FASHION PRODUCT INNOVATION

Name : Dhaya Sivakumar
MMU ID : 22530677

Appendix

Images

Introduction

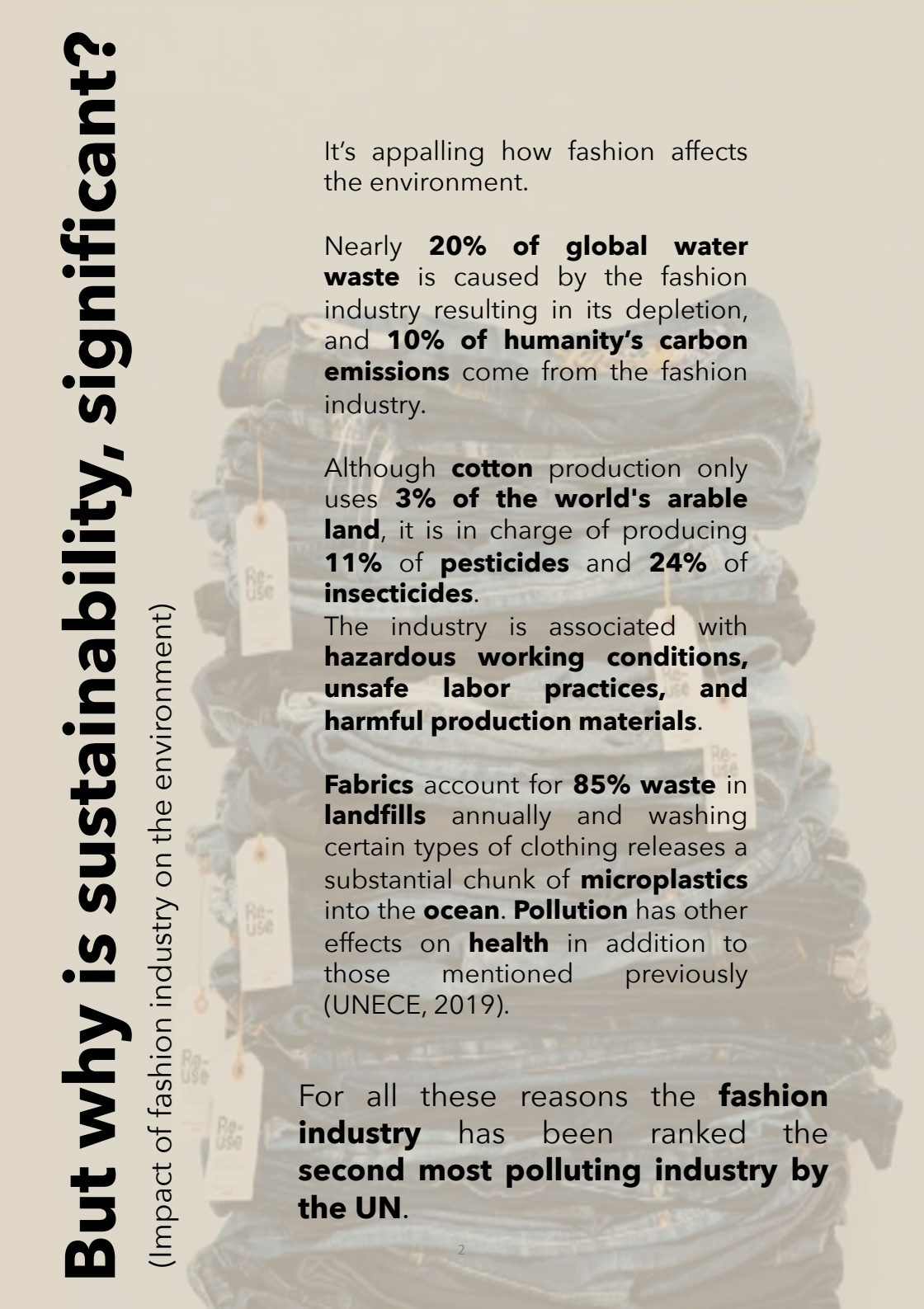
From early 2021 to mid-2022, the fashion sector underwent an intense 18-month period of expansion and is now in need of transformation. Under the category of 'Fashion System', **'Circular textile'** is one of the three most important categories of the ten topics McKinsey predicts will affect the fashion industry in 2023.

Consumer interests and the fashion agenda are more focused on sustainability than ever. Consumers are interested in the **origins of resources, the manufacturing process, and the treatment of workers**. In response, an increasing number of businesses are growing their sustainable product lines (Amed et al., 2022).

(Fig 1)

But why is sustainability, significant?

(Impact of fashion industry on the environment)



It's appalling how fashion affects the environment.

Nearly **20% of global water waste** is caused by the fashion industry resulting in its depletion, and **10% of humanity's carbon emissions** come from the fashion industry.

Although **cotton** production only uses **3% of the world's arable land**, it is in charge of producing **11%** of **pesticides** and **24%** of **insecticides**.
The industry is associated with **hazardous working conditions, unsafe labor practices, and harmful production materials**.

Fabrics account for **85% waste** in **landfills** annually and washing certain types of clothing releases a substantial chunk of **microplastics** into the **ocean**. **Pollution** has other effects on **health** in addition to those mentioned previously (UNECE, 2019).

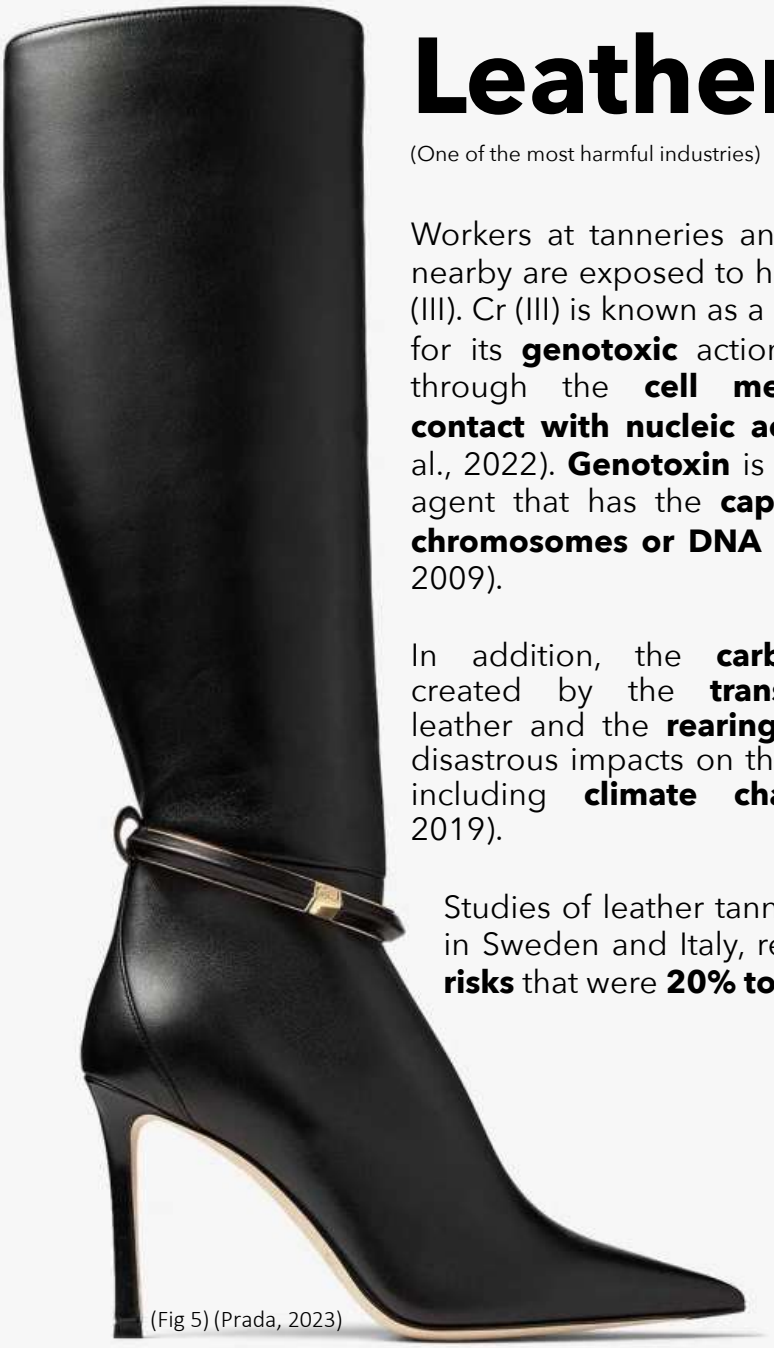
For all these reasons the **fashion industry** has been ranked the **second most polluting industry by the UN**.

The **UN Conference** in New York on September 25–27, 2015, officially unveiled the **2030 Agenda for Sustainable Development** (fig 4), which aims to **eradicate poverty** in. The UN 2030 Agenda envisions a future where there is **unwavering respect for human rights, human dignity, the rule of law, justice, equality, and non-discrimination** (UN Agenda, 2030).

(Fig 2)

(Fig 3)

(Fig 4)



(Fig 5) (Prada, 2023)

Leather

(One of the most harmful industries)

Workers at tanneries and others living nearby are exposed to high levels of Cr (III). Cr (III) is known as a powerful agent for its **genotoxic** action if it can get through the **cell membrane into contact with nucleic acids** (Dubey et al., 2022). **Genotoxin** is a substance or agent that has the **capacity to harm chromosomes or DNA** (Phillips & Arlt, 2009).

In addition, the **carbon footprint** created by the **transportation** of leather and the **rearing of cattle** has disastrous impacts on the environment, including **climate change** (Lerace, 2019).

> Studies of leather tannery employees in Sweden and Italy, revealed **cancer risks** that were **20% to 50% higher**.

Impacts of tanning process

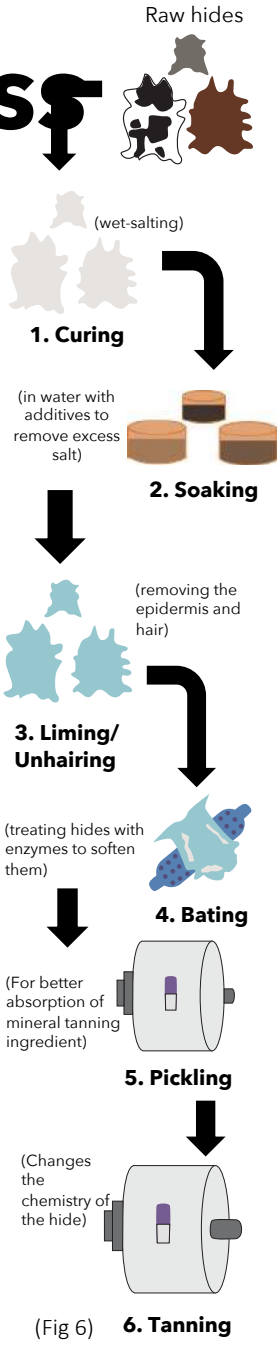
Many issues have been encountered in the tanning business to varying degrees, including **air and water pollution, pervasive odors, hazardous gas poisoning, and improper waste disposal**. Yet, pollution from tanneries, like pollution from any significant sector, has a **detrimental long-term effect** (Nazer et al., 2006).

Wastewater from chrome tanning is extremely **contaminated**. During this procedure, 70% of the total chromium (III) is released (Morera et al., 2011) involving the utilisation of a lot of water.

Leather processing creates ineffective current disposal of **solid wastes** through **landfilling** and **incineration** leading to contamination (Muralidharan et al., 2022).

Tanning generates a significant quantity of **methane**, a greenhouse gas that is at least **20 times more potent than carbon dioxide.**

It is no doubt that the **environment** is **significantly impacted** by the leather industry.

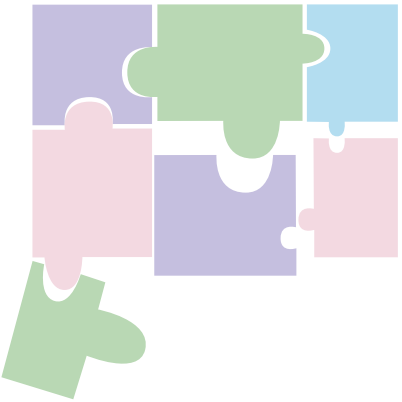


(Fig 6)

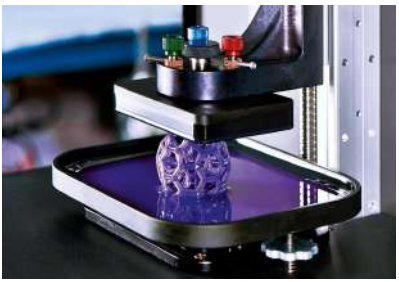
Possible solutions to these problems

Brands have developed several ground-breaking concepts including **recycling and upcycling techniques**.

A few well-known methods may include **3D printing** (Fig 9), **mono materials**, **biodegradable textiles** (Fig 7) (made from pineapple, mushrooms, pomegranate; etc.) **zero waste pattern cutting** (Fig 8) and **recycling garbage into wearables**.



(Fig 8)



(Fig 9) (Boysan et al., 2022)

(Fig 7) (Greenfield, 2022)

Movements including the Extended **Producer Responsibility for Textiles** by France, and the **Sustainability Development Goals** by the United Nations, are promoting and **creating awareness by connecting with fashion brands and consumers** through multimedia for a more sustainable future.

Possible replacement for leather

Although processes like **chrome free tanning, vegetable tanning and sustainable options using synthetic leather such as PVC (polyvinyl chloride), Mylo (mushroom leather), ensure less impact**, plant leathers can be **expensive to create and difficult to generate in big numbers** and, they are **not as strong as genuine leather either.**

Through constructive research one of the most possible substitutes could be 3D Printing products.

3D Printing

The additive fabrication method that first emerged in the 1980's (A. Savini, G. G. Savini, 2015) is a **layer-by-layer manufacturing process** used in three-dimensional printing (3DP) and uses 3D modelling data to create objects in a variety of geometric forms (Park & Lee, 2019).

Bionics

(Fig 10)(V, 2020)

Food industry

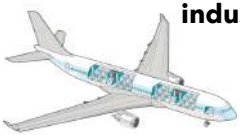
(Fig 11)(Goulding, 2018)

(Fig 12)(Starkey, 2019)

Healthcare

(Fig 15)(Grunewald & Grunewald, 2021)

Aviation industry



(Fig 14)(Stratasys Direct, 2016)

Gaming industry

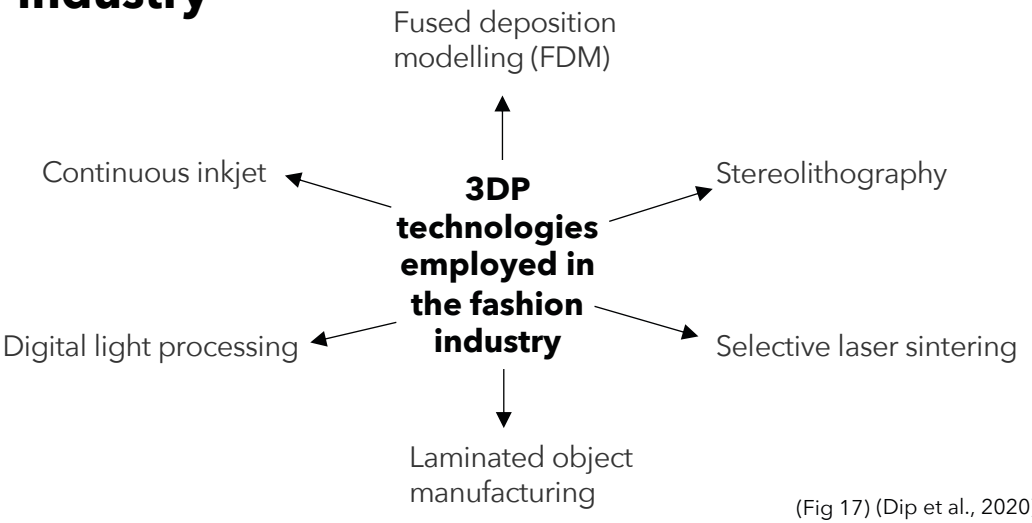
(Fig 13)(Cult, 2022)

3DP in Fashion

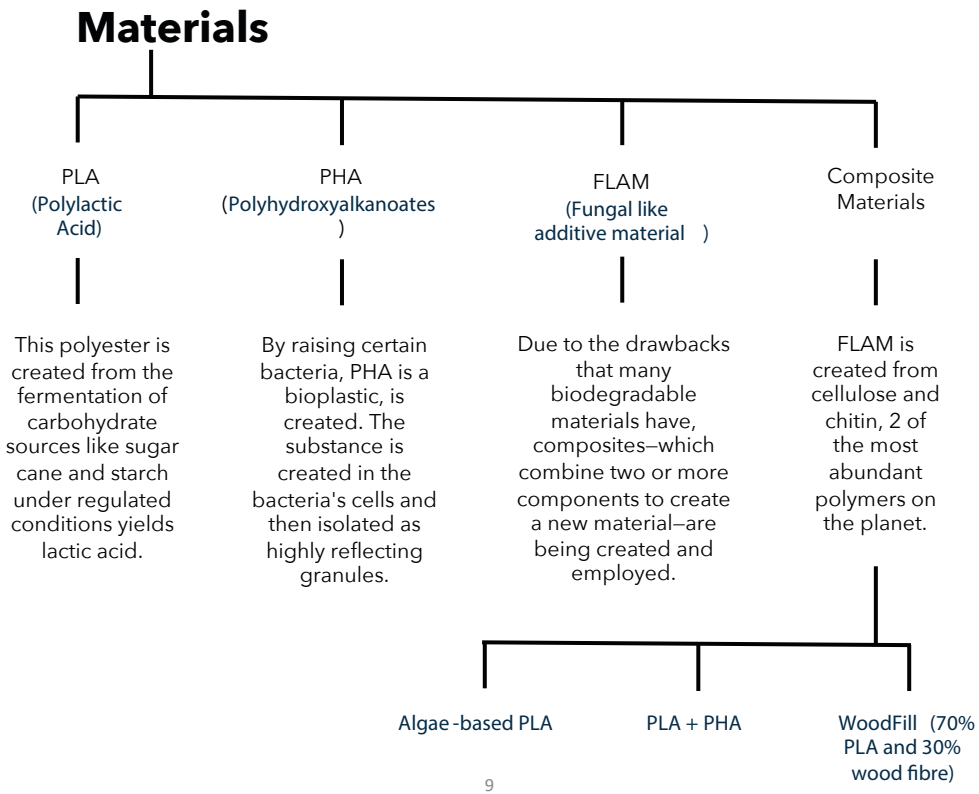
Promotional efforts and interest in **3DP for fashion has surged** during recent years, it has influenced the **apparel industries** (Lee, Eom, & Lee, 2019) to incorporate it as an **alternative to conventional production** procedures (Vanderploeg, Lee, & Mamp, 2017).

(Fig 16) (Pownall & Pownall, 2022)

3DP technologies employed in the fashion industry



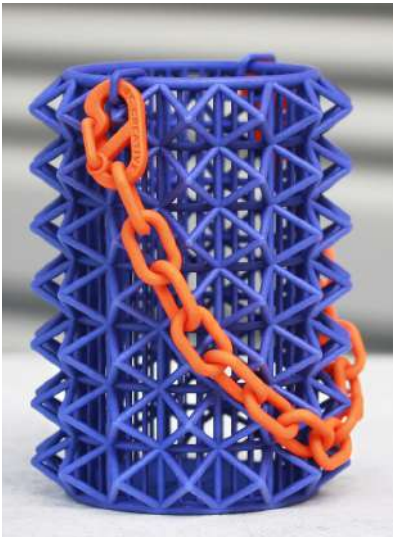
(Fig 17) (Dip et al., 2020).



(Fig 18) (Materials used in FDM 3D printers)

Concept pitch

In 2023, the **Luxury Leather Products** category will bring in **US$3.12 billion** in the UK, with majority of the revenue generated from the US (Statista, 2023), with **personal luxury goods being the highest**. The proposal is to incorporate **3D printed bags as substitute to leather goods** ensuring a more environmentally friendly strategy to fulfil the UN Agenda 2030.



(Fig 19)(Iva, 2021)

(Fig 20) (Parker & Parker, 2021)

PRADA

An integral component of the Italian luxury fashion house **PRADA**, **specializes on leather accessories for the fashion industry** (Prada group, 2023).

(Fig 21)(Prada, 2023)

3DP technology suitable for this concept

Considering the **wide range of materials** that can be used in this technology, the **Fused Deposition Model (FDM)** can be cultivated.

(Fig 22) (Ashton, 2023)

PLA Filament

FDM is an **additive manufacturing technique**, that selectively **deposits melted material** along a preset route to construct components layer by layer. To create the finished physical items, **filaments of thermoplastic polymers** (fig 22) are used (Mazzanti et al., 2019).

It is the largest installed base of 3D printers globally, considering its **ease of use, speed, and cheap cost, rapid prototyping, and the design of composite components** (Garzon-Hernandez et al., 2020). Also, considering its **strength and flexibility, this works well as a leather substitute while preserving the shimmer.**

(Fig 23) (Ashton, 2023)

FDM 3D Printer

FDM printers (fig 23) deposits a thermoplastic or other molten printing substance or polylactic acid (Too et al., 2002). The printing component is heated to a liquid state within a layer-by-layer stream of molten polymer is produced after being first extruded via a nozzle. Each layer follows the CAD file, starting with the item's form before moving on to the filling mechanism. (Dip et al., 2020).

Benefits of replacing leather products **by 3DP**

3DP techniques are naturally "green" and sustainable since each item is created using a certain amount of resources without any waste due to its mechanism of successive layering (Sitotaw et al., 2020). As a result, an object can be shaped without the use of additional equipment or unwanted material waste (Campbell, Williams, Ivanova, & Garrett, 2021).

The use of **bioplastic spools** rather than leather significantly lessens the environmental effect. There is no use of water, nor any animals involved in the process. Although bioplastics are utilized, PLA, the most popular kind, is **not harmful and is approved for use in food packaging** (Mazzanti et al., 2019).

A drastic **decrease** in the length of the **textile production chain compared to traditional textile manufacturing,** this may help offset the issue of the commercial 3D printers' present slow pace (Dip et al., 2020).

Also, the **time** between a concept and a finished product is shortened, **transportation demands** are reduced, and **Low energy consumption** is **maintained** (Partsch et al., 2015).

Fashion industry, renowned for their **intricate work requiring expensive apparatus, cumbersome workflows,utilization of labor**, and tons of **waste** all of which may be **diminished**, and few even **disregarded** with this transformational technology (Sun & Lu, 2015).

2020 research found that the combination of Real printing, CAE modelling, and 3D scanning may create incredible opportunities for the creation of personalized goods (Ahrendt & Karam, 2020). Considering the **high level of customer satisfaction** Prada achieves, this might be a **key sales driver.**

The 3DP method is highly **cost-effective** since it doesn't require the processes necessary for conventional production, inventory, storage, packing, and shipping (Spahiu et al., 2020; Vanderploeg et al., 2017).

Consumers

There **isn't much study** on how consumers currently feel about this technology. Although **past studies** show that majority of those who responded in several **surveys** held the view that **3DP will be helpful for the manufacture of clothing**, but that it **cannot yet completely replace clothing made in the conventional manner** (Corral & Walker, 2017; Spahiu et al., 2020). As a result, it is yet **unable to be used in the production of regular textile garments** (Chakraborty & Biswas, 2020).

Limitations

Even though it aids in waste reduction, a significant obstacle is presented by the loss of traditional fabrics' softness, elasticity, moisture management, **and capacity to regulate heat, as well as by their lack of flexibility, comfort, and strength** (Korger et al., 2020; Mpofu et al., 2020). Due to its layer-by-layer manufacturing, problems with **viscosity** are also seen (Spahiu et al., 2020).

Even though 3D printing enables increasingly complex designs, **not all printers produce at the same quality**. When contrast to SLS, **FDM has the drawback of only permitting a limited amount of micro printing** (Kim et al., 2019). Another notable flaw is the **raw material's incompatibility with the printer** (Kumar et al., 2019) since **information** might be **misleading**.

Moreover, when different pieces are made, it is **challenging to combine** them into one due to the **contact area being comparatively smaller** (Spahiu et al. 2020).

Nonetheless, when the benefits outweigh the drawbacks, 3DP contributes to a significant decrease in waste and practices that affect the environment. While being a new technology that is growing, 3DP still has a long way to go.

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