



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

WP2 Swedish National Report



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1. Introduction

At University of Borås, the Swedish School of Textiles has national responsibility for research within the area of textiles and fashion. The area is focused on the subjects of design, textile technology, and textile management. It examines the definitions, methods, and models related to the development and application of textiles and fashion in research, industry, and society at large. The development of the textiles field is conducted primarily through the research programs of ArcInTexETN, Body, and Space, Re:textile, Smart Textiles, and SMDTex as well as the research projects funded by H2020, Eurostars, VINNOVA, the Knowledge Foundation, SSF, Sparbanks Foundation, Borås City and the Foundation for Swedish Textile Research.

The research methodologies involved desk research analysis, promotional activities, and workshops during the period of August to November. Promotion of the ADDTEX project was done with companies by verbal communication at different events such as 'Techfest' and 'French Swedish Research collaboration days' held at HB. Meetups were also conducted via Zoom with some companies to share the project activities and objectives. The companies were interested and keen to discuss the project objectives. We also contacted via email and telephone to bring different stakeholders together to actively participate in the project workshop. We could identify the best possible time with interested companies and VET to conduct the workshop at HB.

Workshop/living lab was conducted in the month of November involving 5 companies (Vividye AB, FOV Fabrics AB, TST Sweden AB, AB Ludvig Svensson, Imogo AB), 1 VET (Nordiska Textilakademin), and 1 HEI (HB). Representatives from industry partners and researchers from the University of Borås met for a workshop to discuss the smart, green, and digital transition for Swedish textile industries. As University of Borås is the only HEI in Sweden focusing on textiles higher education and Nordiska Textilakademin is the only available VET, the participation from VET and HEI remain limited to University of Borås and Nordiska Textilakademin.

The workshop's key questions were how Swedish textile industries are embracing these transitions in practices and relevant challenges, as well as what skills are required for current and future Swedish textile industry employees. The report is divided into six chapters, Chapter 1 being the introduction, Chapters 2 to 5 highlighting the main output of the project, and chapter 6 is the conclusion.

In Chapter 2, the initiatives, innovation, and tools that are targeted to employ for the overall transition towards sustainability inclusive of green, smart, and digital transitions have been discussed. Chapter 3 highlights the existing initiatives within the area of green, smart and digital transitions. Different perspectives and tools/initiatives interested/undertaken in context to the transitions (green, smart, and digital) at the industrial level and the need for awareness is discussed in Chapter 4. Furthermore, the requirement for education/courses pertaining to the textile industry is described in Chapter 5.

2. Technologies/innovation/documents /tools

Sustainability is the core of Sweden and in the urge, for sustainable development, various initiatives have been undertaken. One of the major steps is the long-term target to have zero net greenhouse gas emissions by 2045 latest. Thus, to contribute to achieving this goal, different textile and apparel industries in collaboration with the Swedish NGO Sustainable Fashion Academy launched STICA to develop action plans for attaining sustainable goals within the entire Swedish apparel and textile industry. The initiative is a major step that can involve all three major transitions such as green, smart, and digital transition.

The following tables provide information about the technologies contributing towards the attainment of respective transitions (green, digital and smart)

2.1.1 Green transition

Table 1. Green

Technology/innovation / Changes	Description	Processes impacted by the technology	Examples (links..)
Initiative STICA	It helps set up science-based targets to reduce greenhouse gas emissions within Swedish textile and apparel industries.	Studies revealed that the majority of the apparel industry's greenhouse gas emissions are generated in the value chain system, particularly during the fiber and material/fabric production.	https://sustainablefashionacademy.org/stica/progressreport2022/
The Swedish Wool Initiative	The project partners from across the value chain collaborate to build system capacity, scale up the use of Swedish wool and contribute to the transition to a sustainable and circular industry for fashion, outdoor and home textiles. The project is contributing to the vision of zero waste of Swedish wool.	The project aim is to contribute to a climate-neutral and circular industry for fashion, outdoor, and home textiles through the development of circular products; a resource-efficient and resilient value chain; with increased competitiveness for the raw material, and products of, Swedish wool, and; a socially sustainable textile industry in the transformation towards a circular economy by focusing/engaging through increased	https://www.vinnova.se/en/p/the-swedish-wool-initiative/

		knowledge of circular design and product development.	
Automation in textile sorting	Green light for large-scale automated textile sorting facility in Malmo.	Textile sector being the major contributor to global environmental impacts, automated textile sorting is of utmost important tool to create circular system.	https://www.ivl.se/english/ivl/press/press-releases/2019-07-03-green-light-for-large-scale-automated-textile-sorting-facility-in-malmo.html
Resell, recycle and increase the lifespan of garments.	The organization aims at increasing the lifespan of garments by integrating sustainability which they believe is the way to growth.	It is one of the sustainability pioneers among Swedish brands. Since 2014, the brand has operated by the motto that 'sustainability leads the way to growth', with the lifespan of its garments as a primary focus. In 2015 Filippa K launched a new concept, the Collect program, whereby people get a discount on new purchases if they return garments they no longer want. By 2030 the brand aims to remake, resell or recycle 100 percent of collected garments.	https://www.filippa-k.com/se/en/start
Textile circularity	The brand believes in prolonging the life of garments. It aims at bringing textile end life cycle by composting their clothing into food soil, thus focusing on textile circularity	It has managed to create products circularity by prolonging the life of garments, as well as by offering repairs, rentals, and second-hand sales.	https://houdinisportswear.com/en-eu
Hydraulic spay dyeing	A new dyeing process developed at the University of Boras turned into a startup company is now addressing the environmental issues in	Textile dyeing and finishing	https://www.imogotech.com/products/dye-max.html

	textile dyeing. The device was explored for its profitability and productivity with dramatically reduced waste water volumes, the greatly reduced energy and chemistry consumption and the increased production speed and consistent and predictable quality.		

2.1.2 Digital transition

Table 2. Digital

Technology/innovation / Changes	Description	Processes impacted by the technology	Examples (links..)
Digital transformation solutions	Creating digital transformation solutions for the industry. It focuses on the entire lifecycle from engineering operations to the supply chain providing integrated solutions.	It benefits the business by accelerating innovation and learning via design, simulation, and training.	https://www.aveva.com/
Digital Printing Technology	With digital printing technology, it is possible to get the material exactly where you want it, which makes it possible to save raw materials and reduce the handling of chemicals that remain after production.	Dyeing, Finishing, Printing	https://www.hb.se/en/the-swedish-school-of-textiles/about-the-swedish-school-of-textiles/news-and-events/news/news/138125/

2.1.3 Smart transition

Table 3. Smart

Technology/innovation / Changes	Description	Processes impacted by the technology	Examples (links..)
Smart and Interactive textiles	Clothing that monitors your health or measures your movements. Technology that makes it possible to recycle textile fibers and reuse them	The platform focus on sustainable textiles, smart textiles, and Industry 4.0 attributing towards advanced technology	https://smarttextiles.se/en/
VR /AR	VR allows students to experience destinations from across the world without ever having to leave the classroom. Imagine students being able to explore the pyramids of giza whilst sat at their desks. This is what virtual reality education allows. Such initiative was taken by Retail lab at the University of Boras.	Education and Training	https://www.handelslabbet.org/casedb/

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

At the University of Borås, there are several initiatives that aim to contribute to green, smart, and digital transitions. Textile and fashion research is conducted on several segments such as customized garments, circular fashion, the relationship between body, material, and movement along with the focus on the advanced textile industry by researching resource-efficient techniques. Within the umbrella of textile and fashion research, there are several other research groups with respective specified focuses. The research groups aim to establish advancement in the textile structure, mechanical recycling, smart and wearable textiles, sustainable value in the textile supply chain, sustainable consumption, and advancement in the development of functional and smart materials using novel resource-efficient techniques.

Within the textile material technology group, apart from ADDTEX, there are projects such as DigiSmartTech and HACKTEX to develop innovative tools for skill enhancement targeted at different levels and professionals pertaining to specific tools such as boosting digital printing technology. In the project "*SusdigiTex – Development of a digital printing process with sustainable inks for functional clothing*" the Textile Materials Technology research group at the Swedish School of Textiles has developed and tested a pigment ink and optimized it for single-colour prints and patterns. Functional properties with water-repellent inks by using components that are free of environmentally hazardous fluorocarbons, which are used as impregnating agents, but must be phased out have also been tested. More details can be found in the link below,

<https://www.hb.se/en/the-swedish-school-of-textiles/about-the-swedish-school-of-textiles/news-and-events/news/news/138125/>

Subsequently, several initiatives to investigate new solutions to support the transition towards sustainability in textile and clothing sector is on-going. A detailed description of ongoing and completed research projects can be found in the link below,

<https://www.hb.se/en/research/research-portal/research-areas/textiles-and-fashion-design/>

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

The representatives from several companies, VET, and representatives from the University of Borås came together to discuss the following two key questions from the individual perspective and experiences. As University of Borås

Key question 1:

- What does green, smart, digital transition in the textile industry mean for your company, and how you are addressing or implementing them?

Representative of Imogo AB explained how the mission of Imogo falls under all three transitions. Imogo actively contributes to the green transition of textile industries through their hydraulic spray dyeing machine which is expected to save a significant amount of water, energy, and other resources. The process is somewhat also related to the digital and smart transitions as emphasized by Imogo. FOV fabrics AB explained the focus on digital and green transitions where the company invests in digital printing technologies as a replacement for conventional dyeing processes.

The company also adopted the zero-emission policy in its decades plan. FOV further explains the increasing awareness and understanding among the consumer of the company in terms of sustainability. Representative of Vividye AB mentioned that the company currently addressing the green transition in the textile industry as they produce reversible ink as a sustainable approach to reuse fabrics. Vividye also expressed their future plan in going forward with digital printing technologies from their current focus on screen printing. Ludvig Svenson AB on the other hand talked about their focus on the LCA analysis of the textile materials with a focus on circularity and green transitions. Product recyclability and lack of a benchmark or bar for LCA analysis for the final report is a concern as it's a requirement for most of their customers. Smart transition is a long-term goal for the company as mentioned by the representative. L. Svenson is contributing to green transition on the management level as the different company site meetings are now running online during and post-pandemic, so the carbon footprint is low. Furthermore, the different sites are well connected due to the pandemic and post-pandemic learnings of digital connection via Zoom, and Teams which in turn is beneficial collectively for the company. This is a lesson and good output from the pandemic experience as pointed out by L. Svenson. Digital technologies' short-run implementation can be thought of, but economic viability must be taken into consideration. TST Sweden AB is also addressing the green transition in its supply chain with an aim toward digital transition as the future approach. However, as an apparel producer, TST heavily depends on the raw materials supplier for their products. They are closely working with their counterpart and maintain regular discussions on this transition. Although the green transition is in practice in many aspects of management, a concrete plan of action is yet to follow at the production level.

Nordiska Textileakademinn– VET based on Borås pointed out that, they have a lot of focus on green transition (80% training) in their curriculum and the remaining 10% each on Smart and 10% Digital transition. They work closely with the companies to create new training modules as per their requirement. Researchers of the University of Borås mentioned the ongoing effort on the development and innovation in new and resource-efficient textile processes such as ink-jet printing, plasma, supercritical CO₂ technology, additive manufacturing technology, spray dyeing, etc. The participants of the discussion unanimously agreed on the current prospect of green, smart, and digital transitions in Swedish Textile industries and the need for educational materials to help train the companies' present and future employees. The companies are in the process of adopting these transitions to their practice. Among all three transitions, companies have somewhat made significant progress in green transition in various capacities including raw material selection, supply chain management, and industrial engineering. Green transition is at the forefront of all transitions in the current scenario as the knowledge and technology are reliable and available. However, some companies also made good progress in the realm of digital transitions like implementing digital and resource-efficient production processes.

Key question 2:

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- Specific needs at the level of the most emerging skills and areas of knowledge development for green and digital technologies in textile industries?

During the discussion, all participants agreed on the need for educational materials focusing on the new technologies introduced in the Swedish textile industries. Much effort was given to the knowledge on basic knowhow about the technologies. Vividye AB, FOV fabrics AB, and TST Sweden AB emphasize basic chemistry education for the current and future employees whereas Imogo AB added the necessity of understanding in relation to time, temperature, chemical, and mechanical agitation.

The gap in this knowledge needs to be addressed in different educational modules (at different levels) in order to ensure the progress of Swedish Textile Industries through the green, smart and digital transitions.

Ludvig Svenson AB pointed out that, Textile industry is facing a critical knowledge gap among students/future employees. The shortage of skilled workers in the textile industries in Swedish is already being felt by the companies. The researcher at the University of Borås added the lack of enrollment of students in the engineering program and proposed further academia-industry cooperation. More active associations between the University of Borås and the companies are expected to boost the confidence of the students towards textile technology and future prospects.

Regarding the method of training, both on-job and off-job training can be useful. The technicians undergo on-job training in problem-solving and six sigma courses, which can be further expanded to the MOOC in the future as mentioned by Ludvig Svenson AB.

Currently, no information or details regarding any tools/technology used at the industrial level have been shared by the representative. In case of any update, the information will be provided in the below tables.

4.1.1 Green

- please describe the 3 most important functional areas

Table 4. Green

Functional areas of the company	Technology/innovation / Changes	Knowledge needed to perform the process	Priority Training Topics to be addressed

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

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

5. Initial and further education on advanced textiles

All the participants understand the need for skill development programs and training modules for the current and future employees of the Swedish textile industries, however, the area of knowledge ranges from fundamental levels such as basic color chemistry, dyes, and pigments, surface -interface science to applied level such as digital printing processes and basic troubleshooting. Multidisciplinary education has also been highlighted as a hotspot for new skill development opportunities. It is important to address the skill shortages. While training institutions report strong engagement with industry, there is a difference in perceptions of graduate preparedness at the entry-level. Regular curriculum reviews are particularly crucial to keep pace with the skill changes related to 4IR.

There is a need to evaluate the quality of industry partnerships and to systematically address advanced textile technologies. Skill preparation between employers and training institutions is critical to assess the quality and relevance of such training and their alignment with employer needs. Preparing the workforce of the future with the right skills and capabilities is central to the industry. Thus, the VETS and HEIS play a major role. Hence, with the current and expected transitions in the industry, it is important to understand the industrial and market needs for which more workshops should be integrated to provide the desired output.

6. Conclusions

Overall, the discussion about the project objective with the industry provided a big boost as many people showed keen interest and the workshop/living lab conducted provided insight into the knowledge/need of digital, smart, and green transitions. The transitions (green, smart and digital) are foreseen as industrial growth, however, its impact or need depends majorly upon market need and customer interest. Cost involvement at the production level and skill development play a major factor during the transition.

There is an increase in demand for the workforce at the production level in textile industries, thus it is important to increase awareness about the need and attract youth through educational and industrial promotional activities/visits. Knowledge gap in reference to existing technology and skill development/awareness about the advanced technology in the textile industry is seen as an important need/requirement.

Partners and researchers discovered the need for a holistic approach to developing current employees' skills during these transitions. The workshop findings will facilitate the flow and co-creation of knowledge between higher education, vocational education, and the business sector within the Swedish textile sector to foster new, innovative, and multidisciplinary approaches to these transitions