## Impact of COVID-19 on the textile, apparel and fashion manufacturing industry supply chain: Case study on a ready-made garment manufacturing industry

Received (in revised form): 21st July, 2020



Samit Chakraborty

#### SAMIT CHAKRABORTY

Doctoral Fellow, Wilson College of Textiles, North Carolina State University, USA

Samit Chakraborty is a PhD fellow and working as research assistant at Wilson College of Textiles. His research is based on implementing innovative technologies and ensuring sustainable supply chain management in the textile manufacturing and fashion retailing industry. He completed his Master's at the University of Manchester, UK and Bachelor's at Bangladesh University of Textiles. He has over five years' working experience as a production merchandiser and product developer in the apparel manufacturing industry, where he developed products for European brands such as C&A and Tom Tailor. With this diverse industrial experience, he joined Daffodil International University, Bangladesh as a lecturer to continue his research and pursue a career in academia. He has published articles on consumer behaviour and sustainable supply chain in various international journals.

Textile Technology Management, Department of Textile and Apparel, Technology and Management, Wilson College of Textiles, North Carolina State University, Raleigh, NC 27606, USA E-mail: schakr22@ncsu.edu



Manik Chandra Biswas

#### MANIK CHANDRA BISWAS

Doctoral Fellow, Wilson College of Textiles, North Carolina State University, USA

Manik Chandra Biswas is a doctoral fellow, recipient of North Carolina Textile Foundation (NCTF) Fellowship, and a polymer and materials engineer with more than ten years' research and industrial experience seeking to innovate real-world textile and polymeric products and guide innovations in green chemistry as well as their adoption by industry. His graduate research (at Master's and doctoral levels) focuses on innovations in the conversion of biomass waste into value-added materials and substitution of petroleum-based additives with biomass derivatives for the strengthening of plastics and regenerated fibres from natural resources. Overall, this research will improve the sustainability of the textile industry by introducing overlap between the circular economies of both the textile and agricultural industries. At graduate level, since 2015, he has supported work in five industry-sponsored projects (all related to green chemistry), filed one US patent application, drafted another patent disclosure and published 12 peer-reviewed journal articles and five book chapters on the use of biomass derivatives towards manmade fibre production and polymer nanocomposites towards sustainability.

Fiber and Polymer Science, Department of Textile Engineering, Chemistry and Science, Wilson College of Textiles, North Carolina State University, Raleigh, NC 27606, USA E-mail: mbiswas2@ncsu.edu

#### Abstract

Over the past few months, the world has witnessed how the COVID-19 pandemic disrupted the supply chain of the textile, apparel and fashion manufacturing (TAFM) industry in various

unprecedented ways. As the global textile market is interconnected, this outbreak has a global impact due to travel restrictions and raw materials shortages. This study highlights the imminent impact of COVID-19 on the TAFM industry supply chain, focusing on root-cause analysis and statistical data on consumption of textile goods, both locally and globally. There has not been any academic research on TAFM supply chain disruption. This paper has fulfilled this research gap. Our research is a two-fold study. The first part reviews the overall impact of the pandemic on the TAFM industry and conducts a text analysis on the statements collected from business reports, academic journals, market researchers' opinions, manufacturers' statements and business journals, in order to identify the most frequently used terms associated with supply chain disruption. The second part is a case study on a ready-made garment (RMG) industry in Bangladesh, which showed that the supply chain disruption due to COVID-19 would increase the production cost. This is alarming for garment manufacturers and exporters, as the worldwide apparel consumption is also projected to reduce during and after the pandemic. Lastly, this study forecasts the takeaways of the TAFM industry from this global pandemic and recommends a mathematical model to tackle any similar situation in future.

#### **Keywords**

COVID-19, supply chain, textiles and apparel industry, fashion manufacturing industry, global impact

#### INTRODUCTION

The COVID-19 pandemic has spread exponentially across the world, creating a significant impact on social lives. The impact varies across different age and culture groups. The lockdown, stayat-home order, social distancing and unemployment have elevated mental stress levels throughout the world. The uncertainty in returning to normal life post-COVID-19 have challenged our day-to-day existence.1-4 The total number of coronavirus cases reached 4,720,196 as of 15th May, 2020 — a huge rise from 292 reported on 20th January.<sup>5</sup> Similar to the present pandemic, there long-term, simultaneous, was also epidemic outbreak propagation and disruption in supply, demand and logistics infrastructure during SARS, MERS, Ebola and Swine flu.6 These pandemic outbreaks impose serious threat to supply chain management by bringing uncertainty in consumption, sales, business and overall economy.<sup>7-9</sup> Initially a health crisis, COVID-19 has now also caused crises in the global economy, trade and

finance, with a projected worldwide economic impact ranging between US\$2tr and US\$4.1tr. Cascading demand, panic buying and shortage of personal protective equipment (PPE), surgical masks, gloves and gowns have disrupted global supplies for healthcare essentials. The unbalanced situation in supply and distribution is prevailing in every industry due to this pandemic.<sup>10</sup>

The coronavirus initially broke out in Wuhan area, China, immediately affecting the Chinese supply chain and then consequently disrupting the entire global supply chain.<sup>11</sup> The exponential increase of COVID-19 cases throughout Asia, Europe and USA has resulted in border closures and home quarantines.<sup>12</sup> COVID-19 has posed a serious threat to the global supply chain because of the economic slowdown. The change in commodity consumption has disrupted in supply, manufacturing, logistics and sales. Hence, it has disrupted the global supply chain by weakening and slowing down global trade.<sup>13–16</sup>

The existing uncertainty and

economic slowdown have also had an impact on the textile, apparel and fashion manufacturing (TAFM) industry supply chain. The fashion world has seen the largest month-to-month drop in retail sales since 1992. Although retail sales had bounced back in the USA by May 2020, levels are still way below pre-pandemic.<sup>17</sup> Moreover, the social distancing restrictions and other related rules imposed by the retailers limit the number of consumers who can be present in a store. Besides, consumers are now concerned about saving money for future emergencies, which has made it more difficult to predict consumers' behaviour. The TAFM industry is experiencing manufacturing plant closure, employee lay-off and significant financial loss. The financial crisis due to this pandemic may eventually lead to a social crisis. Hence, COVID-19 has imposed economic as well as social impact on each stakeholder involved in the fashion manufacturing and retailing industries.<sup>18-21</sup> Although China has restarted manufacturing on a small scale, the overall impact is likely to continue for the foreseeable future. The manufacturers and retailers do not have any expected timeframe when retail and production will revert to the normal condition.<sup>22</sup> Amid this unstable economic environment, manufacturing industries and retail stores will have to invest further after reopening their businesses in order to ensure additional safety and protective measures for their employees, suppliers and customers. This investment, however, cannot guarantee to result in increasing sales and profitability during or after the pandemic.<sup>23,24</sup>

These radical changes can, however, introduce new supply chain models for the future. Industries should develop their own probability models that can predict how the sector-based gross domestic product (GDP) can be affected during any unexpected and unforeseen global supply chain disruption. Mathematical models will also be important tools to inform the supply chain risks. The information and statistical reports available newspapers, business magazines in and online sources have reflected the severity of this disruption. The purpose of this research is to investigate the economic impact of COVID-19 on the TAFM supply chain disruption. The first section introduces the background of the research topic, fulfilment of research gap and the research purpose. This is followed by a brief scientific explanation on COVID-19 sources and preventive measures. Next, the impact on the TAFM supply chain is described, encompassing the data reported on GDP, consumption, order, production, employment, import, export, sourcing and investment. A case study is then conducted on a Bangladesh ready-made garment (RMG) industry to show the change in direct costs, indirect costs and final product price because of supply chain disruption due to COVID-19. The final section discusses the key takeaways for the TAFM industry from COVID-19 and presents a statistical model that can help it to respond to any similar pandemics in the future.

### COVID-19: SOURCES AND PREVENTIVE MEASURES

The phylogenetic research on COVID-19 or 2019 novel corona virus allowed the identification of its subfamily named as Orthocoronavirinae, which belongs to the Coronaviridae family. The virus causes infections in the respiratory system and gastrointestinal tract.<sup>25–28</sup> Researchers found that the virus remains in the incubation period for about five days on average after it is exposed to the human body; infected individuals do not show any symptoms during this period.<sup>29,30</sup>

Different research found that absence of preventive measures such as social distancing could directly generate an average of 2-4 new infections. Hence, it caused the infection to spread rapidly among a mass of people. The rate and number can even increase if no preventive measures are taken. This illustrates the importance of maintaining social distancing, self-quarantine and isolation to limit the spread of the virus and diminish the number of infected people eventually.<sup>31,32</sup> Manufacturers and retailers have mandated different rules for their employees and customers as part of these protective measures, such as wearing masks, washing hands with sanitisers, maintaining 2m distance, online deliveries and following check-in and checkout lanes.33,34

#### **IMPACT OF COVID-19 OUTBREAK**

### Textile, apparel and fashion industry supply chain disruption

The changes in aggregate demand, slowdown in global economy, manufacturing stores closure and production shutdown due to the COVID-19 outbreak have created global structural supply shocks.35 The textile and fashion supply chain has encountered similar impacts from the pandemic. China is a critical supplier of textile inputs. Hence, when the disruptions started with China, the impact consequently extended throughout the whole global market.<sup>36</sup> Figure 1 shows a strong regional dimension and interconnection of the global textile supply chain. When it comes to textiles, China is known as the heart of 'Factory Asia', Italy represents

'Factory Europe' and the USA represents 'Factory North America'.<sup>37</sup> This interconnection demonstrates that the recent supply chain disruption in the hearts of the regional factory representative countries will affect the worldwide textile market. The size of the boxes shown in Figure 1 represents the size of the textile and apparel market of the respective country. For instance, the size of the box for China is the largest among all other countries because of its huge textile and apparel market as well as supply chain network compared to other countries.

The supply chain shock due to this pandemic has driven bullwhip effects in the fashion and RMG industry too, by forcing companies to stop production and sales. For instance, according to recent reports, Swedish fashion brand H&M announced 45 store closures in China. Other major brands such as Gap, Uniqlo, Hugo Boss, Ralph Lauren, Nike, Levi Strauss and Adidas also publicly announced closure of different stores in China.<sup>39</sup> These incidences will directly affect the economy of the textile and RMG export-based countries.

Wazir (2020) shows that the impact on apparel consumption has significantly affected the export of apparel and fashion items worldwide. The EU and USA are the biggest importers of apparel products.40 Wazir's report projects the GDP of these two regions will shrink by 3-4 per cent and 5-6 per cent respectively over the next quarters of 2020. According to this report, there will be a closure of bricks-and-mortar fashion retail stores throughout the USA and Europe for the third quarter of the year. Figure 2 shows the change in apparel consumption in the USA and EU, indicating a projection of 40 per cent lower apparel consumption in USA and



**FIGURE 1:** Interconnected networks of global textile supply chain Source: Produced by authors from the WTO Research Report  $^{\rm 38}$ 



**FIGURE 2:** Apparel consumption projection of USA and EU for 2020 Source: Produced by authors from Wazir<sup>44</sup>

50 per cent lower consumption in EU in 2020 compared to 2019 due to the fall in GDP as well as store closures.41 The total apparel consumption in these two regions is projected to reduce by US\$308bn in 2020. Since, however, US consumers are more inclined to regular purchasing and exhibit more consumerism than Europe, the USA might return to normal consumption levels faster than the EU. Nevertheless, the situation will have an impact on the overall apparel imports in EU and the USA.42 In 2020, the expected apparel imports in these two regions will be a total of US\$158bn, which is about 44 per cent lower than that of 2019.43

The apparel export-oriented industries and the backward linkage industries that depend on RMG export have also reached a pause mode. This will directly affect the GDP of the low-income developing countries, whose economy largely depends on the production and export of apparel and fashion products.<sup>45,46</sup> Due to store closures and sale downturns, Western fashion retailers have cancelled orders worth US\$2.8bn from Bangladesh, which has created a humanitarian crisis scenario.<sup>47</sup> According to *Forbes*,

'a survey of 319 garment factory owners in Bangladesh conducted by the Center for Global Workers' Rights between 21st and 25th March, 2020 revealed that when cancelling orders, over 72 per cent of buyers refused to pay for raw materials (fabric, etc.) already purchased by the supplier. Over 91 per cent of buyers refused to pay for the cut make-trim cost (production cost) of the supplier. As a result of order cancellations and lack of payment, 58 per cent of factories surveyed report having to shut down most or all of their operations.<sup>48</sup> The United Nations Conference on Trade and Development anticipates the global economic slowdown due to COVID-19 will result in a decline in sales and profitability of US\$1tr. It also predicts a decline in global foreign direct investment by 5–15 per cent.<sup>49</sup>

### Unemployment in the textile and apparel industry

The impact on clothing consumption and import will also affect the GDP and employment of top-tier apparel or RMG exporting countries of Asia such as Bangladesh, China, Vietnam and India<sup>50</sup> to a greater extent. Our analysis on the Asian Development Bank's dataset revealed a sharp decline in the GDP (%) and employment of these countries due to the COVID-19 outbreak,<sup>51</sup> which is shown in Figures 3a and 3b. These figures illustrate the impact of COVID-19 on GDP reduction and unemployment, which are crucial indicators of economic downturn due to a pandemic.

The Business of Fashion and McKinsey & Company presented their findings on the impact of COVID-19 on the fashion industry worth US\$2.5tr.52 The shutdown in UK retail stores may also cause millions of jobs to be lost due to this pandemic.53 Amed et al.54 reported staff layoffs and wage cuts due to closure of stores in the developed countries and order cancellations in garment industries in low-cost sourcing and fashion-manufacturing countries, such as Bangladesh, India, Cambodia, Ethiopia and Honduras, which will exacerbate hunger and disease in those countries.55 According to the report, the unemployment rate increased to 5.7 per cent in February 2020 in China, which included a large proportion of manufacturing job losses. Amed et



FIGURE 3A: Mean decline in GDP (as % of sector GDP) Source: Authors



FIGURE 3B: Mean decline in employment (as % of unemployment) Source: Authors

al.'s findings showed that millions of people in the fashion industry would lose their jobs due to this impact. The Clothing Manufacturers Association of India (CMAI) forecasts a drop of 30 per cent in apparel sales and profitability, which may cause a 10-15 per cent decline in employment in apparel manufacturing industry and manufacturing.56 About 1.44m textile and apparel industry workers in Bangladesh might be affected by order cancellations from Western countries.<sup>57</sup> Thousands of factories in Bangladesh could not provide any income or even severance pay to their workers while sending them home temporarily due to order cancellations. Temporary or permanent factory closures in Albania, Cambodia, Myanmar, Pakistan, Indonesia, Sri Lanka and Central America have also hit hard the low-waged garment workers in these countries.58 The pandemic has caused the closure of several garment manufacturing industries in Myanmar, which may lead to tens of thousands unemployed.<sup>59</sup> Although the ILO predicts approximately 305m jobs might be lost due to COVID-19,60 it should provide a breakdown of this number based on the type of industry. This will help the textile, apparel and fashion manufacturers, retailers and researchers to gain a deeper understanding of the industry-based crisis and take steps based on the essential measures.

# Economic impact analysis using natural language processing technique

This paper conducted a text analysis using natural language processing technique (NLP) to explore the insights of economic impact due to COVID-19, based on the data collected from business journals, fashion blogs, market research data and online news portals.<sup>61-64</sup>

#### Research method

After data screening and filtering of statements, data and reports (n=85), the authors have found similar terms related to economic crisis in a different order of frequency from the literature study of the global financial recession 2008-9.65-71 Our approach is based on exploring the most frequently used terms in the statements and information that we collected from these sources, using R software. The conversion of statements into a corpus used 'tm' package in R. This text-mining process used the bag-ofwords approach to convert the text into a data frame consisting of words used in the text frequencies. These are applied using document term matrix (DTM) and term document matrix (TDM). This text-mining approach is widely used to explore reviews, opinions and facts that generally describe a common phenomenon.72-76

#### Result and discussion

The bar chart shown in Figure 4 presents the most frequent words and the dendrogram shown in Figure 5 presents the taxonomic relationships among the terms which support the authors' discussion on economic impact of COVID-19 on the TAFM industry and supply chain disruption. These text analyses depict the severity prevailing on the economy based on the statements and information collected from different sources.77-81 These findings bolster the previous findings related to loss, decline in consumption, store closure and unemployment. The overall analysis depicts an inevitable depression



FIGURE 4: Bar chart showing the terms most frequently deployed in various business magazines, market research reports and newspapers. These terms also relate to the factors that have been discussed in this paper to describe supply chain disruption of the TAFM industry Source: Authors



Cluster Dendrogram

#### dist(review\_tdm, method = "euclidean") hclust (\*, "complete")

**FIGURE 5:** Dendrogram showing the taxonomic relationship among the terms mentioned in Figure 4 and explored from the text analysis of statements sourced from business magazines, fashion blogs, market research reports and newspapers Source: Authors

and recession that the TAFM industry is about to face due to the pandemic, and shows the high stress level that exists in the socio-economic environment of the industry.

#### CASE STUDY ON A BANGLADESH RMG INDUSTRY

The supply chain of the RMG industry is connected to backward linkage industries such as spinning mills for yarn manufacturing, knitting or weaving mills for fabric manufacturing, coloration industry for fabric dyeing, printing and finishing. This chain is joined to forward linkage activities such as packaging, logistics, banking, port services and government support.<sup>82,83</sup> In the current research, the disruption in the textile apparel and fashion supply chain management can be attributed to changes in garment production and distribution costs due to the effects of the pandemic.

#### Methodology

The authors conducted a case study on a knitwear-based RMG company in Bangladesh. The company provided useful insights and information on its production and marketing details. The collected data is based on the costing of a 100 per cent cotton basic t-shirt. The company is expecting to ship the produced styles to its European brands after withdrawing lockdown, despite making no profit because of unwanted newly added inventory and logistics costs. For the purposes of this research paper, however, it has provided the current change in price of raw materials and projected associated production costs to make similar styles in the post-pandemic period. The study compared two different costing and pricing scenarios, before and

after COVID-19. The calculations were completed in an ERP software platform of the respective industry. The net fabric consumption (Net Cons/Dz) required to make a dozen garment pieces in a repeat style was found using computer aided design (CAD) consumption. The freeon-board (FOB) price (transport finished garments up to seaport) was analysed to explore the change in garment price before and after COVID-19.

#### **Results and discussion**

#### FOB pricing before COVID-19

Table 1 shows the fabric price for a single piece (pcs) garment considering the direct cost associated with fabric manufacturing. The yarn price, knit charge and dyeing and finishing cost are based on the average price found from the company's 2019 financial report. The total price per kilogram (kg) of fabric has been derived by multiplying raw material price and processing cost with net consumption per dozen, then dividing the total price per kg fabric by 12 to obtain the fabric price per piece.

Cost is one of the key elements in the garment sector. The company's annual turnover and future survival depends on accurately determining the projected cost of making (CM). Table 2 shows the calculations for cost per minute (CPM), which is the cost of an entire factory associated with one minute of production and is greatly affected by elements such as quality, absenteeism, production delay and management support. Standard minute value (SMV) is the time required for making a garment, which indicates a company's efficiency.

Table 3 shows the rest of the important metrics that determine the FOB price of a garment piece (pcs) and a company's

TABLE 1:	Fabric	costing	of	basic	t-shirt
----------	--------	---------	----	-------	---------

Processing cost	Price/kg	Net Cons/Dz	Total price/kg	Fabric price/pcs
Yarn price	US\$3.10	3.41	US\$10.57	US\$1.08
Knit charge	US\$0.25	3.41	US\$0.85	
Dyeing cost	US\$0.45	3.41	US\$1.53	
Total			US\$12.96	

#### TABLE 2: CM and CPM

ltem	Unit/pcs
CPM (salary, benefits, quality, overtime and overhead costs such as utility,	US\$0.089
management, maintenance)	
SMV of making a t-shirt	6 minutes
$CM = SMV \times CPM = (US\$0.089 \times 6)$	US\$0.53

**TABLE 3:** FOB price including fabric price, CM and other associated costs

ltem	Price/pcs
Raw material cost	US\$1.08
Accessories	US\$0.14
CM	US\$0.53
Commercial cost	US\$0.029
Courier charge	US\$0.01
Lab test	US\$0.01
Sample charge	US\$0.05
Total cost	US\$1.85
Profit (5%)	US\$0.09
Net cost	US\$1.94
Sales commission (3%)	US\$0.06
FOB price of a garment	US\$2.00

profit margin. Any change in the direct and indirect cost metrics forces companies to reduce their profit margin during negotiations with buyer.

#### FOB pricing before COVID-19

The recent lockdown will have a direct impact on the increase of yarn price. Almost all the spinning industries in Bangladesh that produce yarn for export-based RMG industries import cotton fibre from India. Many of the RMG industries directly import yarn from India, Pakistan, China, Indonesia and Taiwan. The unusual price hike in cotton and different types of yarn is common in RMG export business. The authors have projected an increase in yarn price of approximately US\$0.20 per kg taking into account the added cost of logistics and safety measures as well as the unstable situation due to COVID-19. This projection is based on historical information of the company's report and previous history of yarn price fluctuation in both local and international markets.84-86 Table 4 shows that the knit and dyeing charge has been kept constant as per the company's speculation and projection.

The COVID-19 pandemic will force companies to invest in protective measures for their employees. This cost will be added the CPM. Availability of skilled labour force can increase the SMV for a garment piece. It has been projected that average fluctuations of these metrics based on a company's market history can increase the CPM from 1.5 to 2 times. The average change in CPM and SMV will lead to an increased CM, as shown in Table 5.

The associated costs such as estimated changes in accessories and trimmings import and commercial cost test will

TABLE 4:	Fabric	costing	of	basic	t-shirt
----------	--------	---------	----	-------	---------

Raw material cost	Price/kg	Net Cons/Dz	Total price/kg	Fabric price/pcs
Yarn price	US\$3.30	3.41	US\$10.57	US\$1.28
Knit charge	US\$0.25	3.41	US\$0.85	
Dyeing cost	US\$0.45	3.41	US\$1.53	
Total			US\$12.96	

#### TABLE 5: CM and CPM

Item	Unit/Pcs	
CPM (salary, benefits, quality, overtime and overhead cost	US\$0.14	
such as utility, management, maintenance)		
SMV of making a t-shirt	7 minutes	
$CM = SMV \times CPM = (US\$0.089 \times 6)$	US\$0.98	

**TABLE 6:** FOB price including fabric price, CM and other associated costs

ltem	Price/pcs
Raw material cost	US\$1.28
Accessories	US\$0.18
CM	US\$0.98
Commercial cost	US\$0.035
Courier charge	US\$0.03
Lab test	US\$0.01
Sample charge	US\$0.05
Total cost	US\$2.57
Profit (3%)	US\$0.08
Net cost	US%2.65
Sales commission (3%)	US\$0.08
FOB price of a garment	US\$2.73

also increase the final FOB price of the product. These changes will be due to import restrictions, supplier-buyer negotiation, transport cost and delay in port facilities. On the other hand, the reduced consumption in Western countries can force manufacturers to reduce profit margin to 3 per cent from 5 per cent. The company has to reduce its profit margin several times while there is a delay in shipment, increase in bank interest and recession. It has to compete with other garment suppliers to survive in the global market.

The final result shows a projected decrease in the company's profit margin

and 37 per cent increase in FOB price. Retailers will attempt to maintain the pre-COVID product price to meet consumers' expectations, which will further reduce the company's profit. As a result, there will be an unstable condition in the RMG industry supply chain.

#### TEXTILE AND FASHION INDUSTRY TAKEAWAYS FROM COVID-19

There have been different opinions and analysis on reconstructing the supply chain after COVID-19 or how the textile and fashion chain will look after the pandemic. These sources suggest that industries and societies can take lessons from the surrounding failing supply chain systems and modify them after the pandemic for the betterment of consumers and society in general.87,88 First, ensuring safety and security of the workforce is the priority now for manufacturers and retailers. Different manufacturing industries have promised and planned accordingly to ensure safety measures after reopening their businesses.<sup>89</sup> Governments, representatives of manufacturing organisations and retailers should strictly monitor that every industry complies with the

preventive and safety measures taken for its employees.

Secondly, there should be careful studies and analyses of consumer behaviour during this pandemic, because it will provide a smart means for retailers to futureproof their businesses. Experts predict that this unprecedented time of stillness will give consumers not only valuable perspective regarding the priorities of various commodities in their lives, but will also bring changes in their attitude towards shopping and product types in the post-pandemic world.90 Implementation of transparency at all phases of supply chain management, diversification of essential resources, lean supply, total cost ownership and genuineness in maintaining customer retention will help in recovering from financial crisis as well as reconstructing supply chain management.<sup>91</sup> According to some market researchers, however, the economic impact can pause the growing trend of sustainable business models. The supply chain will take a different direction because investors will concentrate more on economic recovery rather than spending further on sustainability.92 Therefore, researchers and industries should work in tandem to maintain balance between reconstructing the existing supply chain and coping with the rapid changes in business. They should also focus on developing data-driven and technology-based digital supply chain to overcome unwarranted supply chain disruption.

Finally, there should be new sourcing, production and distributing strategies to restructure the supply chain system. Market researchers assumed that retailers would be more interested in reshoring and near-shoring in the post-COVID-19 period.<sup>93</sup> The recent initiatives taken by US textile and apparel manufacturing industries for making PPE and masks<sup>94</sup> may reinforce reshoring initiatives and reduce sole dependence on importing medical textiles from remote supplier countries such as China. Therefore, every country should develop a just-intime and lean-based textile and apparel manufacturing and distribution system that can immediately support its local healthcare officials and patients with PPE, gowns, masks and other medical textile products during any future emergency.

#### Proposed model development to predict economic impact on the TAFM industry due to COVID-19

As other industries, the TAFM industry should also prioritise analysing the impact of the pandemic on supply chain disruption in the future. The mathematical model and statistical analysis allow us to gain a better understanding of sourcing, manufacturing and major barriers to sustainable growth during the pre- and post-pandemic period. It will benefit fashion manufacturers and retailers to measure the unexpected supply chain risks and disruptions in the future. The multivariate linear fit regression model presented here can be applied to predict the probable impact on GDP based on the fluctuation in production, consumption, unemployment, import, export and investment due to COVID-19. These factors have largely affected the GDP and contributed to the on-going economic crisis due to COVID-19 as well as during the recession of 2008-9.95-98 These studies concentrated on GDP projection, economic impact forecasting, employment determinants, econometric perspective and recession have emphasised the importance of using these factors in their statistical probabilistic and auto-regressive models.

The above-mentioned factors have been combined here and applied using second order interactions to develop a complex linear fit regression model, where  $\beta_0$  represents the intercept of the relationship in the model,  $\beta_1$ ,  $\beta_2$ , ...,  $\beta_{21}$ are coefficients for independent variables and their interactions and  $\varepsilon$  is the error term. Here each of the factors may have multiple levels (high, medium, low) measuring their respective increase or decrease in multiple financial quarters. As a result, the effect will be different for different countries based on their export/import ratio.

We have defined our factors as consumption =  $X_1$ , unemployment =  $X_2$ , production =  $X_3$ , import =  $X_4$ , export =  $X_5$  and investment =  $X_6$  for our model development.

GDP fluctuation in TAFM industry =  $\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$ +  $\beta_5 X_5 + \beta_6 X_6 + \beta_7 X_1 X_2 + \beta_8 X_1 X_3$ + $\beta_9 X_1 X_4 + \beta_{10} X_1 X_5 + \beta_{11} X_1 X_6 + \beta_{12} X_2 X_3$ +  $\beta_{13} X_2 X_4 + \beta_{14} X_2 X_5 + \beta_{15} X_2 X_6 + \beta_{16} X_3 X_4 + \beta_{17} X_3 X_5 + \beta_{18} X_3 X_6 + \beta_{19} X_4 X_5$ +  $\beta_{20} X_4 X_6 + \beta_{21} X_5 X_6 + \epsilon$ 

Since the variables are collected in different forms or scales of measurements, they should be standardised or transformed by using the log of their values so that the coefficients can be measured in a same scale. This model can be tested further in a research paper using the data collected from the economic reports of the respective country.

#### CONCLUSION

The textile, apparel and fashion manufacturing industry is a major contributor to the global economy. The impact of the COVID-19 pandemic disrupted the supply chain system of this industry and put a brief pause on its smooth operation. This research paper explored and discussed the key points related to this disruption and also reported how it had affected the global production, import, export, GDP, employment and consumption. The case study showed that COVID-19 significantly affected the supply chain management of one RMG manufacturing industry, which resulted in significant disruption to the supply chain of the entire TAFM industry. The graphs and visuals, based on recent business reports, market overviews, journals etc., reflect the economic and social impacts currently prevailing in the TAFM industry due to COVID-19. The restructure of the TAFM supply chain systems has been urged for the betterment of manufacturing and retail industry in the near future. The authors also suggested that companies should develop a lean supply chain model convenient for producing both ready-made garments and PPE, as many countries may need to import large volumes of PPE very soon. This holistic approach will help the textile, apparel and fashion industry to rebound after the COVID-19 pandemic.

#### **AUTHORS' NOTE**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-forprofit sectors. The authors declare no competing financial interest.

#### REFERENCES

 Bavel, J. J. V., Baicker, K., Boggio, P. S., Capraro, V., Cichocka, A., Cikara, M., Crocket, M. J., Crum, A. J., Douglas, K. M., Druckman, J. N., Drury, J., Dube, O., Ellemers, N., Finkel, E. J., Fowler, J. H., Gelfand, M., Han, S., Haslam, A., Jetten, J., Kitayama, S., Mobbs, D., Napper, L. E., Packer, D. J., Pennycook, G., Peters, E., Petty, R. E., Rand, D. G., Reicher, S. R., Schnall, S., Shariff, A., Skitka, L. J., Smith, S. S., IMPACT OF COVID-19 ON THE TEXTILE, APPAREL AND FASHION MANUFACTURING INDUSTRY SUPPLY CHAIN

Sunstein, C. R., Tabri, N., Tucker, J. A., Linden, S. van der, Lange, P. van, Weeden, K. A., Wohl, M. J. A., Zaki, J., Zion, S. R. and Willer, R. (April, 2020), 'Using social and behavioural science to support COVID-19 pandemic response', *Nature Human Behaviour*, Vol. 4, pp. 460–471, available at http://www. nature.com/articles/s41562-020-0884-z (accessed 8th May, 2020).

- (2) Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J. and Zheng, J. (May 2020), 'The psychological impact of the COVID-19 epidemic on college students in China', *Psychiatry Research*, Vol. 287.
- (3) Li, S., Wang, Y., Xue, J., Zhao, N. and Zhu, T. (March 2020), 'The Impact of COVID-19 Epidemic Declaration on Psychological Consequences: A Study on Active Weibo Users', International Journal of Environmental Research and Public Health, Vol. 17, No. 6.
- (4) Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S. and Ho, R. C. (2020), 'Immediate Psychological Responses and Associated Factors during the Initial Stage of the 2019 Coronavirus Disease (COVID-19) Epidemic among the General Population in China', *International Journal of Environmental Research* and Public Health, Vol. 17, No. 5.
- (5) Worldometers (2020), COVID-19 Coronavirus Pandemic', available at https:// www.worldometers.info/coronavirus/ (accessed 11th August, 2020).
- (6) Ivanov, D. (April 2020), 'Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/ SARS-CoV-2) case', *Transportation Research Part E: Logistics and Transportation Review*, Vol. 136.
- (7) Dubey, R., Gunasekaran, A., Childe,
  S. J., Bryde, D. J., Giannakis, M.,
  Foropon, C., Roubaud, D. and Hazen,
  B. T. (December 2019), 'Big data analytics and artificial intelligence pathway to operational performance under the effects of entrepreneurial orientation and environmental dynamism: A study of manufacturing organisations', *International Journal of Production Economics*, Vol. 226.
- (8) Fahimnia, B., Jabbarzadeh, A. and Sarkis, J. (November 2018), 'Greening versus resilience: A supply chain design perspective', *Transportation Research Part E: Logistics and Transportation Review*, Vol. 119, pp. 129–148.
  (9) With a supplementation of the superspectation of th
- (9) Ibid., note 2.
- (10) Park, C-Y., Kim, K., Roth, S., Beck, S., Kang, J. W., Tayag, M. C. and Griffin, M. (May 2016), 'Global Shortage of Personal

Protective Equipment amid COVID-19: Supply Chains, Bottlenecks, and Policy Implications', Asian Development Bank, available at https://www.adb.org/publications/ shortage-ppe-covid-19-supply-chainsbottlenecks-policy (accessed 11th August, 2020).

- (11) Araz, O. M., Choi, T. M., Olson, D. and Salman, F. S. (May 2020), 'Data analytics for operational risk management', *Decision Sciences*.
- (12) Calderon, C., Kambou, G., Zebaze Djiofack, C., Korman, V., Kubota, M. and Cantu Canales, C. (Spring 2020), 'Africa's Pulse, No. 21, Spring 2020: An Analysis of Issues Shaping Africa's Economic Future', World Bank, available at http://elibrary.worldbank.org/doi/ book/10.1596/978-1-4648-1568-3 (accessed 11th August, 2020).
- (13) Hafiz, H., Oei, S-Y., Ring, D. M. and Shnitser, N. (March 2020), 'Regulating in Pandemic: Evaluating Economic and Financial Policy Responses to the Coronavirus Crisis', *Social Science Research Network Journal*, No. 527, available at https://www.ssrn.com/ abstract=3555980 (accessed 11th August, 2020).
- (14) Hailu, G. (May 2020), 'Economic thoughts on COVID-19 for Canadian food processors', *Canadian Journal of Agricultural Economics [Revue canadienne d'agroeconomie]*, Vol. 68, No. 2, pp. 163–169.
- (15) Khan, N., Fahad, S., Naushad, M. and Faisal, S. (2020), 'COVID-2019 Locked down Effects on Oil Prices and Its Effects on the World Economy', *Social Science Research Network Journal*, available at https://www.ssrn.com/ abstract=3588810 (accessed 11th August, 2020).
- (16) Retaildive (2020), 'The impact of the coronavirus on retail While COVID-19 spreads globally, the retail industry braces for the outbreak's fallout', available at https:// www.retaildive.com/news/the-impact-of-thecoronavirus-on-retail/573522/ (accessed 11th August, 2020).
- (17) CBC News (2020), 'U.S. retail sales bounced back by record 17% in May from April's low', available at https://www.cbc.ca/news/ business/us-retail-sales-1.5613776 (accessed 11th August, 2020).
- (18) Campbell, G. (2020), 'Covid-19 Has Decimated the Fashion Industry & Could Spell the End for Hype Product', HighSnobiety, available at https://www. highsnobiety.com/p/covid-19-fashionindustry-impact/ (accessed 11th August, 2020).

- (19) Elle (May 2020), 'How The Covid-19 Pandemic Is Affecting The Fashion Industry', available at https://www.elle.com/uk/fashion/ g32015646/coronavirus-fashion-brands/ (accessed 11th August, 2020).
- (20) Roberts-Islam, B. (2020), 'The True Cost of Brands Not Paying For Orders During The COVID-19 Crisis', *Forbes*, available at https://www.forbes.com/sites/ brookerobertsislam/2020/03/30/the-truecost-of-brands-not-paying-for-orders-duringthe-covid-19-crisis/#568523f45ccc (accessed 11th August, 2020).
- (21) USAFACTS (2020), 'COVID-19's impact on the economy: US retail sales fall 8.7% in March', available at https://usafacts.org/articles/ covid-19-impact-economy-us-retail-salesfall-87-march/?utm\_source=google&utm\_ medium=cpc&utm\_campaign=ND-COVID &gclid=EAIaIQobChMIuYqU\_7236QIVOQ iICR0DtgBZEAMYASAAEgIn6fD\_BwE&f bclid=IwAR0O1gtFVo1PEfCs0hTysAfbXDt AAFLFi4Oda-K4xoEiBL5K8uE9U9bWaW0 (accessed 11th August, 2020).
- (22) Kang, S. C. (2020), 'Global coronavirus spread may paralyze apparel supply chain for months', SP Global, available at https://www.spglobal. com/marketintelligence/en/news-insights/ latest-news-headlines/global-coronavirusspread-may-paralyze-apparel-supply-chainfor-months-57456384?fbclid=IwAR2RdL XQMNHzWpAs8\_kio4E9drfQ8SOpnU9lewCDUMCGhzK6P9\_Nlj3UmE (accessed 11th August, 2020).
- (23) Ovi, I. H. (2020), 'Covid-19 economic fallout: Urgent need for fiscal measures', *Dhaka Tribune*, available at https://www. dhakatribune.com/bangladesh/2020/03/20/ limiting-economic-fallout-of-covid-19urgent-need-for-fiscal-measures-to-tacklecrises (accessed 11th August, 2020).
- (24) Yadav, N. (2020), 'The future of fashion and retail industry in the post-COVID-19 era', YourStory, available at https://yourstory. com/2020/07/future-fashion-retail-industrypost-covid-19 (accessed 11th August, 2020).
- (25) Bar-On, Y. M., Flamholz, A., Phillips, R. and Milo, R. (2020), 'SARS-CoV-2 (COVID-19) by the numbers', eLife, available at https:// elifesciences.org/articles/57309 (accessed 11th August, 2020).
- (26) ECDC (2020), 'Download today's data on the geographic distribution of COVID-19 cases worldwide', European Centre for Disease Prevention and Control, available at https:// www.ecdc.europa.eu/en/publications-data/ download-todays-data-geographic-

distribution-covid-19-cases-worldwide (accessed 11th August, 2020).

- (27) Xie, M. and Chen, Q. (April 2020), 'Insight into 2019 novel coronavirus — an updated interim review and lessons from SARS-CoV and MERS-CoV', *International Journal of Infectious Diseases*, Vol. 94, pp. 119–124.
- (28) Zhu, N., Zhang, D., Wang, W., Li, X., Yang, B., Song., J, Zhao, X., Huang, B., Shi, W., Lu, R., Niu, P., Zhan, F., Ma, X., Wang, D., Xu, W., Wu, G., Gao, G. F. and Tan, W. (February 2020), 'A Novel Coronavirus from Patients with Pneumonia in China, 2019', *New England Journal of Medicine*, Vol. 382, No. 8, pp. 727–733.
- (29) He, X., Lau, E. H., Wu, P., Deng, X., Wang, J., Hao, X., Lau, Y, G., Wong, J. Y., Guan, Y., Tan, X., Mo, X., Chen, Y., Liao, B., Chen, W., Hu, F., Zhang, Q., Zhong, M., Wu, Y., Zhao, L., Zhang, F., Cowling, B. J., Li, F. and Leung, G. M. (March 2020), 'Temporal dynamics in viral shedding and transmissibility of COVID-19', *Infectious Diseases (except HIV/AIDS)*, available at http://medrxiv.org/lookup/ doi/10.1101/2020.03.15.20036707 (accessed 11th August, 2020).
- (30) Lauer, S. A., Grantz, K. H., Bi, Q., Jones, F. K., Zheng, Q., Meredith, H. R., Azman, A. S., Reich, N. G. and Lessler, J. (2020), 'The Incubation Period of Coronavirus Disease 2019 (COVID-19) From Publicly Reported Confirmed Cases: Estimation and Application', *Annals of Internal Medicine*, Vol. 172, No. 9, available at https:// annals.org/aim/fullarticle/2762808/ incubation-period-coronavirus-disease-2019covid-19-from-publicly-reported (accessed 11th August, 2020).
- (31) Ibid., note 25.
- (32) WHO (2020), 'Report of the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19)', available at https://www. who.int/docs/default-source/coronaviruse/ who-china-joint-mission-on-covid-19-finalreport.pdf (accessed 11th August, 2020).
- (33) Alam, J. (2020), 'Bangladesh reopens 600 apparel factories despite virus risk', ABC News, available at https://abcnews.go.com/ Business/wireStory/bangladesh-reopens-600-apparel-factories-virus-risk-70379207 (accessed 11th August, 2020).
- (34) Reda, S. (2020), 'U.S. retailers are taking steps to prepare for impact from the coronavirus', NRF, available at https://nrf.com/blog/ us-retailers-are-taking-steps-prepare-impactcoronavirus (accessed 11th August, 2020).
- (35) McKibbin, W. J. and Fernando, R. (2020),

'The Global Macroeconomic Impacts of COVID-19: Seven Scenarios', *Social Science Research Network Journal*, available at https:// www.ssrn.com/abstract=3547729 (accessed 11th August, 2020).

- (36) Atkeson, A. (2020), 'What Will Be the Economic Impact of COVID-19 in the US? Rough Estimates of Disease Scenarios', National Bureau of Economic Research, Working Paper 26867, available at http:// www.nber.org/papers/w26867.pdf (accessed 11th August, 2020).
- (37) Baldwin, R. and Mauro, B. W. di (2020), Economics in the Time of COVID-19, CEPR Press, London.
- (38) Li, X., Meng, B. and Wang, Z. (2020), 'Recent patterns of global production and GVC participation', WTO, available at https:// www.wto.org/english/res\_e/booksp\_e/gvc\_ dev\_report\_2019\_e.pdf (accessed 11th August, 2020).
- (39) Barua, S. (20200, 'Understanding Coronanomics: The Economic Implications of the Coronavirus (COVID-19) Pandemic', *Social Science Research Network Journal*, available at https://www.ssrn.com/abstract=3566477 (accessed 11th August, 2020).
- (40) O'Connell, L. (2019), 'Value of the leading 10 textile importers worldwide in 2018, by country', Staista, available at https://www. statista.com/statistics/236403/value-of-theleading-global-textile-importers-by-country/ (accessed 11th August, 2020).
- (41) Wazir (2020), 'Impact of COVID-19 Scenario on European and the US Apparel Market The Big Fall: EU and the US Apparel Consumption to Reduce by US\$ 300 bn', available at https://wazir.in/pdf/Wazir%20 Report%20-%20The%20Big%20Fall%20 -%20Impact%20of%20COVID-19%20on%20 EU%20and%20US%20Apparel%20Market.pdf (accessed 11th August, 2020).
- (42) Ibid., note 41.
- (43) Ibid., note 41.
- (44) Ibid., note 41.
- (45) Amed, I., Berg, A., Balchandani, A., Hedrich, S., Rölkens, F., Young, R. and Jensen, J. E. (2020), 'The State of Fashion 2020 Coronavirus Update', Business of Fashion, available at http://cdn. businessoffashion.com/reports/The\_State\_ of\_Fashion\_2020\_Coronavirus\_Update. pdf?int\_source=article2&int\_ medium=download-cta&int\_ campaign=sof-cv19 (accessed 11th August, 2020).
- (46) Satapathy, D. (2020), 'COVID-19 adversely hits textile, apparel, fashion sectors',

Fibre2Fashion, available at https://www. fibre2fashion.com/news/textile-news/ covid-19-adversely-hits-textile-apparelfashion-sectors-265962-newsdetails.htm (accessed 11th August, 2020).

- (47) Ibid., note 20.
- (48) Ibid., note 20.
- (49) Ibid., note 46.
- (50) Techpacker (2017), 'Top 4 Asian Countries for Garment Manufacturing', available at https:// techpacker.com/blog/manufacturing/top-4asian-countries-for-garment-manufacturing/ (accessed 11th August, 2020).
- (51) ADB (2020), 'COVID-19 Economic Impact Assessment Template', available at https://data. adb.org/dataset/covid-19-economic-impactassessment-template (accessed 11th August, 2020).
- (52) Ibid., note 18.
- (53) Ibid., note 19.
- (54) Ibid., note 45.
- (55) Ellis-Petersen, H. and Ahmed, R. (2020), 'Bangladesh garment factories reopen despite coronavirus threat to workers', *Guardian*, available at theguardian.com/ global-development/2020/may/11/ bangladesh-garment-factories-reopen-despitecoronavirus-threat-to-workers (accessed 11th August, 2020).
- (56) Ibid., note 46.
- (57) Textile Today (2020), 'Bangladesh textile and apparel industry during COVID-19', available at https://www.textiletoday.com.bd/ bangladesh-textile-apparel-industry-covid-19/ (accessed 11th August, 2020).
- (58) Ibid., note 46.
- (59) Abdulla, H. (March 2020), 'Mayanmer Covid-19 fund unlikely to cushion garment jobs,' just-style, available at https://www. just-style.com/news/myanmar-covid-19-fundunlikely-to-cushion-garment-jobs\_id138394. aspx (accessed 11th August, 2020).
- (60) ILO (2020), 'ILO: As job losses escalate, nearly half of global workforce at risk of losing livelihoods', available at https://www. ilo.org/global/about-the-ilo/newsroom/ news/WCMS\_743036/lang--en/index.htm (accessed 11th August, 2020).
- (61) Anderson, R. M., Heesterbeek, H., Klinkenberg, D., Hollingsworth, T. D. (2020), 'How will country-based mitigation measures influence the course of the COVID-19 epidemic?', *The Lancet*, Vol. 395, No. 10228, pp. 931–934.
- (62) Ibid., note 39.
- (63) Fernandes, N. (2020), 'Economic Effects of Coronavirus Outbreak (COVID-19) on the World Economy', Social Science Research

*Network Journal*, available at https://www.ssrn. com/abstract=3557504 (accessed 11th August, 2020).

- (64) Patwary, A. A. (2020), 'Covid 19 Implication: Economic challenges of Bangladesh and way forward', Textile Focus, available at http://textilefocus.com/ covid-19-implication-economic-challengesbangladesh-way-forward/ (accessed 11th August, 2020).
- (65) Andersen, L. B., Häger, D., Maberg, S., Næss, M. B. and Tungland, M. (2012),
  'The financial crisis in an operational risk management context—A review of causes and influencing factors', *Reliability Engineering &* System Safety, Vol. 105, pp. 3–12.
- (66) History (2019), 'Great Recession', available at https://www.history.com/topics/21st-century/ recession (accessed 11th August, 2020).
- (67) Koopman, S. J., Lucas, A. and Schwaab, B. (2012), 'Dynamic Factor Models with Macro, Frailty, and Industry Effects for U.S. Default Counts: The Credit Crisis of 2008', *Journal of Business & Economic Statistics*, Vol. 30, No. 4. pp. 521–532.
- (68) Phillips, J. A. and Nugent, C. N. (2014), 'Suicide and the Great Recession of 2007–2009: The role of economic factors in the 50 U.S. states', *Social Science & Medicine*, Vol. 116, pp. 22–31.
- (69) Rose, A. K. and Spiegel, M. M. (2012), 'Cross-country causes and consequences of the 2008 crisis: Early warning', *Japan and the World Economy*, Vol. 24, No. 1, pp. 1–16.
- (70) Torá, I., Martínez, J. M., Benavides, F. G., Leveque, K. and Ronda, E. (2015), 'Effect of economic recession on psychosocial working conditions by workers' nationality', *International Journal of Occupational and Environmental Health*, Vol. 21, No. 4, pp. 328–332.
- (71) Zavras, D., Tsiantou, V., Pavi, E., Mylona, K. and Kyriopoulos, J. (2013), 'Impact of economic crisis and other demographic and socio-economic factors on self-rated health in Greece', *The European Journal of Public Health*, Vol. 23, No. 2, pp. 206–210.
- (72) Ghose, A. and Ipeirotis, P. G. (September 2010), 'Estimating the Helpfulness and Economic Impact of Product Reviews: Mining Text and Reviewer Characteristics', *IEEE Transactions on Knowledge and Data Engineering*, Vol. 23, No. 10, pp. 1498–1512.
- (73) Ghose, A, Ipeirotis, P. G., Sundararajan A. (2007), 'Opinion Mining Using Econometrics: A Case Study on Reputation Systems', Proceedings of the 45th Annual Meeting of the Association of Computational

Linguistics, Prague, Czech Republic, pp. 416–423, available at https://www.aclweb. org/anthology/P07-1053.pdf (accessed 11th August, 2020).

- (74) Hu, N., Pavlou, P. A. and Zhang, J. (2006), 'Can online reviews reveal a product's true quality?: Empirical findings and analytical modeling of online word-of-mouth communication', Proceedings of the 7th ACM conference on Electronic commerce – EC '06, Ann Arbor, Michigan, pp. 324–330, available at http://portal.acm.org/citation. cfm?doid=1134707.1134743 (accessed 11th August, 2020).
- (75) Kim, S-M. and Hovy, E. (2004),
  'Determining the sentiment of opinions', Proceedings of the 20th International Conference on Computational Linguistics – COLING '04, Geneva, Switzerland, Association for Computational Linguistic, p. 1367-es, available at http://portal.acm.org/ citation.cfm?doid=1220355.1220555 (accessed 11th August, 2020).
- (76) Turney, P. D. (2001), 'Thumbs up or thumbs down?: Semantic orientation applied to unsupervised classification of reviews', Proceedings of the 40th Annual Meeting on Association for Computational Linguistics ACL '02, Philadelphia, Pennsylvania: Association for Computational Linguistics, available at http://portal.acm.org/citation.cfm?doid=1073083.1073153 (accessed 11th August, 2020).
- (77) Ibid., ref 59.
- (78) Ibid., ref 61.
- (79) Ibid., ref 62.
- (80) Ibid., ref 63.
- (81) Ibid., ref 64.
- (82) Choudhary, A. S. (2015), 'Cost analysis in garment industry', *International Journal of Recent Advances in Multidisciplinary Research*, Vol 2, No. 9.
- (83) Mohibullah, A., Takebira, U. M., Jannat, F., Shakil, I. K., Abir, I. H. and Hosen, M. (June 2018), 'Improvement of forward linkage to sustain the global apparel market of Bangladesh', *Journal of Textile Engineering & Fashion Technology*, Vol. 4, No. 3, pp. 192–197, available at https://medcraveonline.com/JTEFT/ improvement-of-forward-linkage-to-sustainthe-global-apparel-market-of-bangladesh.html (accessed 11th August, 2020).
- (84) Textile Today (2020), 'Yarn prices increased 8 percent in last 4 weeks', available at https:// www.textiletoday.com.bd/yarn-pricesincreased-8-percent-last-4-weeks/ (accessed 11th August, 2020).

- (85) Textile Today (2020), 'Bangladesh textile and apparel industry during COVID-19', available at https://www.textiletoday.com.bd/ bangladesh-textile-apparel-industry-covid-19/ (accessed 11th August, 2020).
- (86) Umarji, V. (July 2020), 'Spike in Covid-19 cases halts revival of Surat's synthetic textile industry', Business Standard, available at https://www. business-standard.com/article/markets/ spike-in-covid-19-cases-halts-revival-of-surats-synthetic-textile-industry-120071000078\_1. html (accessed 11th August, 2020).
- (87) Evans, M. (2020), '7 Predictions For How COVID-19 Will Change Retail In The Future', *Forbes*, available at https://www.forbes. com/sites/michelleevans1/2020/05/19/7predictions-for-how-covid-19-will-changeretail-in-the-future/#47d796ac5be3 (accessed 11th August, 2020).
- (88) Fallon, J. and Zarocostas, J. (April 2020), 'COVID-19 Crisis Triggering Huge Losses in Textile, Apparel Sector', Yahoo, available at https://finance.yahoo.com/news/covid-19-crisis-triggering-huge-210353308.html (accessed 11th August, 2020).
- (89) Stanton, A. (May 2020), 'Can We Learn from Crisis? Fashion Industry Takeaways from Covid-19', Remake, available at https://remake.world/stories/news/fashionindustry-takeaways-from-covid-19/?gclid=E AIaIQobChMIxuPUpL636QIVgwiICR26\_ QIbEAMYAiAAEgI6KPD\_BwE&fbclid=I wAR0GvPwgHKrrEU8fKNdfPBcrPjW9N xDEmIcH1k1HatR3OT64zi9wHdxUK0w #post-12252 (accessed 11th August, 2020).
- (90) Earth Observatory (May 2020), 'Airborne Nitrogen Dioxide Plummets Over China', available at https://earthobservatory.nasa.gov/ images/146362/airborne-nitrogen-dioxideplummets-over-china (accessed 11th August, 2020).
- (91) Remake World (2020), 'About Remake', available at https://remake.world/about/ the-facts/ (accessed 11th August, 2020).

- (92) Cernansky, R. (March 2020), 'Will Covid-19 disrupt fashion's sustainability commitments?', *Vogue*, available at https://www.voguebusiness. com/sustainability/will-covid-19-coronavirusdisrupt-fashions-sustainability-commitments (accessed 11th August, 2020).
- (93) Marshall, G. (April 2020), 'SMART Supply Chain Revitalizing the Post-Pandemic Economy', LeanCor, available at https://blog. leancor.com/smart-supply-chain-revitalizingthe-post-pandemic-economy (accessed 11th August, 2020).
- (94) Tantillo, R. (April 2020), 'Textile industry unites to play critical role for the nation's production of PPE products', NCTO, available at http://www.ncto.org/ textile-industry-unites-to-play-critical-rolefor-the-nations-production-of-ppe-products/ (accessed 11th August, 2020).
- (95) Hassan, T. A., Hollander, S., Lent, L. van and Tahoun, A. (2020), 'Firm-level Exposure to Epidemic Diseases: COVID-19, SARS, and H1N', Social Science Research Network Journal, available at https://www. ssrn.com/abstract=3566530 (accessed 13th May, 2020).
- (96) Iacus, S. M., Natale, F., Santamaria, C., Spyratos, S. and Vespe, M. (September 2020), 'Estimating and projecting air passenger traffic during the COVID-19 coronavirus outbreak and its socio-economic impact', *Safety Science*, Vol. 129.
- (97) Makridis, C. and Hartley, J. (2020), 'The Cost of Covid-19: A Rough Estimate of the 2020 US GDP Impact', *Social Science Research Network Journal*, available at https://www.ssrn. com/abstract=3570731 (accessed 13th May, 2020).
- (98) Walmsley, T., Rose, A. and Wei, D. (April 2020), 'Impacts on the U.S. Macroeconomy of Mandatory Business Closures in Response to the COVID-19 Pandemic', *Social Science Research Network Journal*, available at https:// www.ssrn.com/abstract=3570117 (accessed 13th May, 2020).