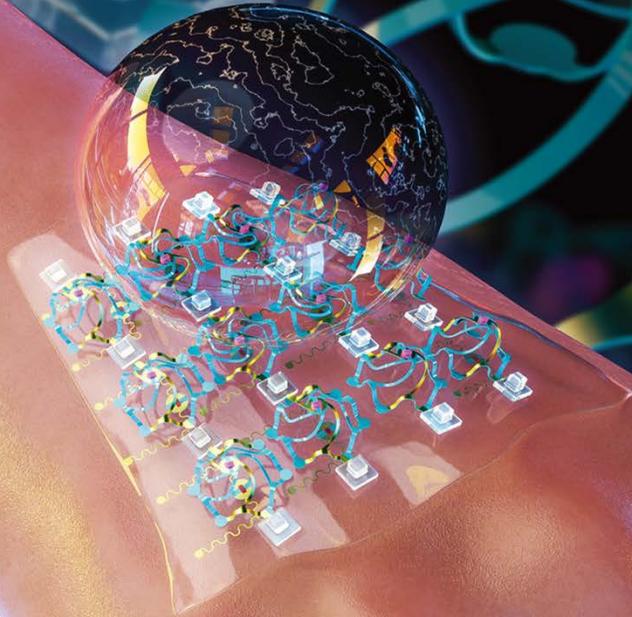


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# Toward Sustainable Smart Textile



KAI QI 10964089  
CUNHAO LYU 10930162  
PINYE ZHOU 10673995  
JIAYING ZHU 10768245

ABSTRACT

Recent years have seen the rapid growth of smart textiles in the global market. Furthermore, with growing concerns about the environmental impact of the fashion industry and injustices in the global supply chain, there is huge scope for the sustainable smart textiles market.

The group report follows the planned process model in Figure 1 and outlines possible scenarios for smart textiles towards sustainability. The analysis of the sustainability crisis and potential solutions will be sequentially presented in four main segments: **smart textile markets, materials, manufacturing techniques and supply chain.**

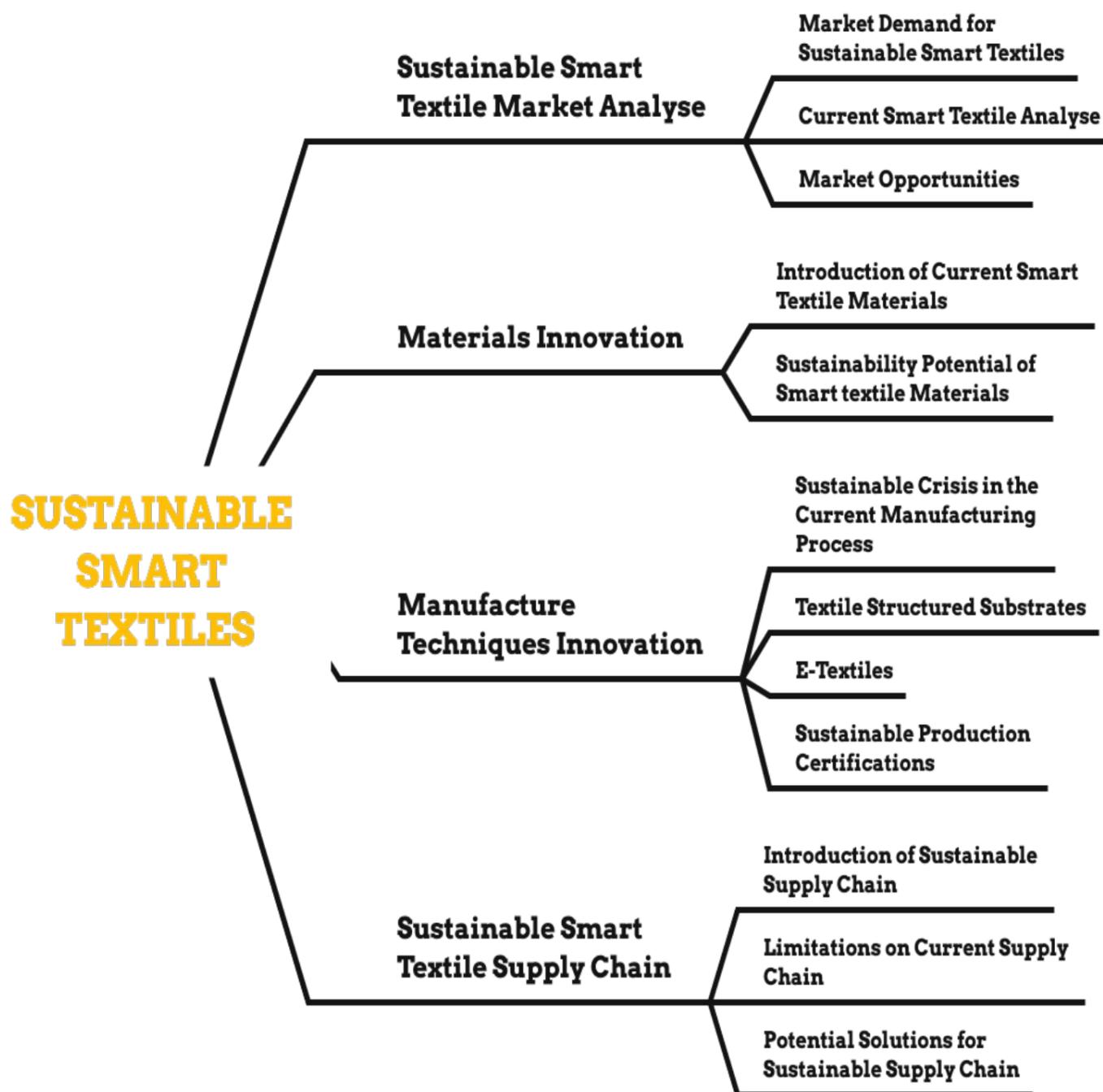


Figure 1. **Process model** of sustainable smart textiles. Created by Author.

HIGHLIGHTS

**MARKET ANALYSIS**

- Total market value is approxin
- Market structure for smart text
- **Competition.**
- Smart textiles market is domin
- **not fashion brands.**
- **North America** is the **main m**
- **Asia Pacific** is the **second larg**
- and has become the **fastest-gr**
- **labour cost advantage.**
- Fashion brands should actively
- companies.



Figure 2. Global Smart fabrics Market

**MATERIAL INNOVATION**

- Pioneering definition of sustain
- **intrinsic sustainability.**
- Materials Innovation : **Nanom**
- **Biodegradable materials.**

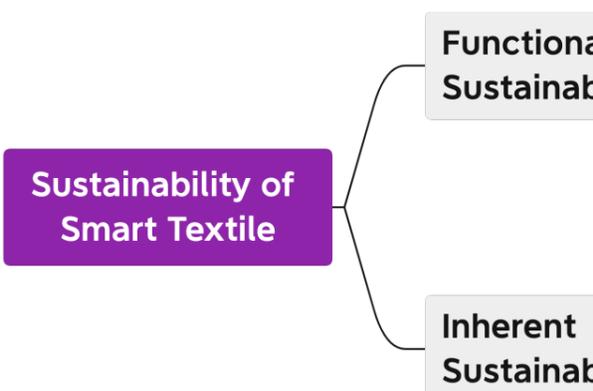


Figure 3. **Pioneering definition** of sustaina

# Smart Textiles

Yanye Zhou, Jiaying Zhu

University of Manchester



## KEY POINTS

Estimated market value: approximately £800 to £1.6 billion.

Market structure: Smart textiles as Monopolistic

Market drivers: Dominated by technology companies,

Market share: Market with a 36% market share.

Market dynamics: Largest market for smart textiles growing region due to its low

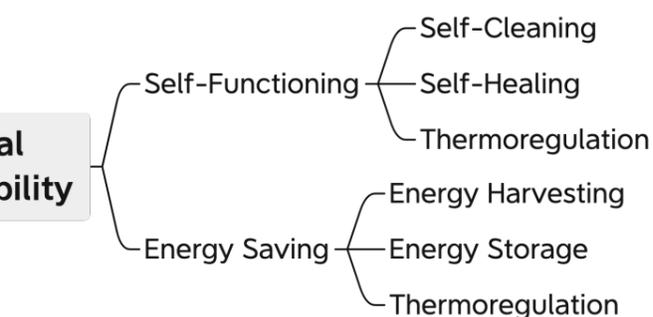
Market strategy: Companies collaborate with technology



Market growth rate. Created by Author.

Marketability: Functional and

Marketability: Sustainable Raw Materials, Bio-based materials,



Marketability of smart textiles. Created by Author.

## MANUFACTURING TECHNOLOGY INNOVATION

- Current challenges: **Environmental Pollution & Energy Consumption.**
- Advanced manufacturing technologies: **3D Printing, Electrospinning, Nanocoating, Thermal drawing, etc.**
- Developing sustainable production certification.

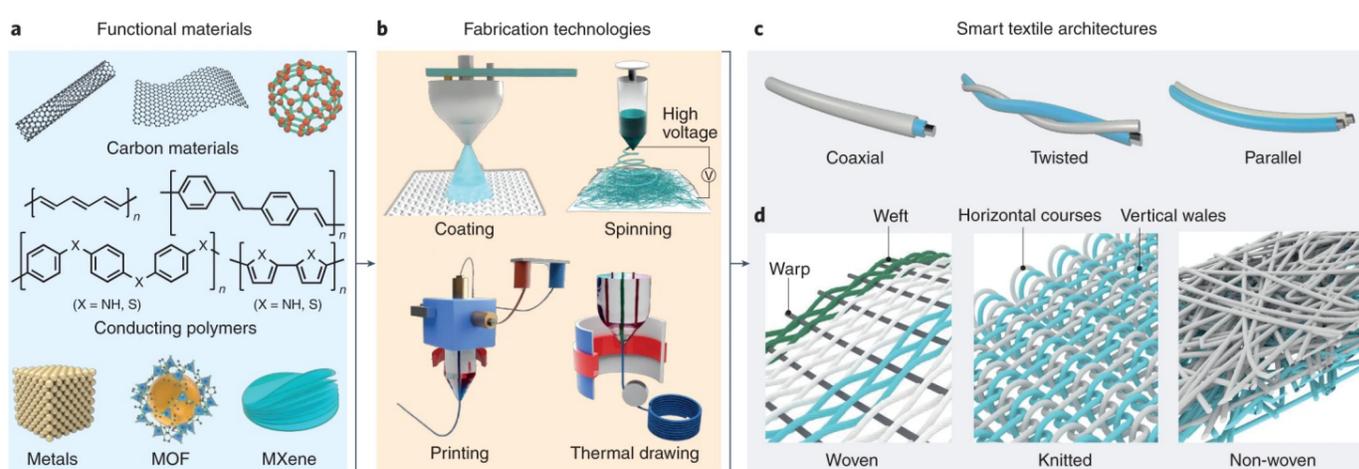


Figure 4. **Fabrication strategies** of smart textiles. Reproduced from Libanori, A. et al. (2022).

## SUPPLY CHAIN

- **Limitations:** Traceability, Environmental Friendliness, Warehouse Logistics management.
- **Potential solutions:** Blockchain Technology & Circular supply chain model.

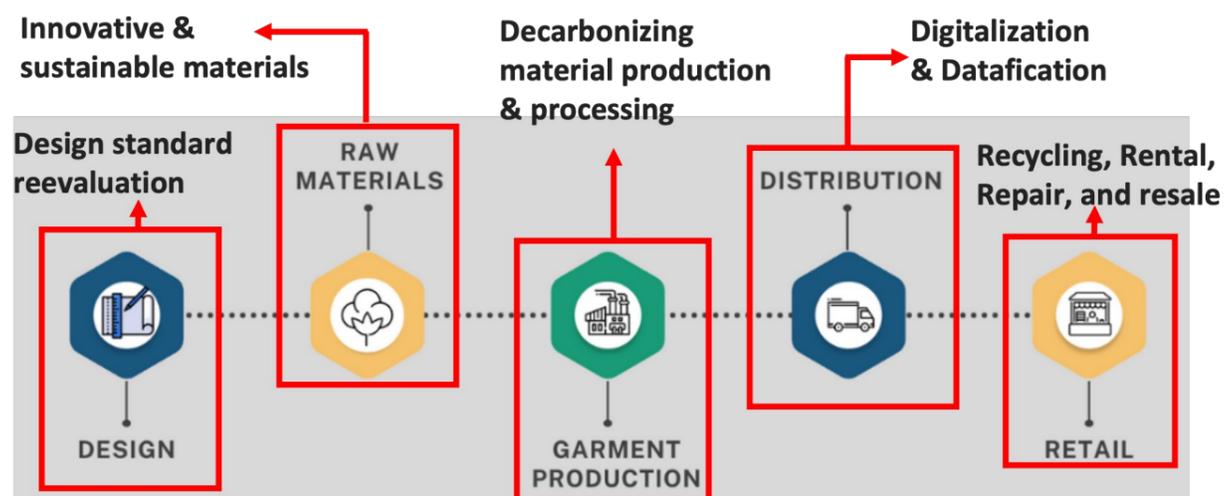


Fig. 5. **Improvement** in future sustainable supply chain. Created by Author.

## CONCLUSION

In summary, it is important to lay out the entire lifecycle of smart textiles in advance. The group report features an in-depth and extensive analysis of **four main segments**, by analysing the **potential markets for smart textiles**, researching **innovative materials**, developing **advanced manufacturing technologies** and increasing transparency in **supply chain**.



### 1. Smart textile Current issue

As the demand for Smart Wearable Apparel continues to rise, Sustainable Smart Textiles have the potential to revolutionise the textile industry, offering new possibilities for customisation, functionality and sustainability. But challenges ahead remain:

- Complex and unique manufacturing process
- Difficult to achieve reliable performance
- Waste in production

### 2. Solution

In the future, 3D print technology is expected to contribute to the progression of intelligent wearable devices by enabling the creation of complex and customized designs, reducing waste and incorporating sustainable textiles and production processes.

### 3. What is 3D print?

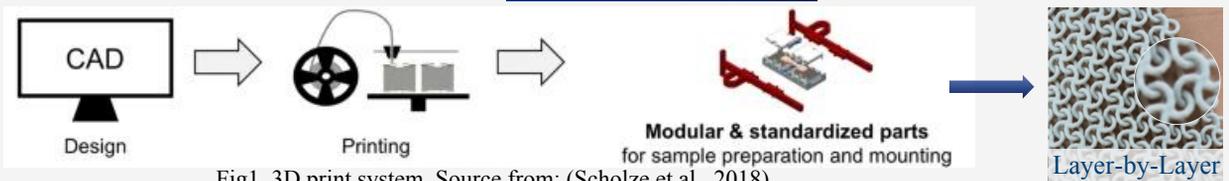


Fig1. 3D print system. Source from: (Scholze et al., 2018)

- Design Flexibility
- Faster Prototyping
- High-standardization
- High throughput

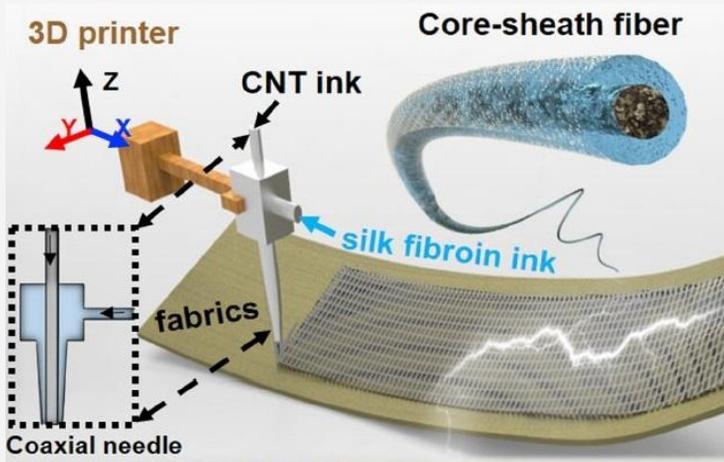
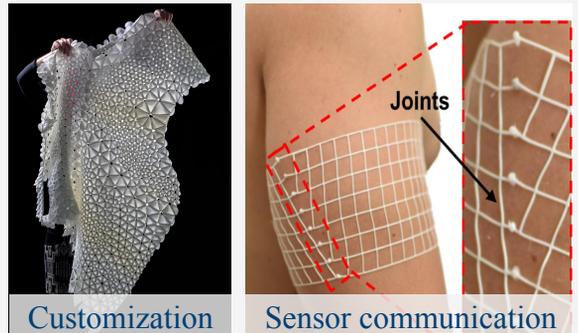


Fig2. 3D print with a coaxial nozzle. Source from: (Zhang et al., 2019)



**Why?---**3D printing enables the creation of **complex** and **custommiazation** designs and incorporates functional elements such as sensors and actuators into textiles.

### 4. How?—Circular economy 3D Print: Sustainable future

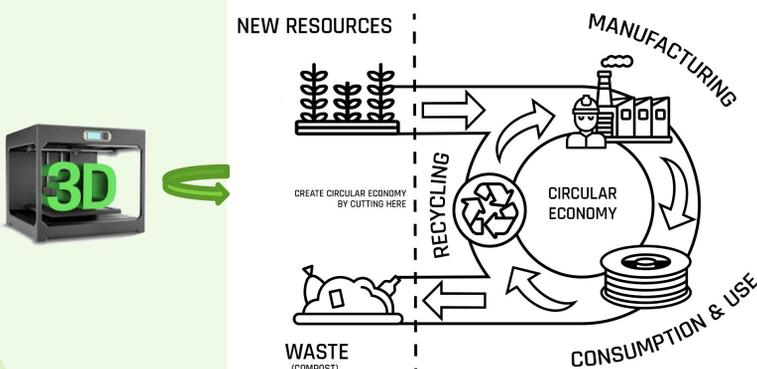


Fig 3. Circular economy principle. Source from:(3dprintingindustry, 2021).

**Reduced Waste:** 3D printing is a more sustainable manufacturing technology, generating less waste than traditional manufacturing methods.

#### Enviromental friendly

- ✓ Enables local production
- ✓ Reducing the carbon footprint
- ✓ Use recycled materials

Overall, 3D printing can impact smart textiles' sustainable development positively or negatively, depending on how they are designed, manufactured and used.



# Towards Sustainable Smart Textiles: Material Innovation

Kai Qi

kai.qi-2@student.manchester.ac.uk

## INTRODUCTION

Smart textiles are a multifaceted concept comprising **functional textiles** and **electronic textiles**. They are capable of sensing and responding to environmental stimuli. However, smart textiles are confronted with heightened sustainability concerns due to their incorporation of **electronic components** and **complex chemical agents** (Fig 1), which sets them apart from traditional textiles.

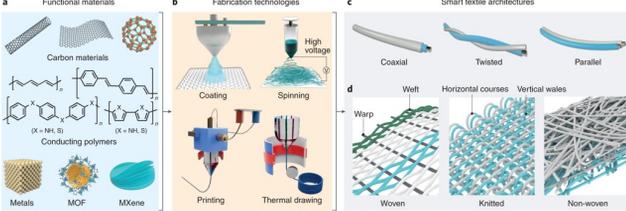


Fig. 1. Fabrication strategies of smart textiles. Reproduced from Libanori, A. et al. (2022).<sup>1</sup>

## MATERIAL INNOVATION

- Functional Sustainability: **Nanomaterials**
- Inherent Sustainability: **Bio-based/ Biodegradable MATL.**
- Future: **Bio-based electronic devices**

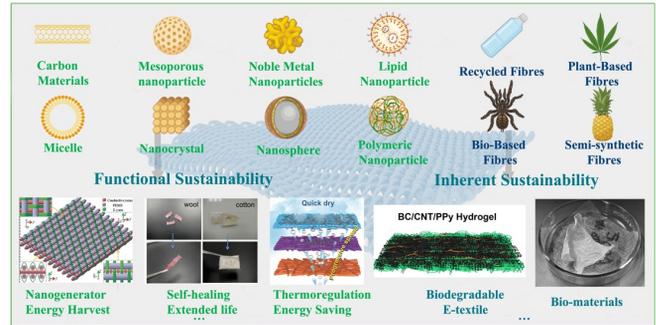


Fig. 4. Material innovation of future smart textiles. Created by Author.



Fig. 3. Analysis of current smart textile materials. Created by Author.

## KEY POINTS

- **Current Challenges:** Environmental & Technical issues
- **Pioneering Definition:** Functional & Inherent sustainability
- **Focused Micro-solution:** Material Innovation

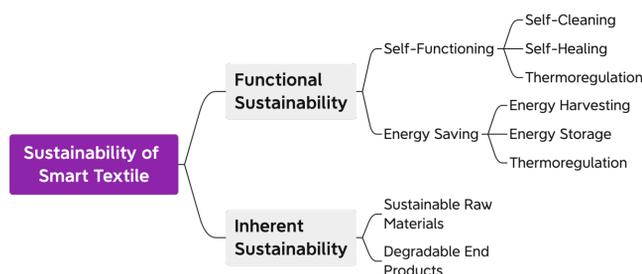


Fig. 2. Definition of sustainability in smart textiles. Created by Author.

## CONCLUSION

Analogous to fast fashion, smart textiles have the potential to captivate the market, yet concurrently pose significant environmental and ethical dilemmas. Developing **high-performance nanomaterials** as well as **bio-based materials** will lead to sustainability through functionality and recyclability. Furthermore, **indicators** for the evaluation of functional sustainability should be established.

## REFERENCE

1. Libanori, A. et al. (2022) "Smart textiles for personalized healthcare," *Nature Electronics*, 5(3), pp. 142–156. Available at: <https://doi.org/10.1038/s41928-022-00723-z>.



# Towards Sustainable Smart Textile: Manufacturing Techniques Innovation

CUNHAO LYU

cunhao.lv@student.Manchester.ac.uk

## INTRODUCTION

Manufacturing techniques innovation can achieve smart textiles sustainability by efficient use of resources, energy-saving and pollution reduction, increased lifespan, durability, and customization (Bureau, 2021).

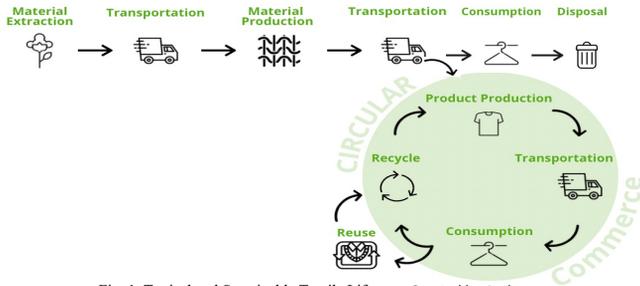


Fig. 1. Typical and Sustainable Textile Lifespan. Created by Author.

## TECHNIQUES INNOVATION

Innovations in textile technology can be applied throughout the entire production process, from design to finishing.

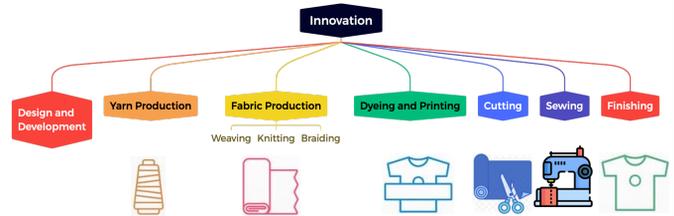
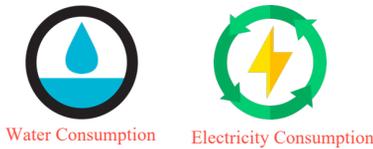


Fig. 2. Possible Techniques Innovation. Created by Author.

### Environment problems



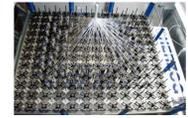
### Technical Bottlenecks



### Current Technologies Enhancements



Rotor spinning



3D braiding



Air-jet loom



Whole garment knitting

### Emerging Technologies



Laser cutting



3D printing



Ultrasonic Welding



Digital Printing

Issues

Solutions

Fig. 3. Problems faced and solutions. Created by Author.

## HIGHLIGHTS

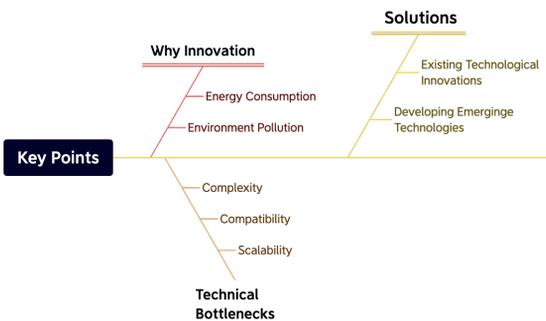


Fig. 4. Key Points. Created by Author.

## CONCLUSIONS

Achieving sustainability in production technology is something that is good for both people and the earth. This can be achieved through the **improvement of existing technologies** and the development of **emerging technologies**.

## REFERENCES

Bureau, N.S. (2021) *Sustainable fashion: Identifying fast fashion flaws and extending the life cycle of clothing*, Green Business Bureau. Available at: <https://greenbusinessbureau.com/industries/fashion/sustainable-fashion-identifying-fast-fashion-flaws-and-extending-the-life-cycle-of-clothing/> (Accessed: April 29, 2023).



### INTRODUCTION

The macro topic from group work focuses on the sustainability issues of smart textiles, which enhance their functionality through technology, and have more complex procedures in the supply chain than conventional textiles, leading to more environmental problems. However, the whole fashion industry, which produces 200,000 and 500,000 tonnes of microplastics from textiles to the marine environment each year, and about 20% of global industrial wastewater pollution, faces the most serious sustainability issues.

### FASHION SUPPLY CHAIN CHALLENGES

Current challenges of the fashion supply chain can be included in the following parts. Improving the traceability of the fashion supply chain, including the ability to accurately track products and materials etc., can effectively address existing supply chain challenges and pressure.



Fig. 1. Current challenges in the fashion supply chain, created by the author

### MICRO SOLUTIONS

Figure 2 demonstrates several technology opportunities for supply chain across the fashion industry, and Blockchain and AI technology will be used for developing a sustainable and transparent supply chain system.

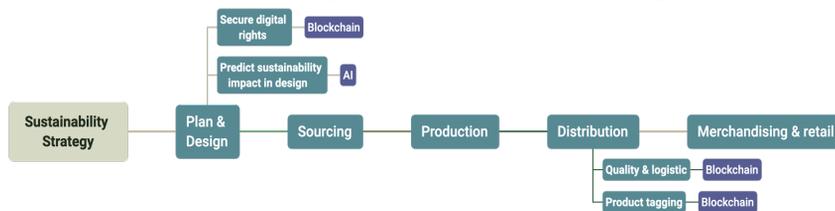


Fig. 2. Technology opportunities in fashion supply chain, created by the author

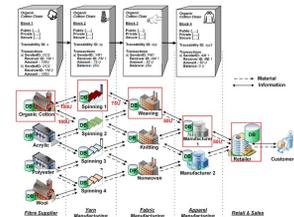


Fig. 3. A complex T&C supply chain network with a marked partner involved in the example scenario. (Agrawal, T.K. et al., 2021)

1) **Blockchain:** It can enable more transparent and accurate end-to-end tracking in the supply of different supply chain, resulting in greater transparency in the supply chain. Fig 3 provides an example of A complex T&C supply chain network with a marked partner involved in the example scenario. (Agrawal, T.K. et al., 2021)

2) **AI:** Achieving supply chain traceability requires the collection of a large amount of complex data from rces, formats and languages. AI captures data and automatically identifies extracts, classifies and links data from several different sources to improve overall data quality.

### EVIDENCE

- Alexander McQueen:** MCQ was the first fashion brand to have an entire label traceable on blockchain.
- Walmart:** Walmart is utilizing Blockchain to add transparency to the food supply ecosystem by digitizing the entire food supply chain process.

### REFERENCES

Forbes, 2022. Available at: <https://www.forbes.com/sites/forbestechcouncil/2022/03/18/why-fashion-supply-chain-traceability-is-a-tech-challenge-that-begins-with-ai/?sh=34b787355f6d>

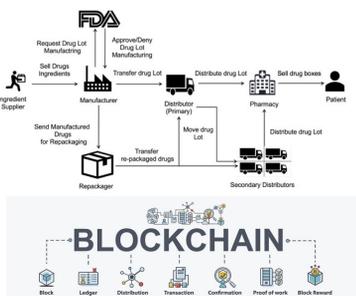


Fig. 4. Examples of blockchain technology used in supply chain