textile product must have (material composition, design,...) in order to be recycled, knowledge about recycling technologies
- **Energy intensity** of production – practical examples and instructions for production design and consideration of ecodesign requirements according to the relevant guidelines, economic aspects and analysis
- The **investment requirement** of green technologies
- Setting up a comprehensive **system of collecting and using textiles**, this is a completely new element
- **Composition information flows** - importance of storing information on the composition of materials - it would allow easier recyclability

- What does innovation relevant to smart mean for companies and where is innovation in the processes

As part of the discussion on the development of advanced textiles, **multidisciplinarity** and the ability to work together in teams of specialized experts with a wide range of knowledge were emphasized. Advanced textiles with specific properties need advanced knowledge for their design and production - **electrical engineering, physics, mathematics, chemistry, biology, IT**. Smart textiles were most often associated with **wearable electronic elements, nanotechnologies and biomaterials**. The need to constantly expand one's knowledge of materials - especially **materials from recycled raw materials**, the ability to evaluate the **properties of recycled fibers**, to solve the specific needs of the **production of recycled fibers** and related phenomena - such as the release of **microfibers and microplastics**, recycling of mixed materials, was emphasized.

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

Digitization is perceived as an area with high potential, but the biggest gap in knowledge is perceived here. The following areas were mentioned most often:

- **Data** collection and sorting, methods of evaluation
- **Visualization** tools for product design and production modelling
- **Online platforms, websites, configurators** - all this for communication with the customer, presentation
- **IoT** – knowledge for remote connection of text components to the Internet, control, matching of functions
- **AI – machine learninig** – production quality monitoring, sample evaluation
- **Digital passport** of the product and technologies that allow the desired information to be stored and displayed
- **Blockchain** – there are still no concrete examples of use here,
- **Cybersecurity** – this area is important, companies see this as a barrier to wider use of digital platforms, cloud, distributed databases.

The above-mentioned areas are reflected in different ways in the content of individual job positions in the textile industry

4.1 Manager

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	Life Cycle Assessment (LCA) (and other Life Cycle analysis)	Sustainable transport and logistic systems	New developments in logistic management and transports
	Ecodesign	LCA software, LCI preparation. Report interpretation	Report interpretation and LCI preparation
	Water reduced processes	Environmental regulations and policies	Changes and new environmental regulations and policies
	PFAS chemicals, microplastics	Smart materials, Woven and nonwoven textiles, electronics, sensors	Raw materials, electronics, sensors, applications
	Collecting and recycling technology	Digital technologies	AI and Blockchain. Data management
	Clothing as a service		
	Digital collaboration plaformes		
	Virtual design of garments		
	Machine learning		
	Blockchain		
	Smart textiles		
	Recycling of mixed materials		
	Biobased fibers		
	Nanomaterials		

4.2 Textile engineer

Textile engineers 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.

Functional areas of the company	Technology/innovation/ Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed
	Life Cycle Assessment (LCA) (and other Life Cycle analysis)	Raw materials, Biobased and sustainable colorants and auxiliary materials, Emerging sustainable processes, BAT (Best Available Techniques) application and implementation.	Emerging techniques and materials, BAT's, Recycling, Process optimization. Ecodesign

Production, Logistics, Quality and Waste management departments		Recycling procedures and materials. Ecodesign	
	Ecodesign	Smart materials, Woven and nonwoven textiles, electronics, sensors	Electronics, sensors
	Water reduced processes	Digital technologies	AI and Blockchain. Data management
	PFAS chemicals, microplastics	LCA software, LCI preparation. Report interpretation	Report interpretation and LCI preparation
	Collecting and recycling technology		
	Clothing as a service		
	Digital collaboration plaformes		
	Virtual design of garments		
	Machine learning		
	Blockchain		
	Smart textiles		
	Recycling of mixed materials		
	Biobased fibers		
	Nanomaterials		

4.3 Technicians and Operators

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.

Functional areas of the company	**Technology/innovation/ Changes**	**Knowledge needed to perform the process**	**Priority Training Topics to be addressed**
Production and logistics	Life Cycle Assessment (LCA) (and other Life Cycle analysis)	Process optimization and BAT's technologies	Process optimization and BAT's technologies
	Ecodesign	Report interpretation	Report interpretation. Issues detection
	Water reduced processes	Production techniques, raw materials	Raw materials, production methodologies, electronics
	PFAS chemicals, microplastics	Digital technologies	Data management, input data, software interaction
	Collecting and recycling technology		
	Clothing as a service		
	Digital collaboration plaformes		
	Virtual design of garments		
	Machine learning		

	Blockchain		
	Smart textiles		
	Recycling of mixed materials		
	Biobased fibers		
	Nanomaterials		

5. Initial and further education on advanced textiles

The focus in the area of initial education on secondary education and higher education is given In the description of the educational offer for the textile industry, in the area of professional education the offer of continuing education courses and online education, which is mostly the product of projects supported by the EU or private initiatives.

Initial secondary education in the Czech Republic is divided into the education programme "Textiles" and educational programme of "Clothing". Textiles is a technologically oriented programme. This programme is offered by only one school school, namely the Secondary Technical School of Textiles in Liberec (https://www.texlib.cz/), educational programme " Clothing" with a higher representation of design subjects is offered at several schools in the Czech Republic, it is rather artistic and craft oriented. Higher education for the textile industry is offered by only one faculty in the Czech Republic, namely the Faculty of Textiles of the Technical University in Liberec (https://www.ft.tul.cz/en/).

VET professionals in the textile field are offered by several organizations: TZÚ - Textile Testing Institute (https://www.tzu.cz/vzdelavani), ATOK - Association of Textile and Clothing Industry (http://www.atok.cz/141-projekty. html), INOTEX – a company focusing on research, development, service and technology transfer in the field of textile refinement and new technologies (http://www.inotex.cz/e-learning.aspx), ČTPT – Czech Technological Platform for Textiles, INCIEN – a non-profit organization focusing on the promotion of the circular economy (https://incien.org/publikace/ , https://incien.org/circularnizadavani/), last but not least also the company matériO – a library of materials (https://www.materioprague.cz/towards-sustainability/).

A more detailed overview of existing programs and courses is provided in the appendix. A detailed report was prepared for the HEI education desk research (Textile Faculty of the Technical University in Liberec), which details the types of educational programs, focus of individual courses, focus of research, types of WBL, impact of COVID, etc.

5.1 Strategies, documents, tools

Strategie vzdělávací politiky ČR do roku 2030+
https://www.msmt.cz/vzdelavani/skolstvi-v-cr/strategie-2030
A key document for the development of the educational system of the Czech Republic in the decade 2020 – 2030+. The aim is to modernize the Czech education system in the field of regional education, interest-based and informal education and lifelong learning, prepare it for new challenges and at the same time solve problems that persist in Czech education

The National System of Occupations
https://www.nsp.cz/odborny-smer/textilni-a-odevni-vyroba
The National System of Occupations is an open and publicly available internet database of information on occupations that occur on the Czech labor market. It is created by employers through sector councils as their representative representatives, and the state is the guarantor.
The given link is directed to the occupations listed in the textile and clothing industry.

The Central Database of Competences
http://kompetence.nsp.cz/
Competences represent a sum of knowledge, skills, abilities, attitudes and values enabling the application and personal development of an individual. It is the language in which the requirements for a worker are described in the National Occupational System. They express prerequisites for the performance of a certain set of activities. They say what the employee should know, be able to do and how to behave.

The National System of Qualifications
https://www.narodnikvalifikace.cz/
The portal is an information base on the system of nationally recognized professional qualifications in the Czech Republic. This tools publishes information about professional qualifications as of today approved and applicable on the labor market in the Czech Republic. This website infrms about everyone news and events in the field of verification and recognition of the results of another education in the Czech Republic.

Project Competence 4.0
https://www.mpsv.cz/documents/20142/372813/2W_Kompeten%C4%8Dn%C3%AD+pyramidy+a+New+Skills+Monitor.pdf/fef6d92b-ef1b-da10-70e3-dd52de104405

1. Analysis of methods of mapping future competencies using foreign ones experience, determination of priority sectors with the impact of Industry 4.0 on the marketwork and elaboration of the methodology for mapping future labor market competencies
2. Networking of experts – establishment and operation of sectoral working groups, training for the professional public
3. Expansion of the Central Competence Database (CDK) with future competencies in selected industries (textile industry is not a focus, but some competences are relevant)
4. Creation of sectoral competence pyramids in individual sectors with linked to the field of education
5. Support of dialogue between employers and educators at the regional/local level
6. Enforcing conditions for the implementation of outputs

5.2 Projects

Name	**EDTEX**
Area	**VET general**
Description	Comparative studies Comparison of the level of vocational education in selected countries - Using the strengths of school programs - To facilitate the integration and employability of young people who are interested in studying T+C industry fields - Support for cooperation between the educational and employer spheres the output is not e-lelarning, cooperation
Link	https://erasmus-plus.ec.europa.eu/projects/search/details/2016-1-CZ01-KA202-023832

Name	**SKILLS4SMARTEX**
Area	**Digital**
Description	Multidisciplinarity for smart textiles - MOOC to use mathematics, physics, materials science and electrical engineering for smart textiles in the areas: • novel fibers and yarns • material and methods • smart textile design • smart textile prototyping manufacturing • data processing • testing of smart textiles
Link	https://erasmus-plus.ec.europa.eu/projects/search/details/2018-1-RO01-KA202-049110

Name	**OPTIMTEX**
Area	**Digital**
Description	1. Course of textile software applications with 5 modules: Design software for weaving Design software for knitting Design software for virtual prototyping of clothing Design software for embroidery Design software for experimental design of e-textiles; 2. A Guide for tech-transfer and for applying software solutions within textile enterprises; 3. A free web e-learning instrument for quick access to the project's educational materials; 4. The project's website with digital & multimedia content on tech-transfer - www.optimtex.eu

	5. A Moodle e-learning platform with implemented courses in national languages - www.advan2tex.eu/portal/
Link	www.optimtex.eu

Name	**MODISTO**
Area	**Green**

Description	- To develop a course in e-learning modality to be used as support for VET teachers, whose contents will be related to eco-design and sustainability, and its use intended for the clothing and fashion sector.
	- To promote and disseminate the e-learning course within VET centers in the four participating countries.
	- To make the resources of the e-learning course openly available and promoted at international level as an open educational resource
	  - Principles of ecodesign.
	  - Sustainable materials.
	  - Eco-labeling and certification
	  - Sustainability criteria in the fashion and clothing sector

Link	https://proyecto-modisto.eu/cs

Name	**ECOMODA**
Area	**Green**
Description	environmentally friendly materials in textile and fashion sector training and educational opportunities and pathways EU experience opportunities and job career development in fashion best practices in textile and fashion sector enterprises ethical fashion; The Training Course will comprise four modules focusing on different aspects of fashion in partner countries such as policies and practices, useful information on sociocultural changes, new frameworks regarding fashion trends, etc.
Link	https://ecomoda-programme.eu/

Name	**TWIN Revolution – ongoing project**
Area	**Green**
Description	The aim of the project is to develop an innovative and interactive tool and training course that will strengthen and requalify vocational education and training students and provide them with the necessary digital and "green" skills and competences.
Link	https://twinrevolution.eu/

6. Conclusions

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

Desk research as well as field research showed that, despite the decline of the textile industry in the past 20 years, the initial professional textile education and professional knowledge base has been preserved, both for middle-level workers and for university graduates. Topics associated with green and digital transformation are not processed in the form of a comprehensive program. Topics associated with green and digital transformation Professional organizations provide VET education. Despite the indisputable impact of COVID on the development of online educational platforms, we note that the offer of online education does not have the character of MOOC educational modules in green and digital transformation, rather partial webinars are available. However, the focus on green topics in secondary school curricula does not fully meet the new requirements of companies, but schools are open to modifying school educational programs. For example, environmental issues are focused only on understanding the framework context, new concepts, such as ecodesign, are still missing and are being addressed on a pilot basis within a sub-project focused on the clothing industry.

Educational programs at universities correspond to the needs of companies to a better extent, but online education is very limited, currently it is only offered in partial areas of textile technology. From this point of view, there is still a significant lack of availability of knowledge for textile companies and other people interested in knowledge in the textile industry.

Companies welcome the initiative of open educational platforms and other forms of education of experts. Companies implement forms of Worked Based Learning in the form of excursions, internships for pupils and students at companies, participation of company employees in lessons (tandem teaching), processing of student works on a topic given by the company, etc. Schools have school workshops available, pupils have the opportunity to set up so-called fictional company (can also be a real company - especially for HEI students)

Businesses are interested in developing digital skills. There is a reasonable assumption that the spread of digital technologies would increase interest in the film industry among young talents.

The survey clearly showed that there is an increasing need for science knowledge - physics, chemistry, biology, polymers, as well as a digital focus.