



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

## **WP2 Slovene National Report**



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## 1. Introduction

TITERA, Slovenia, participating in the ADDTEX project as consulting company and technology provider, dedicated to supporting strategy definition and quality plans, based on the company's broad experience in the topic of interest of Addtex project.

Between September and December months, TITERA conducted desk research in preparation for field research with numerous Slovenian textile companies, and educational institutions and organised an online Living Lab event. Desk research included the search for innovations in fields of green digital and smart among Slovenian textile companies and higher education organisations and their study courses. The research was conducted online, through internet browsing, oriented to seek technologies, programs, services, products and materials in the field of green, digital and smart. After desk research was concluded, intensive online sessions with Slovenian textile companies took place where we obtained information on what knowledge about green digital and smart companies have and what they implement in their everyday work. We also discussed what plans companies have for the near and far future regarding green, digital and smart technologies. Interviews took place online since companies are in different parts of Slovenia, which makes it difficult to find a suitable location and time for a live session, also, company managers are well occupied with daily tasks (electricity crisis, strong price increasing of raw materials, searching for new customers and suppliers due to the war in Ukraine, and still recovering from the economic rapid decrease due to the pandemic lockdown) and other meetings. It was no problem for TITERA to lead these meetings online, since being flexible is key to maintaining good relationships and contacts. The Living Lab event was done online on the 5. 12. 2022 at 14.00 European Central Time and brought together participants from different textile companies and three different educational institutions. In total we contacted 34 textile companies from different textile industry fields, and 50 individuals from educational institutions. For the Living Lab session, we had in total 20 registered participants, 12 participants from 9 different textile companies and 8 participants from 3 different educational institutions. Due to unexpected obligations and other duties, participants from 3 companies could not attend the Online Living Lab event

In this report, we summarize the information obtained during desk and field research with emphasis on the three most important subjects within the green, digital, and smart technologies, processes and materials recognized among Slovenian textile companies.

## 2. Technologies / innovation /documents /tools

### 2.1.1 Green transition

To obtain this information TITERA made Desk Research regarding green, smart and digital transition among Slovenian Textile companies and educational institutions. Further on, TITERA conducted online interviews to obtain information and cover the field research topic. Online Interviews were done with 7 Slovenian Textile companies.

A lot of companies are scarce with online information regarding waste management, protection of natural sources and high-end technology they use for production. Due to high regulations in aviation, automotive and product production for medical purposes, demand for certified materials is high. According to online interviews Titera had with companies regarding the Field research, company managers revealed more information on the green, digital and smart technologies and production processes within companies and also talked about plans for the future and difficulties achieving greener goals. During interviews, TITERA found that companies are aware of EU policy and future regulations regarding the textile industry (waste waters and textile waste management, CO2 footprint, digitalization, and automation of production processes) therefore they are implementing steps to achieve greener goals. There is a high demand for onsite waste management and less energy consumption on production lines (absolutely because of the war in Ukraine and consecutively enormous high electricity costs). During online interviews, TITERA obtained information that companies are searching for good EU practices among other textile companies regarding onsite waste management and waste management cost reduction. They do have goals to implement solutions in their line of work. There is a surprisingly high amount of research done within company laboratories regarding new material developments, product patents and material finishes.

Some companies are intensively participating in EU projects to invent new, eco-friendly materials made from post-consumer waste or production waste (New Cotton, Urim Green, EcoNyl). Companies are eager to gain non-refundable financial resources to transition from fossil fuels to solar panels or heat pumps since these transitions aim for big investments. Companies stated they do struggle with the current situation, energy costs and unpredictable market prices. Some companies put plans for equipment purchases and solar panels implementation on hold due to high energy prices during the current energy crisis. Some stated they have not completely recovered from the Coronavirus pandemic.

Micro garment manufacturers are focusing on a “made to order” policy to avoid buying material in bulk and storing it since it costs more, and it represents the danger that the material is not completely used in the process of garment production and is later discarded as waste. Micro garment manufacturers are aware of sustainability issues so they strive to use eco-friendly materials only (wood silk, Apple skin, Eco cotton, PinaTex, Fair Trade materials).

There is a big emphasis on research regarding greener materials, dyeing and material finishing processes to obtain more durable and ecologically acceptable materials among companies. Processes of fabric and leather dyeing are facing

changes since they are trying to meet high standards regarding Wastewater and lowering the amounts of drinkable water used during dyeing processes. Companies strive to use less environmentally hazardous chemicals and fewer metal salts during the dyeing process. Production of laminated materials uses a lot of toxic glues and other material binders, but during our interview, the company in the leather business stated they are developing and testing new, less toxic and environmentally less hazardous adhesives and are planning to completely transition from traditional materials.

To outline challenges that companies face regarding the green transitions are:

**Waste management:** efficient recycling and reuse facility, located on the company premises, a way the third party involved in waste management is not needed, which helps with lowering the cost of waste removal, building business resilience, breaking the dependency on the third party, and increasing competitiveness. One important issue has to be pointed out reflects the missing regulation about the waste management on the national as also on the EU level. Especially for micro and medium-sized companies. The awareness about the lack of textile recycling production facilities in EU is very much present.

**Green Energy:** by transitioning from fossil fuels to solar panels or heat pumps means, companies gain self-sufficiency regarding energy, which also means lower amounts and consequently lower costs of energy that is not obtained through self-sufficiency. Even though companies focus on this topic a lot, not all have the financial capacity to make this transition happen. Self-sufficiency with greener ways of obtaining energy would mean less dependency on energy market prices and a lower CO<sub>2</sub> footprint.

**Certified Materials:** Even though companies are trying to supply the majority of raw materials from EU countries this practice is not possible as EU strongly depends on the Asian and African markets related to purchase raw materials. Companies are purchasing materials outside the EU since the prices of raw materials in the EU are too high therefore almost non-competitive compared to suppliers from Asia.

Table 1. Green

Technology/innovation/Changes	Description	Processes impacted by the technology	Examples (links..)
<b>Green energy</b>	Companies that are oriented towards green development, transitioned from fossil fuels to Heat Pump and solar cells for greener energy and to obtain self-sufficiency. Some companies have transitioned well, others had to stop plans for transition in face of current unstable market predictions and high costs of electricity which	Infrastructure renovation and high investments. Different sources of energy for production lines and heating.  Business management according to ISO 14001.	<a href="https://www.tekstina-tech.si/en/sustainable-fabric-producers-and-their-environmental-duty">Sustainable fabric producers and their environmental duty (tekstina-tech.si)</a>  <a href="https://www.prevent-deloza.si/en/domov">Domov   Prevent &amp; Deloza   2020 (prevent-deloza.si)</a>

	prevents infrastructural investments. They are also committed to following ISO 14001 standards.		
<b>Certified Materials-Supply Chain</b>	Reliable and transparent supply chain. Some companies are trying to supply the majority of raw materials from EU countries They are committed to purchasing certified materials due to the product specifications (aviation, medicine, automotive, protective clothing etc). They use not just ISO standard materials but also certified materials like Oeko-Tex, Blue Sign, FairTrade, and eco-friendly materials such as ECONyl, UrimGreen and New Cotton.	Commerce, Product design, Trade, Production, and distribution.	<a href="#">dateien155.pdf (boxmark.at)</a> <a href="#">You searched for ISO   Prevent &amp; Deloza (prevent-deloz.si)</a> <a href="#">Sustainable clothing manufacturerTekstina</a> <a href="#">SUSTAINABILITY   Benedetti Life</a> <a href="#">Certificates:: Tosama</a>
<b>Waste Management</b>	<p>Companies are searching for options so waste recycling and reuse could be done on companies' premises. There is a very high demand for Lycra recycling since the amount of waste material is high (Lingerie and swimwear products) but also costs of material removal are high, and this material is sold for incineration.</p> <p>Companies are oriented to implement a closed-loop system. One company is very successful in waste management, since they have completely stopped selling materials for incineration, all the company's waste is sorted on the company premises and sold for further recycling or reuse. Some of the post-consumer textile waste is recycled into new yarns.</p> <p>Overall companies lack knowledge and options on how to approach waste</p>	Production, Product Design, Supply chain	<a href="#">Tekstina Fashion   Fashion fabric in sustainable fibres and textiles.Tekstina</a> <a href="#">The Environment (boxmark.com)</a> <a href="#">High quality high bulk high elasticity dyed PA yarn (beti.si)</a>

	with less harm towards the environment.		
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### 2.1.2 Digital transition

Through desk research TITERA found that Slovenian Textile companies do not handle the latest software and operational tools for digital transitions, further on, Field research gave some more insight into why.

Slovenian textile companies do use ERP or CRP management tools to facilitate certain processes (optimizes productivity and flexibility and offers transparency into a complete business process by tracking all aspects of production, logistics, and financials). Companies' production lines use computer-added CAD/CAM cutting machines to optimize processes, minimize human error and shorten the procedure times.

Not all companies successfully implemented new, computer-added equipment into the production lines since workers on production lines are mostly over 50yr old and not eager on learning new digital skills. One company reported that the implementation of computer added cutting machine presented high investment, but the investment did not bring capital gains, so it was sold out to cover the costs.

Overall production lines do use CAD/CAM systems and they are operated by specialized personnel who has digital and engineering knowledge to operate this type of machines. Also, personnel operating these machines do follow software updates etc. In addition, "fresh" graduated students coming from university studies (Bsc or MSc) do not have satisfactory knowledge about CAD/CAM systems.

Companies reported they use Cloud Storage to store data, but there are no sophisticated programs for advanced data analysis.

Companies do use social media to present products, and milestones and to communicate with customers. They do employ people, who are, among other tasks, responsible for a website and social media editing.

Through interviews, we found that some companies have and some plan to integrate Configurators which is an online software tool to bring an interactive and personalized design experience to customers. Such a solution is offered by garment manufacturer only. A customer has the option to see a product from all sides and personally customize the product (colour, zipper type, leather finish etc.), this makes a better customer experience, and more design possibilities, but also avoids manufacturing products on stock.

Configurators ([Konfigurator ustvarjalnih kablov \(creative-cables.si\)](#), [M TOM Konfigurator - FLORJAN](#), [M TOM Konfigurator - FLORJAN](#), [TRONOG – We digitalize your production](#)) are the latest technology of digital presentation and personalization of products, they are used by the automotive, aviation, textile, and other industries. We found that few



Slovenian textile companies use configurators, even though they are state-of-the-art technology used by various industries all over the world.

We found that Companies do use “in-house” software for direct communication between material testing laboratories and production lines for clearer and shorter communication and immediate stop of production if something does not comply with materials testing regulations.

Since a majority of companies, we conducted interviews with are small or medium-sized companies (only one company classified as a big company), they do not need to implement for example 3D printing, 3D scanning or Artificial Intelligence programs into the work processes. In general, all these new technologies are not cost efficient yet in the EU textile sector at all. Those types of digital tools would mean high-risk investments since their work processes do not exhibit the need for such implementation, they would require additional space and hire new, trained personnel and experts.

Complete research showed that companies do recognize what is needed for process optimization but not all companies operate on a big enough scale, so those kinds of investments cost a lot of money, are not easily repaid and are, in most of our cases, not needed at all. Companies that implemented certain levels of digital technologies in their work processes are a large-scale company, with serial production sites for large quantities and larger facilities, and most of all, they employ a wider range of professionals. They are aware that a higher level of digitalization brings better connectivity of processes.

To outline challenges that companies face regarding digital transitions are:

Configurators – software tool for the customization: Bringing interactive and personalized design experience to customers, multiple design options, complete adaptability of product accordingly to customer needs and wishes, and better customer experience in sizing/fitting of a clothing product. The benefit of customized manufacturing, which saves material costs (no material buying in bulk) and saves time and energy by not performing unnecessary manufacturing processes (dyeing, cutting, sewing, perforating, laminating etc.) to manufacture products which won't sale.

ERP systems: It is a cloud solution, serving as the integrated management of business processes and applications, to gain resilience and real-time agility, to position the growth of a company. Companies do use this since it helps them have a broader overview of work processes from supply chain to sales.

Challenges: Recognizing which processes could pose a higher level of digitalization for more optimal workflow and trying to implement changes without a high risk of wrong investments.

Table 2. Digital

Technology/innovation/ Changes	Description	Processes impacted by the technology	Examples (links..)
<b>Configurators</b>	By implementing configurators there is a better customer experience since configurators allow the customer to take part in designing their product by choosing a color, material type, zipper type, material finish etc.	Configurators impact commerce and production lines from material preparation, cutting, and sewing, to product storage.  Since the product is half customer-made, there is no need to produce large amounts of items and store them, and no need for buying material in bulk and storing it rather than producing items on demand.	<a href="#">Toپر - Iskanje Google</a>  <a href="#">Configurator : Boxmark XTREME Collection – Exclusive leather furniture for interior and exterior. (xtreme-collection.com)</a>
<b>ERP Systems (Enterprise resource planning)</b>	On-time information about different operations such as links between stock and shop, links between laboratory results, and the production line.	Management of different sectors from commerce to sales, from design to production.	
<b>E-documents; E-personal employee folders</b>	Digitalization of employee data (documentation related to the employment relationship, holiday leaves, timesheets, health, safety, pay slips) helps Finance and Accounting and Human Resources departments.	More effective work of Accounting and Human Resources departments.	
<b>VMI (Vendor Managed Inventory) and EDI (Electronic Data Interchange)</b>	Those programs provide multi-location and multi-level inventory management. They ensure maximum productivity by eliminating oversights that could cause project delays.	Inventory management and sales.	
<b>Digital DyeHouse Planning</b>	Support for shade matching and colour-recipe creation and optimization, advanced program with AI.	Production.	<a href="#">Betī d.d. storitve (do Betī d.d.) (kompass.com)</a>

### 2.1.3 Smart transition

Through desk and field research TITERA found that Slovenian Textile companies do not work with smart Business intelligence models or have integrated any product traceability systems or robotics in the lines of production. But they are active participants in projects regarding smart textiles, sustainability, and circular economy.

Companies interpreted smart in means of smart textiles, garments with different sensors and active functionalities, or even the development of conductive materials.

There is a link between market requirements and the production of smart textiles. Since companies rely on third-party companies to cover the design, programming, and device application software, they are open to collaborative projects with different participants on the EU level. Smart textiles are developed with a very specific goal, either cooling, heating, temperature measuring, heart rate monitoring, information about micro-location etc. So, the target group is police, military, or other special forces personnel, but some projects focus on developing garments for professional or semi-professional athletes.

Our research showed that some companies do not exhibit any kind of need to take part in the smart textiles business (because there is no market), yet others, companies that are involved in protective gear manufacturing, see this niche as an excellent opportunity to grow their range of products. However, they are aware about the lack of standards in this field (smart textiles-electronics).

This kind of textiles brings other questions such as the need to hire new personnel (we are already now faced with the lack of workers having the competences in textile engineering, like weaving, spinning, textile chemistry, confection, etc...), so there is no need to outsource programmers or IT staff, and also questions about whether market demand is high enough to justify the recruitment of a new workforce and make smart textiles a regular part of the product range offered to the costumers.

Table 3. Smart

Technology/innovation/Changes	Description	Processes impacted by the technology	Examples (links..)
<b>Garment Sensors</b>	CPU (On board sensors), integrated into different type of apparel.	Design and development of a product according to specific needs.  Research and Development Recruitment needs new staff to operate this field of work.	<a href="#">Smartwear I Program I Prevent &amp; Deloza I 2020 (prevent-deloza.si)</a>  <a href="#">PROJEKT KinShirt (inplet.si)</a>
<b>Nesting- Optimized Leather Cutting process</b>	Used on daily basis, a program using Artificial Intelligence to recognize irregularities in material	Production and material preparation processes.	<a href="#">BOXMARK - Best in Leather Interior</a>

	and adapt pattern layout for maximal material use and minimal material waste.	Nesting machines use some level of artificial intelligence to recognize dimensions, shapes and irregularities on leather skins to optimize the cutting process.	
<b>Dos&amp;Dye Robot</b>	Automated sample production.	Research and development department, Lab technicians	<a href="#">Textile industry :: Beti d.d.</a>
<b>LEAN Tools</b>	Lean tools help the apparel industry to identify and eliminate waste therefore there will increase the profitability and productivity through all the processes, increase the quality level at the lowest cost rate, and these tools implement industry to focus on effective and efficient manufacturing processes.	All employees / All levels	

### 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.

#### GREEN

Company **Tekstina** is one of twelve companies partaking in the project “New Cotton” where textile waste is collected and sorted, and regenerated into a new, man-made cellulosic fibre that looks and feels like cotton – a “new cotton” using Infinite Fiber Company’s textile fibre regeneration technology. Textile waste is collected from multiple textile companies. Multinational players from the textile industry are taking part in the project, aiming for wider public recognition, waste management solutions for the production of recycled materials.

- [New Cotton Project](#)

**Tekstina** also developed Urim Green, a high-tech product, created with a minimum of 20% recycled fibres from post-consumer textile waste and in combination with other fibres, it provides permanent flame retardant properties. It is the optimum choice for eco-responsible producers of flame-retardant garments that care about our environment and future generations.

- [Urim: arc flash fabric offering increased protection \(tekstina-tech.si\)](#)

Company **Vrvica** developed Technology Eladur, making elastic bands resistant to high washing and drying temperatures (220°C). Especially suitable for use in industrial laundromats and where high maintenance temperatures are present. This way elastic bands have longer life cycles and result in less waste.

- [Vrvica – Vrvica](#)

XGREEN, developed by **Boxmark Company**, is a sustainable leather that combines classic recipes with the latest tanning technology. Only purely vegetable tanning agents such as leaves or herbs from trees and plants are used, which are produced during harvesting and have previously been composted. The raw materials are only used to the extent that they grow back naturally. Tanning recipes have been developed with extracts of chestnut, strawberry leaf, Jerusalem artichoke herb, cocoa shell and gall apple.

- [BOXMARK - Best in Leather Interior](#)

XLOOP, developed by **Boxmark company** is a compostable leather, where the production waste is biodegradable. In the tanning process, chromium or glutaraldehyde are avoided entirely and only an organically based, synthetic tanning agent is used. This enables a resource-saving process with significantly reduced water consumption and lower use of chemicals and salts. This also relieves the burden on the production of wastewater, which in turn simplifies its purification.

- [BOXMARK - Best in Leather Interior](#)

DyeCare™ 1.0 is the most sustainable yarn from Beti company to date. It is made from 100% recycled polyester obtained by recycling PET bottles. Beti Technologies applied research group improved the dyeing process by saving 51% of water and 21% of electricity, and with lower gas consumption they also reduce CO<sub>2</sub> emissions by 34% compared to the standard procedure. The quality is proven by certificates OEKO-TEST standard 100 class 1, Global Recycled Standard (GRS) and Bureau Veritas verified energy and water savings report.

DyeCare™ 1.0 yarn also received the GOLD AWARD for the best innovations of 2021, awarded by the Chamber of Commerce of Dolenjska and Bela Krajina (GZDBK).

- <https://www.beti.si/en/dyecaretm-10>

## SMART

Company **Prevent & Deloza** participated in the development of cooling vest with Slovenian police and army forces. The project was presented in 2017 and resulted in the design of a passive cooling vest for armed forces personnel. The passive systems for cooling down people, developed in cooperation with the army and the police at Prevent & Deloza especially for wearing under ballistic protection, are more suitable for use in the field. This type of solution is helpful for the local cooling of the human body. Today, the most common systems for cooling on the market, are cooling systems that function by use of ice, salt and crystals. The Prevent&Deloza system is composed of knitwear, that efficiently extracts heat and moisture from underneath the ballistic protection. Additional functional material provides the quickest evaporation of excess moisture and ensures an adequate extraction and storage of excessive heat. Already, the system manufactured in this way substantially reduces the heat load on a person. By adding the evaporative part of the system, we ensure the cooling of the person wearing ballistic protection, namely by an additional 3°C already after thirty minutes of activity.

- [Volume 19 | Prevent&Deloza | Mission Possible - Cooling Down the Soldier in Body Armour \(soldiermod.com\)](#)
- [Partnerji – Milsistemika](#)

Companies Prevent&Deloza and Inplet participated in the development of a kinesiology assistant, named KinShirt, as an active smart shirt, designed and manufactured in Slovenia. T-shirt gives the user an insight into how to perform individual exercises most efficiently and achieve optimal results. It does not require the use of additional devices (watch, chest strap, etc.) as the sensors are integrated directly into textiles, where they collect and analyze data, which are then

sent to the mobile application via Bluetooth technology. Highly sensitive sensors and communication modules do not impede the individual's mobility and do not general functionality of the shirt. The data collected combines breathing frequency factors, cadence, arm, and leg movement accelerations, and then displays the interpreted results in a mobile application in an accurate, attractive graphical way, allowing the user to adjust and optimize the training plan and achieve the best results.

- [Always thinking forward I Development projects I Prevent & Deloza I 2020 \(prevent-deloz.si\)](#)
- [Smartwear I Program I Prevent & Deloza I 2020 \(prevent-deloz.si\)](#)
- [KinShirt - Evropska sredstva](#)

## DIGITAL

Company **Tooper** has successfully implemented product configurator on their website and is therefore offering their costumers numerous choices regarding colour of elastic bands, zippers and lining of different garments (sweatpants and hoodies). Offering configurators also represents a risk-free purchase since item is made according to the wishes of the customer.

- [Izdelaj si sam | Tooper - Spletna trgovina športnih oblačil](#)

Company **Boxmark** has implemtned configurators for their furniture Xtreme collection (20 standard colors combined with three frame colors the possibilities to create the designer furniture according to customers ideas).

- [Sunlounger : Boxmark XTREME Collection – Exclusive leather furniture for interior and exterior. \(xtreme-collection.com\)](#)

#### 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?

Companies stated there are infrastructural limitations, and a lack of knowledge and skills to make a close loop in waste management possible. There are high demands to recycle or reuse manmade fibres, especially Lycra. High costs of waste removal and incineration of fibres call for different approaches. Some companies sell their waste, so it is shredded and used for fillers. Companies are reducing their textile waste, and some have implemented computer-operated cutting machines to optimize the process and reduce the waste there, but they are still searching for options on how to do recycling and reuse on the company premises to become completely independent from third-party service providers. This way they would increase their competitive advantage in the market, lower their CO2 footprint and become self-sufficient.

Company Aquafil, leader at sustainability in textile industry, has successfully developed and completed the transformation of Nylon 6 waste into regenerated ECONYL® nylon back in 2011. ECONYL® is maintaining the same quality level and performance as standard nylon. Apparel companies such as Napapijri, Burberry, Prada, BenedettiLife and others use Econyl ([Apparel - Econyl](#)). Also other companies such as BMW and Anker ([BMW - Econyl](#))

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

Innovation relevant to smart is interpreted in means of smart textiles, smart sensors, and multifunctional garments. During our research, we found that Slovenian companies are too small and do not exhibit the need to implement Artificial intelligence, Augmented Reality programs or 3D printers. During the online Living Lab session, companies stated they know that younger generations possess the knowledge and digital literacy to quickly familiarize themselves with novelties in the field of smart technologies and processes.

Some production lines in companies have implemented cutting machines, especially companies in a leather business where each piece is unique in shape, size and amount of irregularities such as piece thickness so the process of pattern production must be optimized to achieve the biggest possible efficiency with as little waste as possible.

Some companies have integrated Dos and Dye Robot for automated sample production since it is important to keep up the pace of quality sample products based on fast and ever-changing customer demands.

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

Digital is understood using computer programs that help sectors of Sales, Human Resources, Commerce, Design and Production, and Inventory management to better optimize their work processes, to have real-life information about certain areas of work, and to establish direct links and information flow between certain areas of the company.

Digital is also understood as the implementation of different programs such as Configurators to be able to offer better customer service and experience.



#### 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
<b>Waste management</b>	Procedures to recycle fibres on company premises, procedures to recycle manmade fibres with high amounts of Lycra, avoiding incineration.  Building and operating facilities to collect, recycle and reuse textile waste directly from production lines with no need to outsource service providers.	Knowledge in fields of chemistry, engineering, ecology, sustainability	
<b>Green energy transition</b>	Achieving self-sufficiency by implementing solar panels and heating pumps where possible.	High investments, need to compete for non-refundable EU grants. Staff is not trained in project application writing.	

#### 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
<b>CAD/CAM</b>	Optimization of the work process  Programming the weaving/knitting machine	Basic knowledge in textile construction (weaving, spinning, knitting, cutting) with competences in CAD	CAD courses-basic CAD training - practice
<b>Data analysis</b>	IoT solutions Cloud archiving	Archiving the data Reading the data in cloud The use of internal database	Basic in computer science – course Practice in data analysis – course
<b>Data protection</b>	Working with confidential data		Understanding “safe” protocols – course
<b>Online meeting</b>	Teams Google meet skype	Basic knowledge on how to use a simple tools for online meetings	Basic in communication tools – course Practice internally

		Set-up an online meeting	
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### 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
<b>Innovation</b>	Development of smart textile products	<p>Understanding what are smart textiles</p> <p>Understanding particular smart textile components (sensors, conductive wires, electrodes,...)</p> <p>Understanding technologies for interconnection</p>	<p>Study courses in smart textiles</p> <p>Training/practice on the lab level</p> <p>Practice on the industrial level-practice in the industry</p>
<b>Business models for smart textiles</b>	<p>Economic changes in smart textile products</p> <p>Market analysis</p>	<p>Understanding the end customer need</p> <p>Understanding the marketing</p>	<p>Smart textiles in relation to end customer</p> <p>Market analysis</p>

## 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

GREEN						
INSTITUTION	EDUCATION LEVEL	LEVEL	TYPE	DESCRIPTION/ SUBJECT	OCCUPATION TO BENEFIT	LINKS
University of Ljubljana, NTF*	University	National	Curriculum	Creativity and development of a new product	All occupations in textile ind.	<a href="#">Creativity and product development - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University	National	Curriculum	Production planning and management Quality management	Technicians, engineers, management	<a href="#">Production planning and management - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University	National	Curriculum	Quality management	Technicians, engineers, management	<a href="#">Quality management - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University	National	Curriculum	Textile testing	Technicians, engineers	<a href="#">Basic methods in textile testing - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University level	International	EU Project, 2020-1-LT01-KA203-077874-E10170577	EU Project, 2020-1-LT01-KA203-077874-E10170577	From students to textile companies.	<a href="#">CLEANTEX Project   CLEANTEX project is a .... and aims... EU</a>
University of Ljubljana, NTF*	University level	International	EU Bilateral Project, 2020-2022	Project is focused on the use of waste material for the development of a new cellulose composite, which will be ecologically acceptable according to the principle of "Life Cycle Assessment".	Researchers at University level, dissemination of project for general public	<a href="#">Research projects - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University level	Regional	ARRS project, J2-1720 (D)	Ecologically friendly in-situ synthesis of ZnO nanoparticles	Researchers at University level and Research Institutes, dissemination	<a href="#">SICRIS Ecologically friendly in-situ synthesis of ZnO nanoparticles for the development</a>

				for the development of protective textiles	of project for general public	<a href="#">of protective textiles</a>
Primary School Gornja Radgona	Primary School	Regional	Internal school project	A hundred days in the same T-shirts and trousers	Pupils in primary school.	<a href="#">Slovenian pupils are changing their dressing habits   Slovenia.si</a>
ROG LAB	General Public	Regional	Workshop	Molecular candies	People who are interested in biopolymers, edible bioplastic polymers.	<a href="#">Molekularni cukrčki » RogLab (center-rog.si)</a>

\*NTF= University of Ljubljana, Faculty of Natural Sciences and Engineering

DIGITAL						
INSTITUTION	EDUCATION LEVEL	LEVEL	TYPE	DESCRIPTION/ SUBJECT	OCCUPATION TO BENEFIT	LINKS
University of Ljubljana, NTF*	University	National	Curriculum	Textile testing	Technicians, engineers	Basic methods in textile testing - TOI (uni-lj.si)
University of Ljubljana, NTF*	University	National	Curriculum	Production planning and management Quality management	Technicians, engineers, management	<a href="#">Production planning and management - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University	National	Curriculum	Quality management	Technicians, engineers, management	<a href="#">Quality management - TOI (uni-lj.si)</a>
ROG LAB	General Public	Regional	Workshop	Laser Cut	Individuals with a desire to gain knowledge regarding the use of a Lasercut programs, techniques and work safety instructions.	<a href="#">Usposabljanje: Laserski rezalnik » RogLab (center-rog.si)</a>
ROG LAB	General Public	Regional	Workshop	exploring virtual reality concepts	Individuals with a desire to find out about the effects of virtual reality on our perception of space and elements.	<a href="#">Čarovnije virtualne resničnosti » RogLab (center-rog.si)</a>

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SMART						
INSTITUTION	EDUCATION LEVEL	LEVEL	TYPE	DESCRIPTION/ SUBJECT	OCCUPATION TO BENEFIT	LINKS

University of Ljubljana, NTF*	University	National	Curriculum	Creativity and development of a new product	All occupations in textile industry	<a href="#">Creativity and product development - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University	National	Curriculum	Production planning and management Quality management	Technicians, engineers, management	<a href="#">Production planning and management - TOI (uni-lj.si)</a>
University of Ljubljana, NTF*	University	National	Curriculum	Quality management	Technicians, engineers, management	<a href="#">Quality management - TOI (uni-lj.si)</a>
University of Maribor	University	National	EU Project, 2018-1-RO01-KA202-049110	Skills4Smartex ,	Transfer of innovation from research providers towards textile enterprises & VET schools	<a href="http://www.skills4smartex.eu/about.html">www.skills4smartex.eu/about.html</a>
ROG LAB	General Public	Regional	Workshop	3-D printer workshop	individuals with a desire to gain knowledge from 3-D printers.	<a href="#">Usposabljanje: 3D-tiskalnik » RogLab (center-rog.si)</a>
ROG LAB	General Public	Regional	Workshop	Synthesizer, an instrument that plays by touch	Individuals who want to comprehend knowledge of 3D-printed elements, connected to the circuit via a signal wire. Knowledge of the basic electronic components and manufacturing in the field of electronics.	<a href="#">Pojoče prstne blazinice » RogLab (center-rog.si)</a>

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During the Living Lab session, there was a lot of skill and needs recognition done based on practical experience between textile companies that employ young people or offer practicum to university students and on the other side Educational institutions that educate young people and need to be on track with current needs in the textile industry. During the Living Lab session, companies stated that young people who start working exhibit knowledge about new materials (ecological and recycled fibres) but this knowledge could be more in-depth knowledge, educational institutions reminded that upgrade of this basic knowledge is gained during the postgraduate programs.

Companies also stated that younger people do have knowledge and skills regarding Analytical data processing and do know how to use different Statistical methods to analyze data. The industry reported that when introducing new machines into the existing production lines, they do expect that people will be fast in learning how to operate these new machines but are aware that this is a difficult task for some. Academia recognizes the need on their part, to

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integrate different software programs from the field of textiles into the learning processes, so pupils can gain more software, digital and operational knowledge and have a softer transition on the market. Students show high interest in collaborative working with the Industry.

Companies stated there is a lack of knowledge among young people regarding the product and raw material standards and also the lack or poor knowledge of textile terminology which they mark as a negative point but they suggest that additional training within the companies would sort this issues.

The industry also recognized an insufficient knowledge regarding the field of digitalization, which was also noticed by Educational Institutions, therefore they suggested implementing the use of basic computer programs as a compulsory learning element. Educational institutions recognized the need for interdisciplinarity, involving students in different projects and gaining a broader knowledge of different fields. Since Educational institutions do have a wish for better integration and cooperation between industry and academia so there are rising questions about working scholarships for students since textile companies do now offer any. There was also a question regarding the issue of employment of young PhDs but the Industry was sincere about the problem with high salary payments for personnel with a PhD. There is a general lack of textile personnel but Faculties on the other side are struggling with decreasing enrolment in textile educational programs.

## 6. Conclusions

Research showed that the majority of Slovenian Textile companies are too small to exhibit any kind of need for implementation of programs regarding Artificial intelligence, Business Data Analytics, Argument reality, Robotics, Meta Real software etc. However, they are implementing programs and operations in the field of green, digital and smart if they consider them useful on daily basis and if the investment costs are covered with the use of new machines/programs. Slovenian Textile companies are focused on using certified materials, they are searching for waste management options, and they are transitioning from fossil fuels to greener energy. They also invest in material and procedure research regarding their primary field of work to invent better, environmentally safer and economically more efficient materials. In the field of digital, companies practice different computer programs to make communication between different departments such as sales-inventory, laboratory-production line etc) more efficient. Some companies use configurators to make the customer experience better and to offer the option of personalized items, others use Digital Dye House for accurate colour shade recipes which is a program that operates based on the use of artificial intelligence. In the field of Smart, companies are aware of programs on the market but do not need to implement them. They understand smart means of garments sensors. Some companies implemented computer-operated cutting machines (nesting in leather production), Dos& Dye Robots (for Automated sample production) and Lean Tools (to help identify and eliminate waste and increase profitability and productivity).

- Overall Educational institutions are educating students in means of green (recycling, eco materials, close loop systems) digital (smart product design, computer programs) and smart but are aware that not all programs and equipment they use are up to date with that industry uses on daily basis. There is a strong willingness to cooperate between students and textile companies.