

# Reconciling industrialization and environmental protection for sustainable development in Bangladesh: The textile and apparel industry case

Shahadat Hussein<sup>1,2\*</sup> 

<sup>1</sup> Cornell University, Ithaca, NY, USA

<sup>2</sup> Ministry of Public Administration, Dhaka, BANGLADESH

\*Corresponding Author: [sh2543@cornell.edu](mailto:sh2543@cornell.edu)

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## ABSTRACT

The textile and apparel (T&A) industry in Bangladesh has been the biggest engine for economic growth for the last three decades. Thanks to the growing contribution of T&A industry, the country has consistently achieved high economic growth, alleviated poverty, and increased per capita income. The comparative advantage of a large pool of cheap labor, easy access to power, and a high potential of creating employment opportunities turned T&A industry as the most thriving sector for Bangladesh. However, the pursuit of speedy economic growth has resulted in a large-scale and poorly planned rapid rise of textile factories and enterprises. A growing number of textile industries and their clustering in a few districts in the country are taking a heavy toll on human health, ecosystems, and the overall environment. As a result, the most productive and profitable industry has become one of the most polluting industries in the country and therefore, it is of paramount importance to address the intensifying threat of environmental degradation in a sustainable manner that balances T&A industrial growth and causes the least damage to human health and natural environment. This paper will explore the major drivers of poorly planned T&A industry in Bangladesh and their adverse impacts on human health and the environment followed by some recommendations that can improve the environmental performance of T&A industry to ensure safe growth in Bangladesh.

**Keywords:** textile industry, sustainable development, environmental protection, eco-friendly

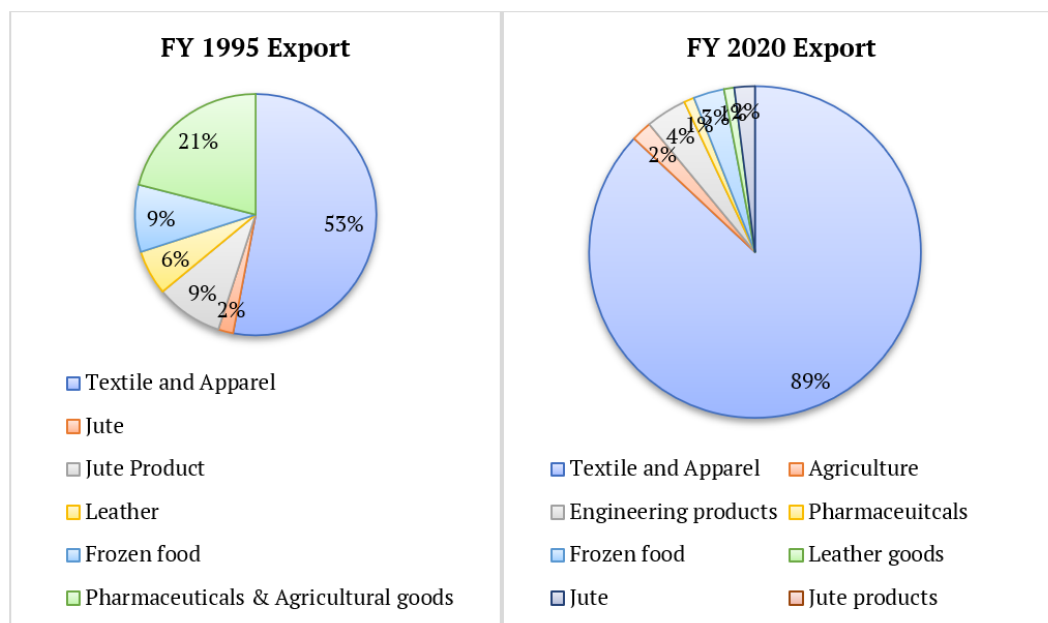
## INTRODUCTION

Although the history of textile production in Bangladesh dates back to the British era thanks to the famous 'Muslin', it turned into a moribund industry during the Pakistan period due to the poor maintenance and lack of institutional support. However, since the mid-1970s Bangladesh focused rapid economic growth, eradication of extreme poverty and unemployment through large-scale industrialization across the country. That is why, the first industrial policy was formed in 1973, which attempted to focus on the transition from agriculture to industrialization. Although 'Desh Garment' was established as the first textile industry in 1979, the Bangladesh government initially did not recognize its potential until 1982 when textile and apparel (T&A) industry emerged as a promising sector. Since then, the Government started providing incentives in the form of duty-free machinery import, loan, and bonded warehouse services to revive the dying textile industry (Mishu, 2018; Quddus & Rashid, 1999; Siddiqi, 2005). By 1990, T&A industry appeared as the most

productive industry in Bangladesh. While in 1982, there were only 47 textile factories, the number reached 2,900 in 1999 and became the sixth-largest supplier of textile goods to the US market (Banglapedia, 2015).

**Figure 1** illustrates the growing contribution of the textile industry to the economy of Bangladesh between 1995 and 2020. As it is evident in **Figure 1**, the role of T&A in the economic development of Bangladesh is both consistent and profound. While in 1995, T&A industry constituted 53.0% of the total export earning, it became a staggering 89.0% in 2020 and surprisingly this trend is still increasing. The current export output from this sector is \$29.21 billion from more than 7,000 factories, which is 6.4% of the global share (DATABD.CO, 2020).

Cheap labor especially women who were previously jobless, low prices of gas and electricity, and favorable government policies have resulted in the speedy development of this sector (Mottaleb & Sonobe, 2011). However, in many cities including Dhaka, rapid industrialization has occurred without appropriate planning (Begum et al., 2011). Although the



**Figure 1.** Textile & apparel sector contribution (Export Promotion Bureau Bangladesh, 2020-21)

Government of Bangladesh formulated policies that created a strong manufacturing base for the economy, the environmental issues were ignored. Being most profitable, T&A industry got a huge impetus, which led to the concentration of T&A industries in big urban centers thanks to cheap labor and energy supply. A staggering 75.0% of approximately 7,000 T&A factories are concentrated in Dhaka and in adjacent cities (Rana, 2016). Being poorly planned, the negative impacts of T&A industries are taking a heavy toll on human health and the environment in Bangladesh. For example, industrial pollution accounts for 60.0% of pollution and the textile industry is the second most polluting industry next to the tannery industry in Bangladesh (Greer et al., 2010). There are 719 washing, finishing, and dyeing factories in Dhaka and adjacent areas, which generate more than 200 tons of wastewater per day that seriously threatens the lives of 18 million residents (PACT, 2016; World Bank, 2007).

Waterbodies located near T&A factories are found to be severely affected by textile dyes (Wang et al., 2022). Turag, Bangshi, Shitalakkhya, and Balu rivers are suffering from the acute absence of dissolved oxygen (Rashid, 2012; Singh, 2019). In addition, the capital Dhaka has the third most polluted air in the world, and the poorly planned textiles and apparel factories are one of the major contributors to this problem (Air Quality Index [AQI], 2019). Due to the detrimental effect, the Government has categorized T&A as a 'red industry' under Bangladesh Environment Conservation Act (1995) and Environment Conservation Rules (1997). Although there has been plenty of research focusing on engineering issues like the production process or wastewater management, there is no research highlighting policy issues both from institutional and stakeholder perspectives, which would provide better guidance in integrating environmental issues into T&A industrial process (Sakamoto et al., 2019). So, a timely revision of the current industrial policy must be made to optimize the socio-economic benefits from T&A industry while conserving the natural environment.

## LITERATURE REVIEW

### Textile & Apparel Industry in Bangladesh & Its Socio-Economic Impact

For many countries, industrialization has been regarded as the overriding principle and prime strategy for rapid economic growth. Kaldor (1967) endorses industrialization as the prime engine of economic growth and believes that industrialization has the strong potential to transform a sluggish economy into a mature one. However, the pattern of comparative advantages determines the nature of industries for any particular country (Balassa, 1979). For example, a large pool of cheap labor was a comparative strength of Bangladesh in the late 1980s and, hence this spurred the country to promote T&A industry, which was its most suitable option. For the last two and half decades, T&A industry has turned out to be the major source of foreign export earnings for Bangladesh, which consistently helps the country achieve a steady GDP growth rate (Lu, 2019). Looking from a broader perspective, T&A serves two major roles in the Bangladesh economy. One, by bringing in direct foreign export earnings. Two, by creating employment opportunities across the country. According to Bangladesh Economic Review (2019), more than 80.0% of the nation's total export comes from T&A sector. In 2018-2019, the total earning was \$27,563 million, which was about 83.9% of the total national export. T&A industry alone constitutes approximately 17.0% of the total GDP of Bangladesh, which is the highest for any single industry's contribution to the national economy (MacLean & Olderman, 2014). Between 2012-2018, Bangladeshi T&A export grew by more than 60.0% (Research and Market.com, 2019). Thanks to T&A sector's robust and consistent contribution, Bangladesh secures an annual growth rate of more than 7.0% for the last seven years (Macrotrends, 2020). Considering the dynamic growth of this sector, the country has set an ambitious export target of more than \$50 billion for the 2022-2023 financial year (Ishaque, 2019).

In terms of employment generation, T&A serves as the most promising and thriving sector as the country has more than 7,000 factories that employ about five million people and 80.0% of them are women (Bangladesh Economic Review, 2019). Women empowerment through education and employment opportunities has always been a big challenge for Bangladesh. Thanks to an ever-increasing number of T&A factories, employment opportunities for women and men have become increasingly accessible.

### Effects of Textile & Apparel Industry on Global Environment & Health

T&A industry leverages significant adverse impacts upon the environment (Visvanathan et al., 2000). The wastes and effluents from T&A industry not only degrade groundwater quality but they are also one of the major factors behind the deterioration of surface waters and hence they are recognized as one of the most polluting of all industrial sectors (Odjegba & Bamboos, 2012; World Bank, 2019). An Ellen MacArthur Foundation's (2017) study predicted that by 2050 the global carbon emission from the textile industry will reach 26.0% and microplastic could grow up to 22 million tons annually. Microplastics stemming from polyester production in the textile factories constitute 31.0% of global plastic pollution in the ocean (International Union for Conservation of Nature [IUCN], 2019).

Although T&A industry were the major contributors to the soaring double-digit growth of China during the 2000s, the country is facing severe environmental degradation mainly caused by the massive effluent discharges from these factories (Greer et al., 2010; You et al., 2009). For example, large scale use of dichlorodiphenyltrichloroethane commonly known as 'DDT', has profoundly deteriorated the water quality in the Yangtze River and Taihu Lake in Jiangsu (He et al. 2012; Qin et al. 2007). Also, a high level of concentration of nitrogen has been detected in the province's Kuihe River (Wu et al., 2007). The depletion of oxygen in water is the most severe effect caused by the textile and dyeing factories poses serious threats to aquatic ecosystem (Kant, 2012). Since 1985, the textile industry has become the most polluting industry in Indonesia with a massive biological oxygen demand (BOD) load of 3,270 kg/day (Sembiring, 1985). The dyes used for textile factories and their uncontrolled discharge to waterbodies are creating 'chemical Fukushima' for Indonesia (Sweeny, 2015). A study by Boucher and Friot (2017) under the International Union for Conservation of Nature (IUCN) revealed that 35.0% of all microplastics directly come from textile industry, and more alarmingly about 85.0% of the wastes from textiles go into landfill each year (Mc-Fall Johnsen, 2019). Textile effluents cause severe human illness globally. Around 40.0% of globally used colorants comprise organically bound choline known as 'carcinogen' and many of these elements evaporate into the air, which causes serious respiratory illness to people especially children (Masood et al., 2014). Being one of the top three textile goods producers, India has been facing an acute environmental crisis in some states such as Tamil Nadu, Uttar Pradesh, Haryana, Gujrat, and Andhra Pradesh (Deshpande, 2020). In fact, textile industry has been categorized as the most polluting industry by the Ministry of Environment and Forest of India (Garg & Kaushik, 2007).

### Adverse Impacts of Textile & Apparel Industry on Eco-System & Human Health in Bangladesh

Bangladesh is facing a mounting challenge due to the clustering of most of T&A factories in a handful of major cities of the country. Department of Inspection for Factories and Establishments (DIFE, 2019) reveals that about 3,000 T&A factories are operating in Dhaka alone. The rest of the factories are mostly located in Gazipur and Narayanganj, which are adjacent to Dhaka. This heavy concentration of T&A factories in few districts is causing severe air, water, and soil pollution in the urban areas, which ultimately leads to an accumulated negative impact on the environment. In textile industry of Bangladesh, a massive 2,000,000 tons of dyes are turned into effluent during the dyeing, printing, and finishing process (Mia et al., 2019). More than 200 rivers are directly affected by untreated effluents from industries and most of these are T&A factories (Mathews, 2018). Wastewater from T&A industry in 2016 was about 217 million m<sup>3</sup> in Bangladesh and it is estimated that this volume will reach 349 million m<sup>3</sup> by 2021 if the current operating system continues (DIFE, 2019). A study by the WHO has recognized Bangladesh as one of the countries with the highest level of antibiotic river pollution with 300 times more concentration of metronidazole than the normal limit (Singh, 2019). Furthermore, crops and vegetables collected from these areas show the presence of harmful chemicals used in dyeing in the textile factories (Islam et al., 2013). Absorption of heavy metals through foods has been shown to exert serious effects on health and productivity of people, which ultimately impacts economic development in the long run. The incidence of illness among people living in Hazaribagh, Savar, Keranigonj, Tongi, Ashulia, and other areas, where industries like textile and tannery are concentrated is 16.0% higher than the other areas of Bangladesh (Nishat et al., 2001). The contaminated water and air cause a number of gastrointestinal and respiratory diseases including dysentery, diarrhea, skin diseases, food poisoning, asthma and bronchitis (General Economic Division, 2019; Gurley et al., 2013). Although there are some partial fixes to mitigate and reduce T&A industry pollution, none of these is complete or comprehensive in nature. Bangladesh Environment Conservation Act (1995) requires T&A factories to install effluent treatment plants (ETPs) but in reality, very few of T&A factories do so (Sakamoto et al., 2019). The lack of political will, corruption, and inadequate coordination among departments are instrumental factors behind the clustering of T&A factories in Dhaka and consequent environment pollution (Belal et al., 2015). Besides, Department of Environment (2018) and relevant stakeholders rarely shares the necessary data and as a result, devising solutions and formulating guidelines based on empirical data turns out be a difficult task (Sakamoto et al., 2019).

## METHODOLOGY

This paper will be an exploratory study using qualitative and quantitative research approaches. The study will use secondary data collected from a number of sources such as relevant journal articles, books, research works, studies conducted by development partners and donors, websites of

different ministries of Bangladesh, published reports from Bangladesh Bureau of Statistics, Annual Economic Review, Annual Development Program, Seventh Five Year Plan, Bangladesh Bank, and reports published by Planning Commission of Bangladesh. Apart from these, reports published by international organizations like Green Peace, UNDP, UNEP, UNFCCC, World Bank, and WTO will be used. To gain insight into the current status of T&A industry in Bangladesh and its relation to environmental degradation, national and international newspapers reports, and updates will be consulted. The collected data will then be analyzed, processed and tabulated to present the findings in a logical and objective manner. Broadly, the work has been divided into three major sections:

- (1) a trend analysis of industrialization with special focus on T&A industry, and its role on the economy of Bangladesh,
- (2) the impact analysis of poorly planned T&A industry on environment and health, and
- (3) formulation of recommendations based on the findings to reconcile industrialization and environmental protection in Bangladesh.

## RESULTS & DISCUSSION

### Industrial Policies with Little Emphasis on Environmental Protection

To expedite economic development, reduce poverty, and create employment opportunities, the Government of Bangladesh formulated its first industrial policy in 1973. Since then, almost a dozen industrial policies have been promulgated. Unfortunately, most of the industrial policies except the last one, which was formulated in 2016 was predominantly motivated by speedy economic growth with no or limited attention to environmental issues.

In general, the industrial policies in Bangladesh were mostly growth-driven in a bid to eradicate poverty and expedite the expansion of industries. Looking into the first to the latest policy, few major trends become obvious, which include-fast economic growth, increased focus on privatization, increasing efficiency of production, building more export processing zone, and making manufacturing sector as the prime engine of growth (Ministry of Industries, 2016). However, while chasing these economic goals, environmental issues have been largely overlooked (Banna, 2014; Roy, 2018).

As Schwarzer (2013) points out, traditional industrial policies predominantly emphasized credit concession, loan facilities, government interventions, and privatizations, which is true for Bangladesh. In fact, the Government engaged stimulation mechanisms to increase productivity and expand industries to maximize the return from labor and capital (Altenburg & Assmann, 2017; Sarkar, 2005). Recently continued global and local environmental degradation and climate change patterns have raised concern, which stirred the Government of Bangladesh to revisit the traditional industrial policy in 2016 (Roy, 2018).

### Poor Spatial Distribution of Textile & Apparel Factories

As there was no specific regulation for setting up a textile industry in the beginning phase, T&A factories are mostly clustered in Dhaka and its adjacent districts thanks to greater access to water supply, labor, and energy. A study by Labowitz (2016) shows that there are more than 7,000 T&A factories in Bangladesh and more than 90.0% of these are located in Dhaka, Narayanganj, Gazipur, and Chattogram. Although there has been a shift of T&A factories from Dhaka to surrounding cities, Dhaka still remains heavily overburdened by the number of T&A factories. Another study by Khan et al. (2016) found that approximately 40.0% of T&A factories are located at Mirpur and Uttara areas of Dhaka City. In addition, the number of workers in T&A factories has dramatically increased from one million workers in 1993 to four million workers presently, and more than 80.0% of them live in Dhaka and adjacent cities like Savar, Tongi, and Ashulia (Khan et al., 2016). A World Bank (2007) report identified apparel industry as the main reason for migration of workers to Dhaka and nearby cities from other districts, which creates pressure on health and environment. The uncontrolled clustering of T&A factories has led to adverse environmental consequences along with transportation and housing crisis in these cities (Alam, 2018; Ali et al., 2008; Sultana et al., 2013).

### Inadequate Effluent Treatment Plants

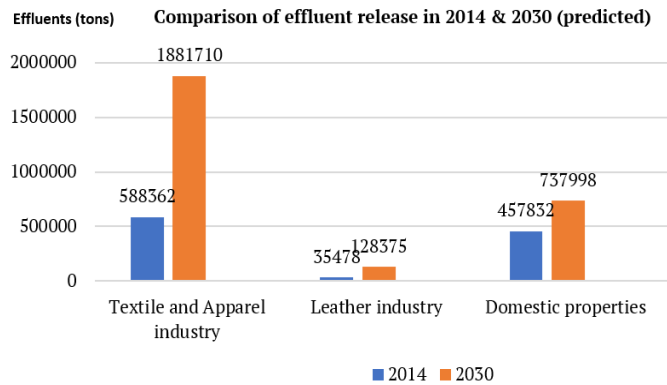
According to Environment Conservation Rules (1997), T&A industry falls under the Red category, one of the most polluting industries that requires ETP (Haque, 2017b; Rupp, 2008). However, the number of estimated factories in Bangladesh with an ETP varies from 40.0% to 80.0% with small textile factories mostly having no ETPs (Haque, 2017b). In addition, only 29.0% of wet processing units fully comply with all necessary regulations (Park, 2011). In an exploratory approach, Haque (2017b) collected 290 records regarding the penalties for water pollution from different newspapers in Bangladesh published from 2011 to 2016. About 255 of the samples were related to T&A industry, which showed that the cost of installing ETPs is higher than each fine given to the factory owner. Thus factory owners in Bangladesh find adopting a green policy or ETPs unprofitable (Karp & Stevenson, 2012).

### Poor Enforcement of Environmental Laws & Regulatory Problems

There are approximately 200 environmental regulations and clauses for environmental protection and ecosystem conservation in Bangladesh (Khan, 2000). However, poor enforcement standards carried out by Ministry of Environment (2019) have not met with optimum success (Reazuddin & Hoque, 2002). Due to enforcement inefficiency, bureaucratic and political corruption, and lack of political will have led to the breach of these regulations routinely (Belal & Roberts, 2010; Mohammad, 2011). Although there is a good number of environmental laws to safeguard water resources from industrial effluents, lack of strict enforcement brought hardly any tangible outcome in curbing pollution (Karn & Harada, 2001). A study by Browne et al. (2014) on enforcement and stringency demonstrates the institutional weakness of Bangladesh, which shows that Bangladesh performs very

**Table 1.** Physiochemical parameters of effluent samples in different districts of Bangladesh

Region/districts	Temp	pH	TDS (mg/l)	COD (mg/l)	BOD (mg/l)	EC (us/cm)	Sources
Dhaka	37.0-65.0	8.7-10.0	460-5,981	508	90-460	250-7,950	Ahmed and Begum (2010), Kamal et al. (2016), & Mahfuz (2011),
Narayanganj	50.0	6.8-11.0	152-1,011	268-1,275	60-450	592-1,696	Islam et al. (2011) & Sultana et al. (2013)
Gazipur	34.7-48.8	8.9-10.0	531-1,006	-	560-965	0.88-1,701	Hannan et al. (2011) & Sultana et al. (2013)
Chattogram	25.0-55.0	8.9-11.0	685-1,338	487-1,120	140-420	1,108-1,907	Sultana et al. (2013)
Reference: Value	50	6.5-9.0	2,100	200	50	1,200	DoE (2008)

**Figure 2.** Pollution caused by different sectors (Sagris & Abbott, 2015)

poorly in enforcing environmental laws. Bangladesh stands at the second to last position before Vietnam, whereas the other rival countries like Malaysia, Thailand, Cambodia, and Indonesia have much better enforcement performances. A World Bank (2018) report also finds the poor enforcement of environmental laws as one of the major obstacles behind curbing pollution in Bangladesh. For example, a study by the Haque (2020) reveals that it is easy to bypass the environmental regulations in Bangladesh. Besides, lack of regular monitoring, strong vigilance, high punitive measures and poor EIA assessment have paved the way for the violations of the environmental laws (Belal et al., 2015; Haque, 2017a; Miah, 2015).

### Impacts on Environment & Natural Ecosystems

The people's report on the Bangladesh environment reveals that major components of environment namely air, water, and soil are facing severe degradation in Bangladesh (Rahman & Chowdhury, 2001). The dumping of untreated industrial effluents are responsible behind this environmental catastrophe (Bala & Yusuf, 2003). Akter et al. (2022) found in a recent study that the lack of strong political commitment and due to financial constrain, the textile factories cannot be safely relocated. Toxic wastes from nearby textile and dyeing factories have destroyed the croplands in vast areas in Savar, Tongi, and Ashulia near the capital (Bhuiyan et al., 2011). A study by Hoque et al. (2018) reveal alarming findings caused by the untreated effluents from these factories. The water bodies are heavily polluted with industrial effluents that result in the lack of sufficient oxygen in water, which is the primary cause of gradual depletion of aquatic biodiversity (Alom, 2016). The Turag, Buriganga, and Balu rivers have already lost the minimum level of oxygen required for living creatures and thereby most of the fishes and other aquatic species have disappeared (Reza & Yousuf, 2016). More than 90.0% of WDF (washing, dyeing, and finishing) units are located near water

bodies like rivers and canals in Dhaka, and Narayanganj as these locations provides easier access to water and easy dumping and discharge facility (ADSL, 2009; Sultana et al., 2013). Consequently, the rivers have become the hotspot of water pollution in Dhaka and nearby districts (Haque, 2018). A study by Islam et al. (2011) shows that T&A factories in Dhaka, Narayanganj, Gazipur, and Chattogram have degraded the water quality to such an extent that aquatic species are facing the risk of extinction. **Table 1** illustrates that total suspended solids, turbidity, BOD, and chemical oxygen demand level are dangerously higher than the reference values.

The alarmingly degraded water quality in the Buriganga, Shitalakkhya, and Turag rivers shows how polluted they are in the sites, where T&A factories are densely clustered (Restiani, 2016). By 2021, the amount of wastewater discharged from the textile and dyeing industry is estimated to reach 349 million m<sup>3</sup> (Hossain et al., 2018).

### Intensity of Water & Air Pollution & Consequent Economic Loss

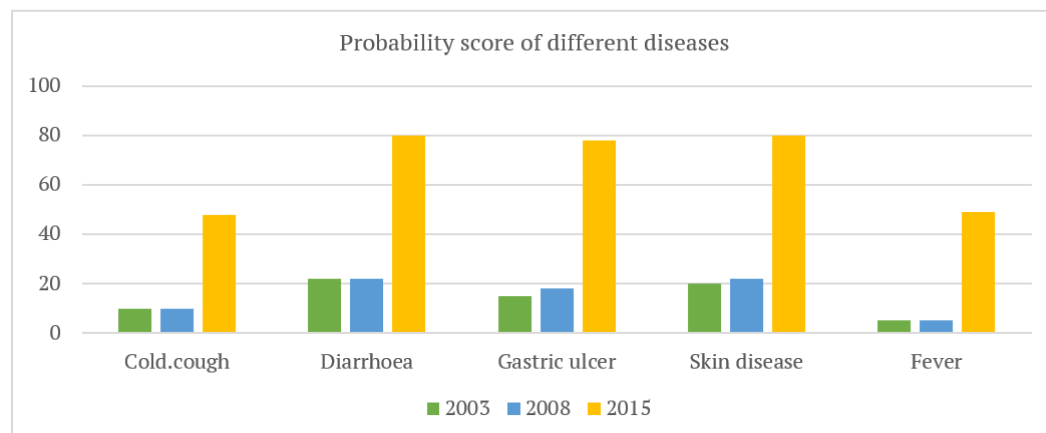
A comparative study has found shocking indications about the future water pollution crisis in rivers of Dhaka and nearby districts due to effluent release. As **Figure 2** shows, the polluting effluents released from textile factories will spike at a dangerous level by 2030 if 'business as usual' continues and no preventive measures are implemented.

In addition, different social aspects including standard of living have degraded in the highly industrialized areas due to detrimental impacts of industrial wastes. The textile effluents have negatively affected soil quality, leading to erosion of soil, and the rise of rise of organic and inorganic particulate matters, which is directly connected to health hazards. From **Table 2**, we find that the number of days with 'very unhealthy' and 'extremely unhealthy' air quality has been steadily increasing in Dhaka and nearby districts. A study by Mia et al. (2019) found that about 10.0% to 25.0% of the dye is lost in textile industry while processing, which is one of the major factors behind air pollution in the northern zone of Dhaka. Gases like CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>2</sub> are major culprits for air pollution (Vallero, 2014). Sakamoto et al. (2019) show in their study that the chemical dyes used in T&A factories stay for a long time in the environment thanks to their high thermal and photostability, which cause a number of respiratory and skin diseases.

World Bank (2006) report on 'Bangladesh country environmental analysis' states that environmental pollution accounts for as much as 22.0% of the burden of disease mainly in the form of respiratory infections and diarrheal diseases, which is responsible for the loss of 3.5% of the annual GDP. Another study by World Bank (2014) found that air pollution in Dhaka, mainly caused by textile and tannery industry is

**Table 2.** Rising problem of air pollution in Dhaka & nearby areas (number of days per year) (CASE, 2018)

AQI level	Category	2014	2015	2016	2017	2018
00-50	Very Good	22	25	63	18	15
51-100	Good	86	101	94	113	74
101-151	Caution	62	66	68	89	76
151-200	Unhealthy	57	54	30	52	50
201-300	Very Unhealthy	22	53	53	44	80
301+	Extremely unhealthy/hazardous	86	66	46	49	67
>15	Number of days	165	173	129	145	197

**Figure 3.** Rising trend of diseases (Halder & Islam, 2015)

responsible for an approximately 0.5% loss in annual GDP. Non-mortality costs due to environmental degradation especially air pollution is about \$370 million per year (Narain & Sall, 2016).

### Impacts on Human Health & Living Standard

Alongside environmental degradation, effluents from T&A have disastrous impacts on human health and overall living standard of the employees and people living nearby (Hoque et al., 2018). A household survey revealed that the incidences of diseases including jaundice, diarrhea, and skin diseases are twice as high in villages and peri-urban areas, where the textile factories are heavily clustered (Khatun et al., 2013; Ullah et al., 2006). Ali et al. (2008) reveal that about 36.7% of T&A industry workers suffer from some kind of poor health and about 70.0% of them suffer from headaches. **Figure 3** shows an upward trend of diseases in the most populated and textile factory-intensive areas in Dhaka and adjacent districts (Halder & Islam, 2015).

Compared to 2003, the number of people facing different diseases has markedly increased as the environmental degradation exacerbated (**Figure 3**). As no noteworthy preventive measures were initiated to improve the current environmental status, the situation steadily worsened over the years. Interviewing doctors and health workers in the relevant areas, Halder and Islam (2015) found that the rising trend of diseases occurs mostly due to the unsafe water and air pollution. Another field survey conducted with textile workers in different regions of Dhaka has shown that due to dense setting of T&A factories in Dhaka, Gazipur, and Narayanganj, workers are deprived of proper facilities, which include sufficient living space, clean air, potable water, sanitation, and space for privacy (Bhuiyan, 2012). Paul-Majumder (2003) attributes the unhealthy physical setting of textile factories to

the psychological stress and self-reported poor mental health of its workers. A cross-sectional epidemiological study conducted by Steinisch et al. (2013), finds that the dense setting of T&A factories within a limited space has both long and short-term negative health effects on its employees.

## RECOMMENDATIONS

Given the overwhelming socio-economic cost of the poorly planned T&A industry, it is both a necessity and opportunity for Bangladesh to adopt green growth policies that benefit both the industry and the environment in the long run. However, a paradigm shift in policy intervention and physical decentralization of the industry is not an easy task and it entails broad, strategic, and multi-stakeholder collaboration from the Government, private sector, civil society, and the investors. To bring a holistic change from policy formulation to public awareness, recommendations in **Table 3** can be applied.

## CONCLUSIONS

The evolution and expansion of T&A industry in Bangladesh suffers from poor planning and lack of vision. By chasing a fast and growth-driven development track, Bangladesh did not address potential environmental issues with due seriousness at the early stage. This was not just because it was obsessed with rapid growth but also because it could not afford to do so given the large population and the fragile economy it inherited from the British and Pakistan regimes. Thereby the social and economic circumstances strongly influenced the growth trajectory of the country.

**Table 3.** Recommendations

Recommendations	Responsible sectors/stakeholders	Timeline	Possible outcomes
<b>Reforming industrial policy:</b> Present industrial policy does not fully address emerging challenges of environmental pollution caused by T&A industry. In a bid to make this sector moving forward in a sustainable & environment-friendly way, current industrial policy has to be redefined with clear action plans & visionary goals. Policy & guidelines should address relevant environment pollution related policy, regulatory gaps, & flaws so that no loophole is abused by factory owners.	-Ministry of Environment -Department of Environment -Ministry of Industries -Planning Commission -Leading private sectors	Medium & long	A policy platform for protecting environment will be recognized, which will make production processes more efficient & environment friendly.
<b>Strict enforcement of existing environmental laws &amp; penalties:</b> Environmental laws in Bangladesh are not rigidly enforced as current penalty system does not provide an effective deterrence & it requires an overhaul. Along with other laws, 'polluter pays principle' mentioned in section 7 of 1995 ECA should be properly applied.	-Department of Environment -Environmental Courts -Special Environment Tribunal	Short	Once penalty for violating environmental laws is strictly applied, factory owners will be more careful & avoid potential punishment.
<b>Making research data available:</b> Necessary research data both from factory owners & government institutions must be made available in their offices & websites so that comprehensive research can be conducted by government agencies & individuals time to time to improve operation & maintenance of apparel industries.	-Bangladesh Garment Manufacturers & Exporters Association -Department of Environment -Ministry of Environment	Short, medium, & long	Making relevant information & data available will render production & operation system transparent. Owners will avoid illegal & harmful means of production process for fear of prosecution.
<b>Relocation of T&amp;A industries:</b> A complete decentralization of textile industries is a demand of time given fact that more than 70.0% T&A factories are clustered in Dhaka & nearby cities. Having such a large number of factories in a few districts is environmentally, socially, & economically detrimental. So, the Government must introduce policies to make factory owners shift & relocate their industries to other district, where industrial density is lower.	-Private T&A owners -Ministry of Finance -Ministry of Planning -Ministry of Environment -Department of Environment -BGMEA	Long	Stress on environment in highly clustered areas within Dhaka & nearby districts will be reduced. It will positively impact public health by reducing environmental pollution. This will also help balancing distribution of economic benefits for people of other districts.
<b>Strengthening monitoring &amp; evaluation:</b> Monitoring & evaluation structure in Bangladesh are weak & inadequate due to insufficient number of workforce & corruption. To bring change in this aspect, number of inspection officers has to be increased as well as their inspection has to be cross-checked so that officers do not make illegal deals with factory owners.	-Department of Environment -Environmental Courts -Ministry of Environment -Ministry of Industries	Medium	Proper & timely monitoring will reduce number of violations, which will result in healthy industrial operation.
<b>Environmental policy integration:</b> Environment is a cross-sectoral issue & thereby it entails multi-scale efforts from a number of sectors like fisheries, agriculture, water resources, industry, & environment. A comprehensive policy with environmental priorities must be formulated.	-Ministry of Environment -Planning Commission -Department of Environment -Ministry of Industries	Long	It will initiate a clear guideline & roadmap for setting up new industries. Also, existing industries will be guided to retrofit poorly & inefficiently functioning apparel factories.
<b>Make environmental impact assessment effective:</b> In Bangladesh, it is required to have a feasibility study & environmental impact assessment if project falls under 'red' category. As T&A industry falls under <i>red</i> category, environment impact assessment must be rigorously maintained before a clearance certificate is issued.	-Ministry of Environment -Planning Commission -Department of Environment -Ministry of Industries -Project Director -Industry Owner	Medium	Making environmental impact assessment mandatory will reduce number of harmful industries. Also, it will ensure safeguard policies for approved projects & industries on part of factory owners, which will benefit environment.
<b>Requiring ETPs:</b> Lack of ETPs & their inefficient functioning are main drivers behind massive load of untreated effluents that cause irreparable damage to environment & human health. So, installation of ETPs & their maintenance must be made mandatory.	-Department of Environment -Local Public Administration -Department of Environment	Short	Detrimental impact of effluents on environment & human health will be reduced. Water, soil, & air will be far better in quality, which will have positive impacts on public health & aquatic species.

Being a developing country, Bangladesh had to strive hard to accelerate economic growth, eradicate poverty, and resolve unemployment while simultaneously attaining its development goals. Placed under such a predicament, the country exploited T&A industry, which proved surprisingly successful in its context within a short time due to the comparative advantages like cheap human resources and

available power supplies. For more than 30 years, T&A has consistently been the most reliable and biggest export-earning source for the country. However, unidimensional focus on economic growth has led to many social and environment ramifications that have accumulated for many years. Spiraling environmental degradation is one of the most obvious problems that has posed one of the biggest challenges for the

country in recent years. Alongside the tremendous role of T&A industry in attaining economic development, the environmental issues relevant to it have emerged as a major threat for natural ecosystems and the environment. However, given the massive contribution from T&A industry, the country cannot afford to cease its progress; it would not be a wise step as well. Rather, turning them into a sustainable and eco-friendly mode of operation is the most profitable solution that harms neither the industry nor the environment and public health. So now is the time to critically evaluate the whole system from top to bottom. In this regard, reformation of current policies, relocation of the highly clustered factories to safer areas, and transformation of their mode of operation to adopt green energy are the key priorities to be addressed with a definite timeline and action plan. Mainstreaming an environmental agenda across various issues and plans of government through a national development plan, climate change strategies, and framework for pollution control has already started in Bangladesh although the progress and implementation have been slow. The Government must expediate the process through establishing a broad coalition of stakeholders. Some industries have already been moved outside the capital. Recently, the tannery industry has been relocated outside Dhaka City, which is a ray of hope for decentralization of such other industries like T&A. However, for T&A industry, mere relocation is not enough rather a paradigm shift in their energy usage, effluent treatment, water use, and above all, their entire production process has to be fully addressed. The Government of Bangladesh must strive to achieve the dual goal of attaining economic development and simultaneously protecting the environment and health of T&A industry workers as well as the surrounding population. This conundrum of balancing economic prosperity and enterprise profitability on one hand with human health and welfare on the other is a worldwide challenge. To keep this vision in the forefront and apply in real life, the government of Bangladesh must engineer visionary and realistic plans to tackle not just the ongoing challenges but also the foreseeable challenges in the coming decades. In fact, achieving the 'Vision-2041' (target of developed country) largely hinges on cleaner production process and resilient growth of T&A industry by addressing environmental protection sustainably. It is strongly hoped that this research will provide some guidance and insights for policymakers, stakeholders, relevant government departments, and the private sectors in Bangladesh to initiate a convergent effort to navigate T&A industry in a greener, cleaner and safer way to join the worldwide quest for sustainable development and ensure green growth for itself in the coming decades.

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**Data sharing statement:** Data supporting the findings and conclusions are available upon request from author.

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