Impact of COVID-19 on Sustainability in Textile & Clothing Sectors

Bhagyashri N. Annaldewar, Nilesh C. Jadhav, and Akshay C. Jadhav

Abstract There has been a severe setback towards the sustainability in textiles and clothing sector due to the outbreak of the COVID-19 global pandemic. There has been a loss of momentum towards sustainable textile production, and also the 3R's (Reduce, Recycle and Reuse) have taken a back seat. This brings into line the zero-waste hierarchy concept for a circular economy by taking specific initiatives like rethink/refuse/redesign, implementing 3R's, composting, material and chemical recovery, etc. The outbreak of COVID-19 has forced the textile sector to focus on developments that will enhance human beings' protection by producing antiviral clothing materials such as personal protective gears like private protective suits, masks, hand gloves, etc. This personal protective equipment (PPE) has generated a waste mountain of PPE worldwide and has created havoc in terms of sustainability. This chapter will emphasise the impact on sustainability in terms of textiles and clothing industries in detail. It will contribute towards cleaner production and sustainability in the textile sector because of COVID-19 by taking a step towards the opportunities for change in textile processes as per the laws. In addressing these inquiries, we use a structure for analysing sustainability and the textile and garments sector, featuring the chances and difficulties for a sustainable change concerning design, production, utilisation and end-of-life. This chapter's primary concern is to identify whether the ongoing pandemic will support the sustainability evolution concerning the textile and clothing sector.

Keywords COVID-19 · Sustainability · Textiles · Waste management · Supply chain

B. N. Annaldewar · N. C. Jadhav · A. C. Jadhav (✉)
Department of Fibres and Textile Processing Technology, Institute of Chemical Technology, University Under Section-3 of UGC Act 1956, Mumbai 400019, India

S. S. Muthu (ed.), *COVID-19*, Environmental Footprints and Eco-design of Products and Processes, https://doi.org/10.1007/978-981-16-3860-2_4

1 Introduction

Ever since the outbreak and development of COVID-19 in Wuhan city, China, during the late December of 2019, medical care units around the entire globe have battled to restrict the spread of the contamination. The causal specialist, SARS-COV-2, is a respiratory infection that belongs to the coronavirus family which is firmly identified with 2003 SARS-COV-1 known as severe acute respiratory syndrome coronavirus epidemic and 2013 MERS known as middle east respiratory syndrome outburst. The virus infection proliferates locally by human-to-human transmission due to hand to mouth transmission from defiled surfaces or due to inhalation of contaminated respiratory droplets are suspended in the air. The distinctive highlights of SARS-COV-2 are that it is profoundly infectious, with actual multiplication numbers going from 1.4 to 7.2 and is exceptionally pathogenic, with casualty rates in the scope of 1.4% in New Zealand to 14.9% in the United Kingdom. Within seven months since its first presence, COVID-19 has infected more than 18 million individuals over 180 nations and killed more than 700,000 individuals. The medical authorities urgently attempt to discover protected and successful medications to restrict illness seriousness and save lives.

At the hour of composing this article, an effective vaccination is not accessible. The medical authorities need to depend on conventional public health precaution techniques like testing, case recognition, contact tracing and isolation. These intercessions depend on why our wellbeing frameworks can rapidly and proficiently distinguish contaminated people and guarantee that they do not get into close contact with healthy individuals. Practically speaking, this is an incredible undertaking, as considerable extent of cases either do not show up any symptoms or have very mild symptoms. This is absolutely why government authorities around the world are suggesting general safety precautions on personal hygiene and sanitisation such as hand washing, social distancing and universal masking [1].

The COVID-19 pandemic has unfavourably hit the textile, apparel and fashion industries globally with colossal damage to organisations that cannot be measured now as the virus infection keeps spreading. The demand for textile materials worldwide and domestic markets has come to a halt because of the frenzy circumstance aroused due to the COVID-19 outbreak. Because of the lockdown, a wide range of textile industries are shut, and it is not easy to think about when those will be permitted to open. Labourers have been running to a great extent amid a wide range of disarray. The business sector is terrified because of money crunch, production network unsettling influence and labour-related issues. Stores are shut, and practically all buyers are dropping or delaying orders as they have extensive inventories. They may not place orders in the upcoming months too. The daily wage labourer who forms 80% of the labour force in textile and clothing manufacturing plants is on streets or back in his hometown terrified [2].

Developing consciousness of the textile business' ecological impression regarding chemical and water usage, overall carbon emissions generated and textile waste, natural resources utilisation, use of poisonous chemicals, generation of wastage,

energy usage, carbon emissions and water contamination have concentrated on sustainability problems in textile and clothing sectors. Huge ecological effects occur during the numerous processes from fibre production, yarn preparation, cutting, sewing, weaving, knitting, dyeing, printing and finishing processes, and there is expanding burden on designers, brands and manufacturers to carry out feasible practices into activities at different processes as well as more extensively into essential administration and marketing approaches.

The research underlines the requirement for principal changes in the plan of action, including moderate fashion development and sustainable practices through the inventory network. Although the fashion industry business is broadly considered the most ecologically dangerous industry, it keeps developing, especially the short style fragment, which has a more prominent negative effect because of its emphasis on modest assembling, regular presentation of new products and transient product use. To neutralise these hurtful results, product and process advancements to implement sustainable manufacturing practices have arisen, for example, plan development with R's principle, closed-loop fashion framework and so forth. There is a more noteworthy need and criticalness to execute sustainable practices in textiles and garments sectors given their worldwide importance, size and significance [3]. Due to this pandemic, there is a danger that sustainability will drop off plans in the fashion business, as brands concentrate around endurance, intending to secure individuals, money and liquidity.

This chapter gives an overview of the impact of COVID-19 on sustainability in the textile industry. It also provides various solutions for sustainable development in the textile industry, which can help recover the sector from this pandemic.

2 Impact of COVID-19 on Textile and Clothing Industry

Among the most self-important monetary areas, the clothing business is one of the greatest helplessly influenced areas. The essential explanation can be the first contaminated country by COVID-19, China, known as the clothing business's primary source objective. The secondary cause can be the spread of COVID-19 in almost all the nations and regions worldwide, including the USA, Italy, Spain, Germany and so on and one worldwide movement. The global pandemic in COVID-19 has influenced the current activity methods of different textile sectors by posting limitation of social gathering, relocation of migrant workers and affecting every stakeholder directly from farmers to traders/exporters in the value chain textile sector. Few points are focussed on and referenced underneath:

- **Supply chain disruption**
  The exponential increase of COVID-19 cases throughout Asia, Europe and the USA has resulted in border closures and home quarantines. COVID-19 has posed a severe threat to the global supply chain because of the economic slowdown. The change in commodity consumption has disrupted supply, manufacturing,

logistics and sales. Hence, it has disrupted the global supply chain by weakening and slowing down international trade [4]. This effect of COVID-19 on the textile business has seen as a scourge emergency. The fundamental explanation is that the principal source of raw materials for the textile business, China, has been affected by the outbreak of COVID-19. Prompt after the lockdown announced in China, the entire inventory network of those enterprises relying on China got upset. The lead textile manufacturing nations' in the world are Bangladesh, Myanmar, Sri Lanka, Pakistan and so on are fundamentally dependent on China for their raw materials requirement. For example, Bangladesh is subject to China alone for more than 50% of clothing raw materials and around 40% of the machinery and spare parts for this industry.

Similarly, Myanmar is additionally reliant basically on China for around 90% of raw materials. As per an overview, it has been tracked down that 93% of Bangladesh suppliers announced that they confronted a deferral in raw material shipments during this pandemic. Other than these, because of these deferrals, the cost of the raw material has expanded. In Myanmar, it is anticipated that around 10% of plants in the Yangon region of Myanmar are now shut. In any event, 20 production lines across the entire Myanmar have been closed because of the lack of crude materials.

- **Cash flow constraints**

  The subsequent effect is order cancellation from the retailers and brands' end. The purchasers of this industry intend to delay future orders just like the current orders in handling. Another effect of COVID-19 on the textile business is the conceded instalment by the retailers. Because of the lockdown due to COVID-19, the deals of the retailers and brands go to nothing. Other than these, no transportation is accessible in this pandemic for the merchandise shipment, and other related undertakings likewise get stuck. Therefore, the brands and retailers informed the production line proprietors about the postponed payment instalment [5].

- **Unemployment**

  Coronavirus represents a genuine danger to worldwide general wellbeing in both developed and developing nations. The textile and clothing sectors' specialists have almost no instruction, are unskilled, have low financial and frequently provincial backgrounds and have less bartering power, bringing about their recognisable proof as vulnerable. The outcomes of the COVID-19 pandemic for these specialist workers are critical and incorporate vulnerability about whether they will be qualified for compensation during the COVID-19 pandemic and related issues, for example, absence of cash for essentials like food and worries about the re-opening of processing plants during COVID-19 disease. Other concerns are the health risks due to the lack of deterrent measures in the working environment and the improvement of psychological health conditions given the deficiency of employment and the dread of contracting COVID-19. With such shortcomings and in the lockdown conditions, starvation results from COVID-19 for the powerless and low-level pay. The COVID-19 lockdown and the resulting financial recession have prompted significant income loss for the poor working workers. They have

driven away from home, break isolation rules and risk infection to this deadly disease trying to discover new ways to take care of their family [6].

- **Change in consumer behaviour**
  With additional time spent at home, consumers are being urged to reconsider their utilisation. Similarly, numerous individuals make garments purchases in front of special events, like weddings and vacation get-away; however, as a large number of these occasions have been cancelled or delayed, the impulse to purchase new garments is no longer there. Layoffs, furloughs and pay cuts are likewise influencing sales. Data from the industry propose the recurrence of fashions products purchased diminished during the beginning phases of the general health emergency. All the more significantly, buyers' psychological transmission capacity has also shifted from buying lifestyle needs, such as apparel, to day by day needs, such as food and beverages [7]. Likewise, customers prefer online-based shopping instead of visiting crowded shopping centres, which they casually did previously.
- **Shutting of retail stores**
  Retailers have reacted to the COVID-19 pandemic by covering their entryways. Numerous unmistakable clothing retailers worldwide, for example, H&M, Ralph Lauren, Chanel, Walmart, Sephora, Apple, Nike, Madewell, Everlane, Urban Outfitters and Lululemon have reacted to the Covid-19 pandemic by covering their entryways. Additionally, a couple of retailers, for example, Pink, Victoria's Secret and TJX are likewise shutting their online business websites incidentally. Significant shopping centres among all nations have additionally close [8–10].
- **Impact on Fashion events**
  COVID-19 hits the significant fashion events. Fashion weeks have been dropped in Melbourne, Beijing, Shanghai, Tokyo and Seoul. As the pandemic has advanced, creators need to apply their inventiveness to an assortment and how and where it will be delivered and exhibited. Designers have adjusted with producing and displaying their style products by streaming presentations online without a live audience present [11].

3 Use of Textile Materials for Avoiding the Spread of COVID-19

Protective gear comprises apparel put to shield medical services experts or any other person from the infectious disease. These, for the most part, include gloves, mask and gown. It will help to incorporate a face shield, goggles, surgical masks, gloves, surgical gown, headgear and safety boots for diseases that are spread by air or blood. Personal protective equipment (PPE) is essential to forestall COVID transmission in treatment centres and numerous activities like cleanliness, proper management of waste and internments and epidemic associated consideration. Scarcely any instances of personal protective equipment's are given underneath [12].

- **Surgical mask**
  A surgical mask comprises textile materials and plentifully utilised in offering protection to the patients infected with COVID-19. A surgical mask is manufactured using nonwoven fabric made up of polyester, viscose, polypropylene, etc., having a pore size of 0.3-10 μm. They are predominantly nonwoven; however, some of them are manufactured using cotton knitted fabrics. A surgical mask is obligatory in a crowded place where 6 foot of distances is complicated to maintain. This will help delay the transmission of the deadly coronavirus infection from individuals with no symptoms or from individuals who do not realise that they have been affected by the virus or not [13].
- **Surgical cap**
  A surgical cap is utilised in offering protection to the patients that are infected with COVID-19. The surgical cap is made up of polyester, polypropylene cotton, etc. They are additionally produced with cotton knitted textures. The surgical cap that goes with the surgical gown covers the medical specialist's head and also the hair, the ends. Surgical caps prevent any doctor or medical staff from splashing harmful fluids on the scalp. Nonwoven textile materials are broadly utilised for the production of surgical caps.
- **Surgical gloves**
  Surgical gloves are abundantly used to offer protection to the patients infected with COVID-19. Surgical gloves are made up of various mixed fibres in the form of a composite structure. Gloves are essential material to forestall, and they serve as protection in COVID-19 infected patient. Clinical gloves are manufactured with various polymers, nitrile rubber, latex, neoprene and polyvinyl chloride. These gloves are liberated with dust or powdered with corn starch to lubricate the gloves, making them simpler to wear.
- **Surgical gown**
  Surgical gowns are comprised of cotton, polyester, nylon, viscose or blended fabric. Surgical gowns are worn to prevent the doctor and the medical staff from getting infected from contagious diseases through vulnerable patients, like those with debilitated invulnerable immune systems.
- **Surgical shoe**
  A surgical shoe comprises textile materials like polyester, cotton, polythene or polypropylene, rubber, latex, etc. It assists with keeping medical staff foot clean and germ-free.
- **Ventilator bag**
  The ventilator bag is comprised of high thickness polyethene (HDPE) strands. In case a patient is attacked with COVID-19 and unable to breathe, ventilators are utilised to carry out the treatment of patients to encourage respiration [13–15].

4 Sustainability

Sustainability implies an ability to keep up some entity, result or process after some time. Sustainability can likewise be characterised as the practical and impartial dissemination of assets intra-generationally and between generationally with the activity of financial exercises inside the limits of a limited environment [16]. Sustainability includes the mix of ecological wellbeing, social value and monetary essentialness to make flourishing, sound, various and strong networks for this age and ages to come. Sustainability perceives how these issues are interconnected and require a frameworks approach and an affirmation of intricacy.

The most acknowledged definition of sustainability is the improvement that addresses the issues of the current age without compromising off the capacity of people in the future to addresses their problems [17]. A sustainable society needs to meet three conditions: its rates of utilisation of inexhaustible assets ought not to surpass their paces of recovery; its paces of the utilisation of non-sustainable assets ought not to reach the rate at which reasonable inexhaustible substitutes are created, and its paces of contamination of outflow ought not to exceed the assimilative limit of the environment [18].

5 Aspects of Sustainability: Environmental, Economic and Social

There are three aspects of sustainability which are discussed below:

- **Environmental**
  The environment can be characterised as the physical encompassing of man/woman. He/she is a part on which he/she depends on his/her exercises like physiological working, creation and utilisation—this actual climate environment from air, water and land to natural resources. Environmental degradation is an intense issue overall, which covers an assortment of issues, including contamination, biodiversity misfortune and animal extinction, deforestation and desertification, and global warming and much more. The environmental degradation and deterioration of the environment through the diminution of resources incorporate all the biotic and abiotic elements that structure our surroundings: water, air, soil, plant, animals and any other living and non-living component the earth. The primary consideration of environmental degradation is human generated (present-day urbanisation, industrialisation, overpopulation development, deforestation and so on) and natural calamities like (hurricanes, floods, rising temperatures, dry seasons, fires, etc.) [19, 20]
  Environmental pollution alludes to the degradation of the quality and amount of natural assets. Various types of human exercises are the fundamental reasons behind environmental degradation. For instance, the smoke transmitted by the

vehicles and processing industries extends the proportion of poisonous gases, which is recognisable worldwide. The waste things, smoke transmitted by vehicles are the central driver of pollution. Unconstrained urbanisation and industrialisation have caused air, water and sound pollution. Urbanisation and industrialisation help to grow the breakdown of the sources of water. So, addition, the smoke released by vehicles and substances like carbon monoxide, chlorofluorocarbon, nitrogen oxide and other clean elements causes air contamination [21, 22].

The harm caused by human beings to the environment is right now not included as an expense in monetary and social terms. This absence of "environmental value" has permitted us to over-misuse "free" natural resources—which are, obviously, not free. It has additionally prompted over-production of cheap products with exceptionally short life expectancies, which are generously disposed of into the environment after utilising, and afterwards, new affordable merchandise are bought and disposed of again. This cycle continues endlessly, influencing the planet's ability to re-establish its ecological administrations eventually [23].

Environmental sustainability is about the natural habitat and how it stays profitable and strong to help human existence. Environmental sustainability relates to biological system honesty and conveying limit of natural habitat. Environmental sustainability improves human wellbeing assistance by securing crude materials utilised for human necessities and guarantees that sinks for human squander are not surpassed to forestall damage to people. The ramifications are that natural resources should be collected no quicker than they can be recovered, while waste should be produced no quicker than the environment can acclimatise them. This is because the earth frameworks have limits inside which balance is maintained [16, 24].

- **Economic**

  The centre necessity of sustainability is that current financial exercises would not bring about an unreasonable burden on people in the future. This rule is sufficiently enough to suggest distinctive choice principles for protection. Sustainability advancement requires upkeep of the natural and human resource base fundamental for long haul financial development of ecological resources [25].

  Economic sustainability is utilised to characterise different techniques that promote financial resources for their best potential benefit. A sustainable economic model recommends a fine dispersion and professional designation of resources. The thought is to encourage the utilisation of those assets effectively and capably, giving long-term benefits and setting up productivity. The pleasant thing about adopting an all-out strategy for sustainability is that if you focus on social and ecological issues, benefits will frequently follow. Social activities affect consumer behaviour and worker performance, while environmental actions, for example, energy productivity and contamination mitigation can directly affect diminishing waste. Economic sustainability ensures that the business makes a benefit, yet additionally that business tasks do not make social or environmental issues that would hurt the organisation's long-term achievement [26].

- **Social**
  The social component of sustainability depends on how equivalence and understanding of the interdependence of individuals within the society are the basic requirements for an adequate quality of life, which is the principal objective of development [19]. The social aspect of sustainability refers to, in broad terms, public strategies that help social issues. These social problems relate to our prosperity and incorporate features like health care, housing, education, employment, etc. So forth, it guarantees that people do approach social administrations, do not endure lack of information on their privileges and exercise a dependable impact on advancing social strategies and amenities, both locally and nationally [20].

6 Sustainability in the Textile and Clothing Industry

The textile and clothing industries are the most polluting sectors on the planet. Its sustainability challenge includes different, organised and muddled issues [27]. Textiles and clothing currently play a critical part in the worldwide public dissertation on chemical society, environmental change, lack of water shortage and human liberties [28]. Their production and utilisation bring up a few issues and stresses that make difficulties over how individuals live their social, economic and political lives. Large numbers of the problems concern a few basic cultural and private practices and the job of multiples and frequently contradictory principles related to production and utilisation of textiles [29]. There are innovative solutions that settle some portion of the difficulties; others require dedicated activities concerning consumers, government, NGOs, business and others, and progressively so globally [30]. Especially organisations and customers have been distinguished as foremost entertainers now because of the quick fashion and textile industry's idea. Strategists and activists consider how organisations and consumers can be urged to assume liability, make voluntary strides towards sustainability upgrades and on occasion even be through and through compelled to change their decisions and practices [31]. The more profound inquiry is, notwithstanding, regardless of whether, how, and how much they can take on new liability for guaranteeing that the textile and clothing sector turns out to be more sustainable. Researchers stress on the problematic areas in the globalised textile, and clothing sector is profoundly intricate. Technological solutions aside, they find that adjusting behaviour and practice regularly requires the more complex task of working with changing the principles related to production and utilisation and being sensitive to various geographic, cultural and political contexts [32]. Aggregated studies likewise recommend that better data and correspondence from governments, activists, organisations, educational institutions, the media and others are vital [33]. Therefore, finding a proper solution for the various environmental, labourers' treatment and monetary issues inside the globalised fashion-driven textile and apparel market sector require innovative thinking and endeavours on both the supply and demand side of the market at different societal and administrative levels. The specific sustainability challenge is this requirement for an operative interaction

between supply side and demand-side entertainers that brings feasible, sustainable principles and practices all the more straightforwardly into focus [34, 35].

7 Impact of COVID-19 on Environmental Sustainability in Textile Industry

The COVID-19 emergency has reemphasised the imperative role of plastic materials in our daily life. Plastics materials have contributed monstrously towards the medical services area and public health security throughout the ongoing global pandemic. Notwithstanding the inconvenience of countrywide lockdown, maintaining social distancing, limitation on voyaging and general get-together, continuous utilisation of hand sanitisers alongside utilisation of plastic-based personal protective equipment (PPE), viz. hand gloves, medical gowns, aprons, face safeguards, facial masks and other necessary PPEs for forefront health and safety officers and workers as prudent steps have also been implemented to maintain a strategic distance from infection defilement to battle the spread of COVID-19. Consumer's behavioural changes combined with the reliance on online shopping through e-commerce websites and take-away facilities for home-delivery of essential things during the global pandemic which have prompted an impressively expanded interest for plastic-based packaging materials, including single-use plastics contrary to the background of predominant boycotts or limitations in numerous nations. The contagion has also initiated a novel type of customer interest and social variations like frenzy purchasing, amassing food products and groceries among the majority and accordingly brought about an upsurge in the plastic-based packaging materials in numerous nations. A flood in the plastic demand throughout the worldwide pandemic is, subsequently, essentially because of PPEs and packing materials. Most of the PPEs are comprised of polymers like polyvinyl chloride (PVC), polypropylene (PP), low-density polyethene (LDPE), polyurethane (PU), polycarbonate (PC), while the plastics utilised in packing materials fundamentally comprises of polyethene terephthalate (PET), high-density polyethene (HDPE), low-density polyethene (LDPE), polystyrene (PS), etc.

Harmful and infectious COVID-19 biomedical waste (BMW) comprising of contaminated plastic-based PPEs and some other expendable things due to the affected sources like COVID-19 medical clinics, remote offices, containment zones, alongside comparative non-contaminated items from non-affected sources are created. In this manner, the COVID-19 biomedical waste generation can be straightforwardly connected to the great utilisation, for the most part, plastic-based personal protective equipment, and other non-reusable materials have been justified since the introduction of novel coronavirus epidemic. The increasing utilisation of plastic-based packing materials has combined with the expanding interest for medical items and packing materials amidst the pandemic has increased the plastic wastage around the world altogether. Accordingly, the pandemic has introduced a significant

environmental challenge regarding plastic waste generation globally. Waste management amenities are commonly intended for consistent state activities with reasonable varieties in squander size and composition underneath ordinary situations. Nonetheless, the pandemic-incited alteration in waste creation and composition elements is almost certain to affect the current facilities' regular activity. Further, the decrease in plastic reusing due to plunging oil and petrol costs considering diminished transport activities in the crucial hour of pandemic-incited lockdowns has turned plastic waste management into a massive task [13].

Surgical masks and hand gloves ought not to be worn longer than a couple of hours and ought to be adequately disposed of to stay away from cross-infection. In this sense, a few nations have attempted to execute safety measures thinking about removing possibly contaminated PPE. For instance, the Portuguese Environmental Agency suggested that all conceivably contaminated PPE utilised by residents should be discarded as blended wastes (not recyclables) in fixed and sealed trash containers that will probably follow incineration facilities or will be subjected to landfilling. A few states in the USA have likewise quit recycling programme as administrations have been worried about the danger of COVID-19 spreading in recycling centres, consequently focussing on both incineration and landfilling. Such a decrease in squander recycling is different from the circular economy's objectives and sustainable development of events and surprisingly generating plastic waste pollution. By and large, PPE will probably wind up disposed of without precautionary steps alongside empty containers of hand sanitiser and organic wastes in regular municipal waste, or more regrettable, littered in the surrounding habitat. Erroneous removal of disposable gloves and face masks, alongside other plastic products, has been found littering in nearby public places [14].

There are various kinds of face masks accessible as indicated by their utilisation during the pandemic, like medical, filtering facepiece and non-medical, for example, cloth masks. All in all, medical face masks involve three layers, an external one of nonwoven fibres (they are usually resistant towards the water), a centre one is generally made up of a melt-blown filter, which is the essential filtering layer of the mask and an inward layer consists of soft fibres. Specifically, cloth masks are launderable and economical since they are produced with commercial synthetic materials like spandex, chiffon, flannel artificial silk, cotton quilts and among others. These engineered textile materials are made with polymers or polymers-normal fibre blends. The most utilised polymers in the assembling of these synthetic textile materials are polyester, nylon or polyether-polyurea copolymer. Subsequently, these kinds of textile materials may likewise add to the microplastics pool as fibres discarded during domestic washing into wastewaters and later reach wastewater treatment plants (WWTP). A laundry machine can trigger the subsequent discharge of these textile filaments into the seas. In April 2020, the utilisation of face masks for everybody out in the open spaces was obligatory in almost every part of the world. The manufacturing of face masks has expanded more than multiple times somewhat recently. This strong demand and importation and unnecessary use can prompt the fumble of medical waste by medical staff and residents because of the worldwide COVID-19 pandemic. Besides, the lack of information about the sort of domestic

waste produced and its lack of arrangement by the people at home also contribute to the expanded plastic pollution during the pandemic. The present circumstance has cautioned scientific researchers because of the expansion of plastic waste in water bodies. Besides, cloth masks likewise address a peril to marine creatures since they can get tangled with the straps. In this sense, there are right now a few missions that request people to cut the straps from the face masks to evade animals getting caught in them.

Notwithstanding the mounting upsurge in PPE and dispensable plastics, the pandemic has produced substantial technological advances to dodge COVID infection. The utilisation of silver and copper nanoparticles with dynamic functionalities to battle microorganisms and guarantee asepsis illustrates this. South American nations, for example, Chile and Argentina, have showcased face masks with fungicidal, bactericidal, and antiviral properties and utilisation of spray and gels with copper nanoparticles. This innovation is being used to disinfect clinics, hospitals and nursing homes. It is identified that synthetic or engineered nanoparticles have been designated as arising contaminants. A few studies have reported nanoparticles' release in aquatic flora and fauna from commercial items and their drawn-out impact as a common pollutant in these water bodies and their extreme threat to marine animals [15, 36].

8 Solutions for Achieving Environmental Sustainability in the Textile Industry

8.1 Waste Reduction

Addressing and reducing PPE plastic contamination requires transdisciplinary cooperation among natural and social researchers, policymakers and waste managers on both municipal and national levels. In ensuring ourselves against COVID-19, we ought not to risk environmental health's integrity and make a future quandary as plastic pollution from PPE utilisation. To encourage legitimate disposal of the rapid and continuous increase in volumes of PPE waste from the society, we suggest the following measures [37]:

- Encourage general society to decrease the utilisation of dispensable gloves and wash hands frequently instead.
- Encourage and make available reusable face masks that can be now and again cleaned.
- Develop legitimate PPE disposal practices, find out about the subtleties of PPE waste management pathways and carry out improved collection techniques open to the general population.
- Raise far-reaching awareness on appropriate PPE discarding practices through focussed government promotion and training camps.

8.2 Minimise the Need for PPE in Health Care Settings [38]

The accompanying intercessions are recommended by World Health Organisation (WHO), limiting the utilisation and demand for PPE while guaranteeing to protect medical staff and others from the exposure to the COVID-19 infection in medical care settings is not compromised.

- Wherever possible, use telemedicine and phone hotlines to assess suspected cases of COVID-19 firstly, subsequently limiting the requirement for these people to go to medical care facilities for assessment.
- Use physical hindrances to lessen exposure to the COVID-19 infection, like glass or plastic windows. This methodology can be executed in territories of the medical care setting where patients will initially present, like emergency and screening zones, the patient enrolment desk area at the emergency division or at the pharmacy store window where the prescription is gathered.
- Postpone elective, non-urgent method and hospitalisations decrease the frequency of visits of severe patients with the goal that PPE can be rearranged to administrations in which COVID-19 patients get care.
- Cohort affirmed COVID-19 patients without coinfection with other contagious microorganisms in a similar room to smooth out the work process and encourage broadened PPE utilisation.
- Designate committed medical care workers/groups just for COVID-19 patient consideration so they can utilise PPE for longer timeframes.
- Restrict the quantity of healthcare workers from going into the rooms of COVID-19 patients on the off chance that they are not associated with giving immediate consideration. Smooth out the work process and diminish to a protected level consideration that requires face-to-face interaction between health specialist and patient.
- Consider utilising explicit PPE just if in direct close contact with the patient or when contacting the surrounding (for example, wearing a surgical mask and face safeguard, not utilising hand gloves or medical gown over the scrub suit, if going into the patient's room just to inquire or make visual checks).
- Visitors should not be permitted to visit confirmed COVID-19 patients, but if it is strictly necessary, confine the number of visitors and the time allowed; give clear instructions about why PPE is needed and why it should be utilised during the visit, about how to put on and remove PPE and perform hand cleanliness to guarantee that visitors avoid exposure.

8.3 Personal Protective Equipment (PPE) Reuse

COVID-19 brings massive difficulties in supporting the inventory supply chain for the single-utilised plastic PPE. Post-COVID-19, the transformations and adjustments in clinical practice will initiate enormous demand for PPE. Effective counter procedures

for forestalling COVID-19 spread by incorporating alleviating probable high-risk aerosol transmission in medical care services utilising medical PPE and the suitable utilisation of face masks by the overall population that carries a lesser transmission jeopardy. PPE reuse is an expected temporary arrangement during the COVID-19 pandemic, where there is expanded proof for the effective positioning of reusing strategies. A few of the system are discussed underneath:

- **Dry and moist heat**
  Few researches have been carried out on the utilisation of various systems of heating for PPE processing. Heating usually causes irreparable physical harm in virus proteins that restricts binding to host cells. The issue with thermal methodology is to discard off COVID-19 with destructing PPE. It is very well be settled by decreasing contact time by up surging temperature. For instance, utilising 72 °C for 15 s gives a comparable degree of fatality to using a holding temperature of 60 °C for 30 min. The centres for disease control and prevention (CDC) expressed that, considering inadequate research available as of April 2020, moist heat has revealed a guaranteed probability to disinfect filtering facepiece respirators (FFRs).
- **UV irradiation**
  Ultraviolet (UV) irradiation causes the inactivation of many viruses by destroying the DNA or RNA through a photo-irradiation procedure. UV disinfecting exploits various wavelength bands where UVC (200–280 nm) is better than UVB (280–320 nm) and UVA (320–400 nm). Ideal irreversible molecular harm happens around the wavelength of 254 nm. There is a developing interest in the utilisation of UV innovations aimed at treating COVID-19 with other discoveries. The CDC also noticed that ultraviolet germicidal irradiation (UVGI) is a capable technique for PPE reuse, yet expressed that not all UV lights generate similar intensity and power; therefore, treatment times need to be changed likewise. Besides, UVGI is probably not going to deactivate all the viruses and other harmful organisms on an FFR because of shadow effects created via numerous FFR's construction layers [39].
- **Hydrogen peroxide**
  Hydrogen peroxide is a powerful oxidant and thrives as a disinfectant either as gas plasma, vapour or solution. For FFRs, hydrogen peroxide vapour (HPV) use is very much reported for not affecting filter performance and promising high throughput sterilisation. One method has been tried on FFRs inoculated with SARS-COV-2 and demonstrated to be effective, though the outcomes are only preliminary. It is right now being utilised in certain parts of the USA to sanitise enormous clusters of FFRs for redeployment to users with nitty–gritty depictions regarding how to carry out HPV use [40].
- **Ozone treatment**
  Another investigation reveals that ozone gas, a profoundly responsive chemical made from 3 oxygen atoms, might give a secure way to sanitising specific sorts of PPE that are popular for safeguarding medical care service personnel from

COVID-19. The team led by scientists at the Georgia Institute of Technology utilising two microorganisms like the novel coronavirus; further examination exhibited that ozone can deactivate viruses on things, for instance, polycarbonate face safeguards, Tyvek gowns, safety goggles and respirator masks without harming them as far as they do consist of stapled-on elastic straps. The investigation exhibited that the ozone treatment's uniformity and viability relied upon keeping up relative humidity of at least 50% in chambers utilised for sterilisation [41].

8.4 Use of Biopolymers for PPE

The entire solid waste management administration procedure of urban areas and countries has been affected by the remarkable amounts of expendable materials needed to protect against the virus infection. As one model, the aggregate sum of clinical waste created in Wuhan, where the pandemic began, is required to be nearly 25% more prominent in 2020 than in 2019. Supplanting the oil-based polymers used to make surgical outfits and masks with biopolymers would decrease not just the sea contamination generated by these all-durable single-use materials, yet also their overall carbon footprint [42]. Chances will emerge to address this challenge over flawlessly associating study and entrepreneurial environments, creating another line of conceivably usable bioplastic material.

A bioplastic comprised of plastic made somewhat or entirely from natural polymers produced from organic sources like sugarcane, potato starch, straw and cotton or the cellulose from wood. Some bioplastics decompose in the outer environment, while others are made with the goal that they should be composted in an industrial composting plant, supported by bacteria, enzymes and fungi. Bioplastics are generally made to be chemically indistinguishable from ordinary industrial plastics. Plastics produced using organic materials usually require a minimum amount of energy to have yet are similarly recyclable. They utilise fewer pollutants through the manufacturing process. Per ton of finished materials, the worldwide global warming effect on bioplastics' manufacturing process is often very considerably less than conventional plastics. Future green innovation exploration should be reached to form new biopolymer-based packaging and wrapping that include complex viruses and parasites [39].

9 Impact of COVID-19 on Social Sustainability in Textile Industry and Its Solution

The world of work is confronting a worldwide health emergency unlike any in the 100-year history. Simultaneously, this exceptionally globalised sector is battling with serious inventory side disturbance; as labourers are advised to remain at home, supply chains come to a standstill and production lines close. Notwithstanding the health

risks presented by the virus infection, the industries' financial losses have influenced the business and livelihood of managers and labourers at the same time. Industrial facility and retail closures all around the world have compromised the feasibility of enterprises which led to labourers being suspended or losing their jobs. Small and medium-sized ventures (SME), a fundamental source of employment and development in the industry, will probably endure the most significant effect of this worldwide emergency.

Falling production and sales have had a massive thump on workers' impact, both regarding employment and working condition. For instance:

- An estimated 200 industries in Cambodia have either suspended or decreased production, and 5,000 labourers have lost their jobs positions.
- In Myanmar, a deficiency of raw materials from China has led to the closure of at least 20 factories and 10,000 jobs. At the same time, the number of orders has plummeted.
- In Vietnam, an expected 440,000 to 880,000 labourers could confront decreased hours or will become jobless. In the most-dire scenario, this figure could surge to as many as 1.3 million.
- In Bangladesh, as many as 2.17 million labourers have been affected by the global emergency, with many confronting unemployment as a maximum number of orders are cancelled, and production has been halted steeply. It is assessed that under 20% of firms can keep paying staff compensation for over 30 days under these conditions, and over 1,000,000 specialists have effectively been fired or furloughed. Non-payment of wages and the shutting down of processing plants is particularly hard for labourers in nations having very weak social protection frameworks [43].

Specialists concur that COVID-19 will additionally challenge working conditions and place labourers in a more dubious position. Critical impermanent and permanent job loss expanded utilisation of transient agreements, reduced wages and inconsistent payment will probably keep on affecting workers worldwide, which will give rise to an economic recession which will further lead to lower than pre-pandemic levels of interest in the near-term. For certain labourers, this will prompt delayed challenges in bearing the cost of essentials like house rent, food and other needful and mandatory supplies and may put a few workers in an undeniably unsafe circumstance both inside and outside of the work environment. These effects will probably be exacerbated by an absence of sufficient social assurance measures. As competition for jobs in the factories during the financial emergency will stay high, compliance with labour laws and codes of conduct may fall, and decent work shortfalls may rise. For instance, instances of union association busting, whereby labourers belonging to the associations are lopsidedly laid off contrasted with non-unionised labourers, have been reported in few nations. Moreover, decreased net revenues and precarious production requests resulting due to the pandemic may bring down compensation for labourers and increment surge orders; further, fuelling pressures connected to boisterous abuse attack in production lines, regardless of the expanded event of

such practices, savagery and badgering just as gender equality will probably get less consideration in the close term because of COVID-19, as industry stakeholders will be engrossed with other pressing subjects such as occupational health and safety and have fewer assets to spend on projects to help labourers [44].

9.1 Solutions for Achieving Social Sustainability in the Textile Industry

COVID-19 is a pandemic which assaulted practically all nations of the world until now. Among all the financial sectors, the clothing business is perhaps the most affected sectors. The retail shops are shut with no income, which prompts the request to cancel the order to the clothing manufacturing suppliers. Accordingly, the workers have tumbled upon a depriving circumstance. They do not get their fair compensation, just like any help from any partners or stakeholders. They need to spend a solitary day with a tragic life. In this way, it is necessary to think for the workers at any rate since it is the subject of their endurance. The public authority can uphold the law that no production lines can be shut/laid off without satisfying the labourer's obligations. Indeed, if any crisis emerges for production line closure, the manufacturing plant needs to guarantee the labourers' wages until the circumstance recuperates, as no labourers can be terminated. The brands and consumers may help the workers by proceeding with the order and make the payment in due time. The monetary establishment may uphold the sector by giving credits and other financial backings. A multi-stakeholder initiative, including brands and retailers, bosses, governments, workers union and other related partners, is in an urgent emergency [45].

To battle against the emergency, at present, a few activities are taken by different corporations. For example, ten global associations' alliance has encouraged style brands and governments to secure a piece of garment labourers and future-verification supply chains in the middle of the COVID-19 global pandemic. To battle amplified disparities and secure textile labourers livelihood. Whose jobs are in question because of the COVID emergency, the alliance encouraged processing plants to "guarantee on-time payment of wages to labourers who remain effectively utilised. They have likewise asked employers that if offices need to close briefly, it ought to be a top concern of all stakeholders, all things considered, to help labourers straightforwardly or get funds to connect this period that they cannot work. At the point when worker reduction cannot be stayed away from because of long-term manufacturing plant shutdown or due to bankruptcy, all labourers ought to get their full legitimate privileges, including wages, advantages and severance pay. The alliance further desires to execute defensive measures in plants, for example, setting up healthcare facilities to limit the danger infection, including labourers in the decision-making process, giving them admittance to worker union and providing safe transportation [46].

10 Impact of COVID-19 on Economic Sustainability in Textile Industry and Its Solution

Still, there is no estimation about the financial damage that occurred because of COVID-19. The business analyst concurred that it would contrarily affect the worldwide economy. China's President Xi Jinping, speech on TV 23 February 2020 "It is unavoidable that the novel Coronavirus pandemic will significantly affect the economy and society". At the G20 congregation in Riyadh, Saudi Arabia, dated on 24 February 2020 Japanese Finance Minister Taro Aso articulated: "The spread of the new coronavirus is a public health emergency that could represent a genuine danger to the macro scale economy through the halt in production activities, interferences of individuals' development and cut-off of supply chains". The principal explanation behind it that China, known as "the global" factory, is the manufacturing centre for much of the worldwide business, i.e. energy, automobile, steel, textile, agribusiness, coal and electronic gadgets including mobiles, and so China has become one of the significant suppliers for the intermediate product to the final producers. China is represented 20% of the worldwide manufacturing intermediate products exclusively, but it was just 4% in 2002. Due to COVID-19, it is expected that worldwide development could be sunk by around 50% in 2020, contrasted with the assumption in November 2019. Other than these, the yearly worldwide GDP growth is assessed to reduce to 2.4% in 2020, all in all, which was 2.9% in 2019 [47].

Fashion is the second biggest market for consumer products after food and beverages. Also, the fashion business plays a focal part in creating income and employment, utilising more than 60 million individuals around the world. In certain countries, the sector is an essential contributor to national industrial yield and domestic value-added. The share of textile and clothing in manufacturing is high in many nations. The COVID-19 pandemic made a dramatic contraction in demand and production. The fashion business has been among those sectors all the more seriously hit by the coronavirus emergency [48]. The worldwide textile market was assessed to decline from $673.9 billion in 2019 to $655.2 billion in 2020 at a compound annual growth rate (CAGR) of—2.8%. The decline is principal because of a financial slowdown across several nations inferable from the COVID-19 outbreak and the measures to control it [49].

10.1 Solutions for Achieving Economic Sustainability in the Textile Industry

- **Managing Supply Chain Disruption**
  Given that the probable outbursts upset the input-sourcing, organisations should consider altering the sourcing mix to likely enhance hazard. When both suppliers

are found close to topographical proximity of each other, double sourcing methodologies are exposed to more noteworthy lockdown interruptions. Likewise, organisations with geologically various organisations of suppliers are as yet revealed to supply chain network interruption if a product depends on contributions from numerous suppliers as a solitary disturbance can have an ensuing consequential ripple effect [50].

The administration should figure out which of its products are especially exposed to solitary source dependencies or isolated area dependences and hope to assemble proper risk management methodologies. Temporarily, this could incorporate redistributing stock across districts or reduce reliance on products in danger of disruption. In the intermediate-term, organisations can hope to fabricate "buffers" to moderate the ripple effect only when a solitary supplier is undermined. This should be possible in two fundamental ways: (1) organisations can generate an inventory buffer, or 'safety stock of crucial components and products, and (2) organisations can generate a period buffer by deferring the manufacturing of products where demand is eccentric [51, 52].

Given the possibility of flare-ups disturbing input-sourcing, organisations should consider changing the sourcing blend to all the more likely expand hazard. Double sourcing methodologies, where the two providers are found close geological near each other, are presented to more major lockdown interruptions. Essentially, organisations with topographically various providers of providers are presented to inventory network disturbance if an item depends on contributions from multiple providers as a solitary interruption can have a resulting gradually expanding influence. The board should figure out which of its items are especially presented to single-source conditions or single area conditions and hope to construct fitting danger the executive's methodologies. For the time being, this could incorporate redistributing stock across districts or diminishing reliance on items at risk of interruption. In the intermediate-term, organisations can hope to fabricate "cradles" to alleviate the gradually expanding influence when a solitary provider is undermined. This should be possible in two primary manners: (1) organisations can make a stock cushion, or "security load" of fundamental parts and items, and (2) organisations can make period support by postponing the creation of merchandise where the request is inconsistent [53, 54].

- **Managing Demand Disruption**

  As referenced, the interest in fashion merchandise has observed a dramatic drop because of the effects of COVID-19. With individuals progressively telecommuting and going out less now and again, it tends to be accepted that the idea of the request for some fashion materials will change. The association's store network and the chain management include recharging product supplies as they are sold, instead of transportation of all stock to regions towards each fashion season [55].

  This has allowed the group a severe level of adaptability in reacting to request a change. Accordingly, fashion industries ought to consider restocking all through the fashion season in light of genuine interest rather than towards the beginning

of the season based on anticipated interest. This technique yields more superior agility in reacting to potential interest interruptions [56].
It was discovered that organisations with a solid online presence could support sales when retail shops are shut. For instance, ASOS is an online retail store that announced cancelling less than 1% of its Spring/Summer 2020 intake. Online product contributions are simpler to refresh than actual ones. Thus, organisations with online retail stores can quickly change their item subscription to suit innovative demand conditions. In the long haul, all fashion firms should look to upgrade their online presence. Extravagance organisations should put a specific spotlight on the advancement of "the digital experience" given their objective market is acclimated with a high quality of administration in stores and expects a similar on the web. This should be possible inside by putting resources into restrictive online store facades and unions with trustworthy online retailers. Ongoing advancements in expanded reality innovation can likewise be adjusted to make digital showrooms and fitting rooms. Firms in this manner search for creative approaches to building up their online presence in the post-COVID-19 business environment to moderate demand interruptions by improving the customer experience [57–59].

11 Outlook of Textile and Apparel Industry Post Coronavirus

The worldwide outbreak of COVID-19 has created chaos in the fashion industry. The spread of the infection will undoubtedly have real ramifications, and organisations have begun feeling the heat with store shutdowns and vulnerability in orders. Since the pandemic is still in its developing stage, it is hard to foresee the full degree of the effect. Nonetheless, some fundamental changes can be anticipated due to this pandemic and how it can shape the business again [60].

- **Global Demand of Medical Textiles Increases**
  Sales of medical protective equipment, including surgical gowns, surgical masks, hand gloves and protective clothing, have bounced radically. The supply of these items is not able to keep up with the rising demand. The quick spread of the infection across the globe has sensitised individuals to hygiene and healthcare protection. The massive market for medical protective stuff like face masks, hand gloves and hygiene products, for example, wipes, is expected to increase and sustain even after the end of the COVID pandemic. This is a rewarding opportunity for the textile sector sooner rather than later [61].
- **Increased Focus on E-Commerce Sales and Digitalization of Supply Chain**
  To keep away from groups' occurrence and lessen the spread of coronavirus, shopping centres and retailers found a way to close their physical stores. The e-commerce websites of these stores are operational in specific nations. During the underlying period of COVID, shoppers expanded their online buying as a protected option in contrast to visiting actual stores. This move could prompt a changed

purchasing behaviour after the pandemic and fabricate long-time e-commerce business clients. Brands and retailers are additionally headed to consolidate digital strategy in their purchasing process. Online commercial websites are required to become more famous as brands and retailers hope to augment advanced choices of displaying their products and encouraging the purchasing and selling process [62].

- **Shorter textiles supply chain**
  The COVID-19 crisis can go about as an accelerator for choices for change that is long past due in the fashion sector and can at this point no longer be delayed. There are likewise various and interconnected drivers in the business environment that need significant changes in textile value chains to work on a worldwide and domestic level. The COVID-19 emergency has revealed insight into the dangers of depending solely on long worldwide supply chains. Closeness to consumer markets, nearshoring and "safe shoring" can be a business threat reduction technique. Simultaneously, it is also a methodology that can make a client-focussed supply chain network stronger to interruptions [62].

12 Conclusion

An informative examination dependent on the overall survey on the impact of COVID-19 has been presented in the chapter above to uncover the explanations to attain sustainability in the world's textile and clothing industry during this pandemic. The recent outburst of the coronavirus disease (COVID-19) has uncovered the textile and clothing industry's fragility. It is observed that the force predominance of apparel brands, unapproved subcontracting of clothing manufacturing units and utilisation of provisional workers by suppliers are the significant causes tormenting the public security aide in textile clothing supply chains working worldwide. As a relief strategy, suppliers, brands, industrial committees and NGOs should work as one after the COVID-19 pandemic to address the absence of government-managed security in the textile and clothing sectors inventory network. Another sourcing model, which would incorporate disturbance hazard sharing agreements and social security benefits for the labourers, should be approved. Likewise, brands ought to energise suppliers' utilisation of a long-lasting labour force by tuning the supplier choice and request for allocation strategy. This chapter's primary purpose was to identify the significant reasons behind the lack of sustainability caused due to the pandemic in the textile clothing supply chain operations worldwide. Even though this work chapter primarily focuses on the sustainability in textile industries during the COVID-19, its discoveries and consequences have a comprehensive impact on textile industries that mainly hinge on skilled labourers. Lastly, the textile, clothing and fashion manufacturing industries should implement strategic techniques and tactics to tackle similar situations shortly.

References

1. Beesoon S, Behary N, Perwuelz A (2020) Universal masking during COVID-19 pandemic: can textile engineering help public health? A narrative review of the evidence. Preventive Med 139:106236
2. https://www.fibre2fashion.com/industry-article/8635/covid-19-lockdown-impact-on-textile-industry
3. Islam MM, Perry P, Gill S (2020) Mapping environmentally sustainable practices in textiles, apparel and fashion industries: a systematic literature review. J Fashion Market Manage Int J 25(2):331–353
4. Chakraborty S, Biswas MC (2020) Impact of COVID-19 on the textile, apparel and fashion manufacturing industry supply chain: case study on a readymade garment manufacturing industry. J Supply Chain Manage Logistics Procurement 3(2):181–199
5. Sen S, Antara N, Sen S, Chowdhury S (2020) The unprecedented pandemic "COVID-19" effect on the apparel workers by shivering the apparel supply chain. J Text Apparel Technol Manage 11(3):1–20
6. Kabir H, Maple M, Usher K (2020) The impact of COVID-19 on Bangladeshi readymade garment (RMG) workers. J Pub Health 43(1):47–52
7. Brydges T, Retamal M, Hanlon M (2020) Will COVID-19 support the transition to more sustainable fashion industry? Sustain Sci Pract Policy 16(1):298–308
8. https://textilevaluechain.in/2020/04/01/impact-of-covid-19-coronavirus-on-global-and-domestic-market-of-textile-and-fashion-industry/
9. https://en.wikipedia.org/wiki/Impact_of_the_COVID19_pandemic_on_the_fashion_industry
10. https://www.tpci.in/indiabusinesstrade/blogs/tangled-web-the-impact-of-coronavirus-on-indian-textile-industry/
11. Aneja A, Pal R (2015) Textile sustainability: major frameworks and strategic solutions. In: Muthu SS (ed) Handbook of sustainable apparel production. CRC Press, Boca Raton, pp 289–306
12. Alam SMM, Islam S (2020) The implication of textile materials applied in preventing the spread of COVID-19. Biomed J Sci Tech Res 28(5):22009–22018
13. Parashar N, Hait S (2021) Plastics in the time of COVID-19 pandemic: protector or polluter? Sci Total Environ 759:144274
14. Silva ALP, Prata JC, Walker TR, Duarte AC, Ouyang W, Barcelò D, Rocha-Santos T (2021) Increased plastic pollution due to COVID-19 pandemic: challenges and recommendations. Chem Eng J 405:126683
15. Ardusso M, Forero-López AD, Buzzi NS, Spetter CV, Fernández-Severini MD (2021) COVID-19 pandemic repercussions on plastic and antiviral polymeric textile causing pollution on beaches and coasts of South America. Sci Total Environ 763:144365
16. Mensah J, Casadevall SR (2019) Sustainable development: Meaning, history, principles, pillars, and implications for human action: a literature review. Cogent Soc Sci 5(1):1653531
17. Barooah N, Dedhia EM (2015) Study of socio-economic status of women engaged in handloom weaving and measures for enhancing their sustainability. Int J Res Soc Sci 5(4):653–665
18. Alhaddi H (2015) Triple bottom line and sustainability: a literature review. Bus Manage Stud 1(2):6–10
19. Mamidipudi A, Bijker W (2012) Mobilising discourses: handloom as sustainable socio-technology. Econ Polit Weekly 47(25):41–51
20. Maurya PK, Ahmad SAAA, Zhou Q, da Silva J, Castro EK, Ali H (2020) An introduction to environmental degradation: Causes, consequence and mitigation. Environmental degradation: causes and remediation strategies. Alteration in Haematological Indices of Heavy Metals Pollution in the Kali River, Uttar Pradesh, India, pp 1–20
21. Kumar V, Singh J, Kumar P (2020) Environmental degradation: Causes and Remediation Strategies. Vol. 1. Agro Environ Media, Publication Cell of AESA, Agriculture and Environmental Science Academy, pp 1–21

22. Chopra R (2016) Environmental degradation in India: causes and consequences. Int J Appl Environ Sci 11(6):1593–1601
23. Choudhary MP, Chauhan GS, Kushwah YK (2015) Environmental degradation: causes, impacts and mitigation. In: National Seminar on Recent Advancements in Protection of Environment and Its Management Issues (NSRAPEM-2015). Maharishi Arvind College of Engineering and Technology, Kota, India
24. Goodland R (1995) The concept of environmental sustainability. Annu Rev Ecol Syst 26(1):1–24
25. Foy G (1990) Economic sustainability and the preservation of environmental assets. Environ Manage 14(6):771–778
26. Balaji NC, Mani M (2014) Sustainability in traditional handlooms. Environ Eng Manage J 13(2):1–2
27. Boström M, Karlsson M (2013) Responsible procurement, complex product chains and the integration of vertical and horizontal governance. Environ Policy Gov 23(6):381–394
28. Boström M, Jönsson AM, Lockie S, Mol APL, P., O. (2015) Sustainable and responsible supply chain governance: challenges and opportunities. J Clean Prod 107:1–7
29. De Bakker F, Nijhof A (2002) Responsible chain management: a capability assessment framework. Bus Strateg Environ 11:63–75
30. De Brito MP, Carbone V, Meunier Blanquart C (2008) Towards a sustainable fashion retail supply chain in Europe: organisation and performance. Int J Prod Econ 114:534–553
31. Goworek H (2011) Social and environmental sustainability in the clothing industry: a case study of a fair-trade retailer. Social Responsib J 7(1):74–86
32. Harris F, Helen R, Dibb S (2016) Sustainable clothing: Challenges, barriers and interventions for encouraging more sustainable consumer behaviour. Int J Consum Stud 40(3):309–318
33. Laudal T (2010) An attempt to determine the CSR potential of the international clothing business. J Bus Ethics 96(1):63–77
34. Mol A (2015) Transparency and value chain sustainability. J Clean Prod 107:54–161
35. Niinimäki K, Hassi L (2011) Emerging design strategies in sustainable production and consumption of textiles and clothing. J Clean Prod 19:1876–1883
36. De-la-Torre GE, Aragaw TA (2021) What we need to know about PPE associated with the COVID-19 pandemic in the marine environment. Mar Pollut Bull 163:111879
37. Ammendolia J, Saturno J, Brooks AL, Jacobs S, Jambeck JR (2021) An emerging source of plastic pollution: the environmental presence of plastic personal protective equipment (PPE) debris related to COVID-19 in a metropolitan city. Environ Pollut 269:116160
38. World Health Organization (2020) Rational use of personal protective equipment for COVID-19 and considerations during severe shortages: interim guidance. No. WHO/2019-nCoV/IPC_PPE_use/2020.4. World Health Organization, Geneva
39. Rowan NJ, Laffey JG (2021) Unlocking the surge in demand for personal and protective equipment (PPE) and improvised face coverings arising from coronavirus disease (COVID-19) pandemic: implications for efficacy, reuse and sustainable waste management. Sci Total Environ 752:142259
40. Celina MC, Martinez E, Omana MA, Sanchez A, Wiemann D, Tezak M, Dargaville TR (2020) Extended use of face masks during the COVID-19 pandemic: thermal conditioning and spray-on surface disinfection. Polym Degrad Stability 179:109251
41. Toon J (2020) Ozone disinfection could safely allow reuse of personal protective equipment. Biomed Saf Stand 50(16):121–123
42. https://www.chemistryworld.com/features/sustainable-covid-19-protection/ 4012826.article
43. https://www.ilo.org/sector/Resources/publications/WCMS_741344/langen/index.htm
44. https://www.ilo.org/asia/publications/WCMS_755630/langen/index.htm
45. Sen S, Antara N, Sen S, Chowdhury S (2020) The apparel workers are in the highest vulnerability due to COVID-19: a study on the Bangladesh apparel industry. Asia Pacific J Multidiscip Res 8(3):1–7
46. https://fashionunited.uk/news/fashion/fashion-industry-coalition-fights-to-protect-garment-workers/2020042248606

47. Sen S, Antara N, Sen S, Chowdhury S (2020) The unprecedented pandemic COVID-19 effect on the Bangladesh apparel workers by shivering the apparel supply chain. J Text Apparel Technol and Manage 11(3):1–20
48. https://www.unido.org/stories/will-covid-19-accelerate-transition-sustainable-fashion-industry#story-start
49. https://www.researchandmarkets.com/reports/5019783/textile-global-market-report-2020-30-covid-19
50. D'Adamo I, Lupi G (2021) Sustainability and resilience after COVID-19: A circular premium in the fashion industry. Sustainability 13:1861
51. Kumar A, Luthra S, Mangla SK, Kazançoğlu Y (2020) COVID-19 impact on sustainable production and operations management. Sustain Oper Comput 1:1–7
52. Akintayo WL (2020) Revitalising the nigerian textile industries for mitigating the effect of COVID-19 and achieving sustainable economic development. KIU J Human 5(3):57–66
53. Teng X, Chang BG, Wu KS (2021) The role of financial flexibility on enterprise sustainable development during the COVID-19 crisis—a consideration of tangible assets. Sustainability 13(3):1245
54. Wu HL, Huang J, Zhang CJ, He Z, Ming WK (2020) Facemask shortage and the novel coronavirus disease (COVID-19) outbreak: reflections on public health measures. EClinicalMedicine 21:100329
55. Barreiro-Gen M, Lozano R, Zafar A (2020) Changes in sustainability priorities in organisations due to the COVID-19 outbreak: averting environmental rebound effects on society. Sustainability 12(12):5031
56. McMaster M, Nettleton C, Tom C, Xu B, Cao C, Qiao P (2020) Risk management: rethinking fashion supply chain management for multinational corporations in light of the COVID-19 outbreak. J Risk Financ Manage 13(8):173
57. Taqi HM, Ahmed HN, Paul S, Garshasbi M, Ali SM, Kabir G, Paul SK (2020) Strategies to manage the impacts of the COVID-19 pandemic in the supply chain: implications for improving economic and social sustainability. Sustainability 12(22):9483
58. Yu H, Sun X, Solvang WD, Zhao X (2020) Reverse logistics network design for effective management of medical waste in epidemic outbreaks: insights from the coronavirus disease 2019 (COVID-19) outbreak in Wuhan (China). Int J Environ Res Public Health 17(5):1770
59. Sundari KM, Sowmiya MB (2020) Tirupur textile start-ups in COVID 19 pandemic situations-scot analysis. J Manag 2(7):81–88
60. de Abreu MCS, Ferreira FNH, Proença JF, Ceglia D (2020) Collaboration in achieving sustainable solutions in the textile industry. J Bus Ind Market
61. Impact of COVID-19 on the Indian Textile Industry. https://wazir.in/textile-apparel-insights/industry-report/
62. Mishra M, Mishra P (2021) Prioritising financial crises due to COVID-19: an economic safety and sustainability approach in India. Int J Syst Dyn Appl 10(1):1–11