SUSTAINABLE FASHION

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-Potential Direction for Technological Development

Sustainability

Circular Business

Recycle

The overgrowth of the fashion industry in the past decades, dominated by a linear model, has led to many problems, making sustainable fashion a focus of both industry and academic attention. Sustainable fashion is a macro and multi-faceted subject, with technology being one of the key drivers in many of the approaches and practices towards sustainable fashion. This report discusses the current landscape and future of technology in sustainable fashion around a number of interrelated and inclusive themes. It is also worth noting that other drivers and players within and outside the fashion industry simultaneously influence the development and application of technology during the fulfilment of sustainable fashion.

Process Model for this Report

DEFINE MACRO TOPIC

Overview of Sustainable Fashion

TARGET MAIN THEMES

Waste, New Materials and Products, Business Model

OVERVIEW OF CURRENT LANDSCAPE

Academic and Industrial

CONSUMER AND MARKET

Market trend in Sustainable Fashion

OPPORTUNITIES AND CHALLENGES

Align technical issues with market trends

DIRECTIONS AND LIMITATIONS

Indicate potential direction

Introduction

Sustainability in fashion can be analyzed from three interrelated perspectives: **economic, social, and environmental,** each comprising different subfactors (Elkington, 2008). Currently, fashion scholars and practitioners are not only concerned with economic performance, but social and environmental aspects are also receiving more attention than ever before in the past decade (Mckinsey, 2022; Mukendi et al, 2020). While sustainable fashion (SF) has become a major area of academic research and business practice, it still lacks a clear-cut definition (Henninger, 2016). In this paper, SF is defined as **all movements aimed at making fashion-related subjects more sustainable**, including but not limited to waste reduction, animal welfare, and human rights, etc (Mukendi et al, 2020).

Technology is a critical driver that enables sustainable fashion to thrive and develop, with multiple advanced technologies being applied throughout the fashion industry (Peter et al, 2014). Some of the technologies have proved to make fashion more sustainable, such as blockchain, which improves supply chain transparency, and 3D knitting, which reduces material waste (Scaturro, 2008).

This paper aims to review technologies applied in three important themes of sustainable fashion, which are **waste, sustainable business model and new material and from of fashion** (metaverse) (Figure 1.1). It will then suggest the potential direction for technological application and development in these areas.

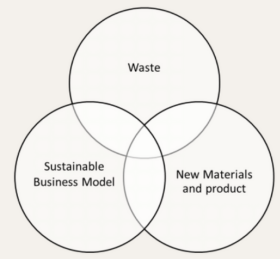


Figure 1.1
Themes of sustainable fashion in the report

Introduction of SF

In the Target Main Themes Part, Waste is the main focus. Sustainable Materials and new form technology and Circular business model are also mentioned. With both micro topics are focusing on waste combining with circular business, we researched them as the main theme, while sustainable materials and technology are aligned and also worth to be researched.

Then comes the market analysis for the sustainable fashion. Pie charts and line graphs are made to clearly illustrate the upward trend in the future, which shows the importance for us to research in this area. A general opportunities and challenges for the three main themes are also listed to give a clear vision of the current situation.

Finally, suggestions and limitations part give the specific limitations and further technical research opportunities based on three main themes. Overall, 71 references are used in this report.

The theme of waste in sustainable fashion has been highlighted a serious issue in various sustainable fashion theories, thus warranting considerable attention in this report.

Shown in Figure 2.1.1, the textile and fashion industry involves a **long and complex supply chain**, where different forms of waste are produced, including textile, energy, water, etc (Shirvanimoghaddam et al, 2020; Jacometti et al, 2019). Textile waste, in particular, has emerged as a major global concern, with the whole fashion industry generating over 92 million tonnes of textile waste annually (Niinimäki et al, 2020). Waste is generated at every stage of the textile and fashion value chain from **production** to **consumption**, and generally, it can be classified into two categories, namely **pre-consumer waste** and **post-consumer waste** (Shirvanimoghaddam et al, 2020).

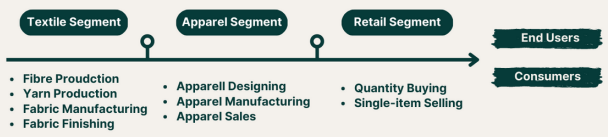
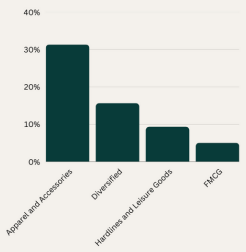


Figure 2.1.1 Traditional Apparel Pipeline (Auther's own, 2023)

FASHION SHOWED THE FASTEST GROWTH YOY IN CONSUMING SECTION

Figure 3.1.1 Fashion industry grows faster
Source: Deloitte Global Powers of Retailing 2023



THE FASHION INDUSTRY RETURNS TO GROWTH, WITH SUSTAINABLE NICHES AND CIRCULAR FASHION BUSINESS MODELS TAKING AN INCREASING SHARE OF

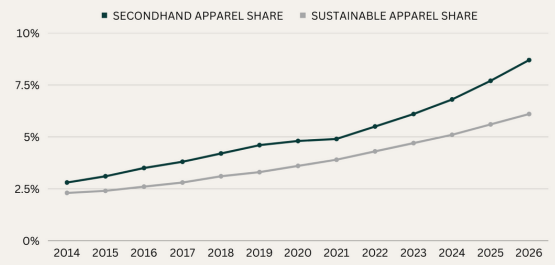


Figure 3.1.2 The growth of sustainable fashion (Statista, 2022)
Source: Statista Global Consumer Survey (2022)

4.1.1 Sorting and identification: develop a cheaper and more accurate method for all wastes

Due to the complex material composition of waste, identifying and sorting it in order to allow more materials to be accurately recycled is a problem that technology needs to address. In addition to traditional physicochemical techniques such as thermogravimetric analysis and infrared spectrometer techniques, identification methods based on digital technologies such as AI and ML(Machine Learning) currently have advantages in terms of accuracy and cost for some materials but are not yet applicable to all materials (Damayanti, 2021). The widespread use of LoT and blockchain technology is expected to identify and sort waste in a retrospective manner, but both will take longer to become widespread (Luscuere, 2017; Damayanti, 2021).

4.1.2 Cost and production volume: develop a more efficient way

Existing mechanical or chemical recovery methods have shortcomings in terms of volume and cost, due to factors such as complex processes and energy consumption, therefore recycling technology needs to seek breakthroughs in process optimization and reduction of resource consumption (Wener and Carmalt, 2006; Damayanti, 2021).

4.1.3 Recycled material performance

Consumer research shows that quality is still the most important element of clothing (Mintel, 2019). Existing recycling technologies damage the fibers and thus affect the fabric quality, especially natural fibers (EAC, 2019). To ensure the quality of clothing made from recycled materials, recycling technologies that are less damaging to the material need to be developed.

4.1.4 Environmental impact: less pollutants and consumption

The process of material recycling inevitably generates chemical pollution and consumes resources, such as water and energy, and recycling technology should be developed in a direction that minimizes these environmental impacts (Yousef et al, 2020; Sustainfashion, 2023).

Main Themes

Market Trends

Justification

Technology Project | Group 4 | Jiamian Wang, Jun Liang

POST-CONSUMER WASTE RECYCLING

Introduction
Challenge
Potential Solution

MANCHESTER 1824
The University of Manchester

- A process turning textile waste into new fibers that are then used to create new garments or textile products

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Fashion and textile industry is a highly resource-intensive and waste generating industry. As the industry experiencing a transformation from linear to circular, several methods are developed to make fashion industry more sustainable. Upon all methods, one of the most sustainable and scalable levers available is post-consumer waste recycling.

Currently, less than 1% of textile waste is fiber-to-fiber recycled due to various obstacles need to be overcome.

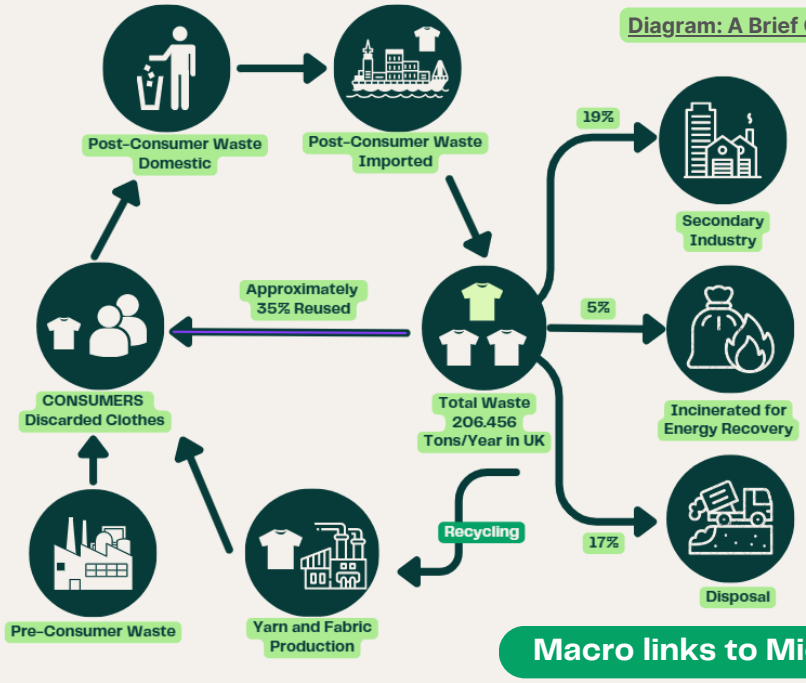

Diagram: A Brief Circular Model of Fashion Industry Created by Author

Macro links to Micro

Micro Challenge

1.Sorting
Sorting and separation of the different fibre types from each other and from impurities such as zippers and buttons. Advanced, accurate, and automated fiber sorting and preprocessing are not yet developed.

2.Sourcing
Lack of systematic and efficient sourcing of waste textiles for the recycling technology developers

3.Mixed Fibre Issue
Clothing labels don't always give accurate information on fiber composition

4.Toxic chemicals
During the process of recycling used garments containing toxic chemicals, these chemicals remain persistent and cause further contamination of newly produced recycled fabrics, which creates a significant barrier for safe and efficient recycling practices.

5.Downcycling
The quality of the re-produced material lower than its equal product made by virgin raw material.

Potential Micro Solution

1. 3D Printing
Help customization, upcycling, efficient production and closed-loop recycling

2. Advanced Textile Sorting Technology
Scanning technology such as near-infrared scanning systems (NIRS) can be used to overcome the sorting level, by identifying composition and properties of a material without damaging or altering it.

3. Advanced Chemical Recycling
Method such as enzymatic recycling are making progress to address the existing toxic chemical challenge, and it requires further development.

4. Nanotechnology
Purify specific material from waste, help in toxic chemicals challenge; Creation of new material; Enhance the efficiency of recycling process.

5. Blockchain
To improve the traceability, transparency and efficiency, blockchain technology can be applied to eliminate sourcing challenge.

6. Biochemicals
Biochemicals such as UPM's BioPura bio-mono ethylene glycol (MEG) are fully researched to create a holistic circular economy in the polyester value chain, while it requires further research.

7. Collaboration
Standardisation should be setted to ensure the quality, and regulatory action could help prevent some issues, simplifying feedstock sourcing for recyclers and driving up collection rates (currently 30%).

"Textile recycling at scale could help solve waste problem – an 18 to 26% post-consumer recycling rate could be achieved by 2030" -Mckinsey&Company

Top 3 References

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