Research Report

Feasibility Study on Developing Capacity Building Framework for Green Industry in RMG Sector in Bangladesh

Ministry of Commerce
BANGLADESH

AFD
AGENCE FRANÇAISE
DE DÉVELOPPEMENT

BKMEA
Working Today to Shine Tomorrow

November 2018

Research Report

Feasibility Study on Developing Capacity Building Framework for Green Industry in RMG Sector in Bangladesh

Submitted to:

Ministry of Commerce
Government of the People's Republic of Bangladesh
Dhaka, Bangladesh

*Prepared and Submitted by***:**

Bangladesh Knitwear Manufacturers & Exporters Association (BKMEA)
Planner's Tower (4th floor), 13/A Sonargaon Road,
Banglamotor, Dhaka-1000, Bangladesh

November 2018

Contents

LIST OF ACRONYMS AND ABBREVIATIONS

AFD	Agence Française de Développement
BB	Bangladesh Bank
BDT	Bangladeshi Taka
BGMEA	Bangladesh Garment Manufacturers and Exporters Association
BKMEA	Bangladesh Knitwear Manufacturers and Exporters Association
DCED	The Donor Committee for Enterprise Development
EPA	United States Environmental Protection Agency
EPB	Export Promotion Bureau of Bangladesh
ETP	Effluent Treatment Plant
EUI	Energy Usage Intensity
FGD	Focus Group Discussion
GOB	Government of Bangladesh
ILO	International Labour Organization
KIIs	Key Informants Interviews (KIIs)
LEED	Leadership in Energy and Environmental Design
MDGs	Millennium Development Goals
PDB	Bangladesh Power Development Board
RMG	Ready Made Garments
SDGs	Sustainable Development Goals
SMEs	Small and Medium Enterprises
SREDA	Sustainable and Renewable Energy Development Authority
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
USGBC	United States Green Building Council

LIST OF TABLES

LIST OF FIGURES

ACKNOWLEDGEMENTS

The study is expected to provide necessary information in terms of investment opportunities, prospects and constraints in materializing the "green industrialization" in Bangladesh's RMG sector to factory owners, policy makers, as well as development partners.

The study would not have been possible without the partnership and financial support from the Agence française de développement (AFD) France, and the Ministry of Commerce, Government of the People's Republic of Bangladesh. Therefore, we would like to express our sincerest gratitude to AFD for funding the study, and the Ministry of Commerce for their valuable guidance and direction that we received throughout the study period.

We duly acknowledge the spontaneous help and cooperation by the factory owners, top management and other key personnels for providing us the platform to conduct the survey. We owe to both the factory owners and management personnel for taking part in focus group discussions (FDGs). We also owe to the green RMG factories to facilitate us for conducting the case studies, and different other stakeholders for their passionate involvement in the key informant interviews (KIIs).

Our special thanks go to the consultant supervisor of this study Dr. A K M Nazrul Islam for his all-out supports from the state of questionnaire designing to the final preparation of the study report.

The real strength behind conducting this study was a dedicated and energetic study team comprising young economists/environmental economists, planners, designers/architects, engineers, sociologists, and other relevant areas of expertise from BKMEA. We are really glad to appreciate the works and efforts by the personnel involved in preparing the questionnaire, conducting the survey, data input, data cleaning, coding, data analysis and drafting the report.

Last but not the least, our sincere gratitude goes to the Board of Directors of BKMEA, especially the President, Mr. A K M Salim Osman, MP for their supports and guidance to complete this study.

.

EXECUTIVE SUMMARY

Bangladesh's ready-made garments (RMG) industry is the second largest in terms of export earnings from the global apparel industry right after China. Although the sector has contributed a lot to the socio-economic uplift of the country, its environmental consequences can't be ignored, particularly at this stage of environmentally-conscious consumerism and the fast degradaing state of the environment in the country that needs immediate attention. Much of the environmental degradations and depletion of the stock of environmental resources across the world can be attributed to the ever-expanding industrial sector. Thus, any possibility of embracing the "go green" approach by the country's largest manufacturing sector, the RMG industry, needs a very careful scrutinization- both in terms of competitiveness and environmental positive externalities.

In recent years green industrialization across the world has gained steady supports from both socially and enviroinmentally conscious consumer and producer groups. With this changing trend, many RMG units in Bangladesh in recent years have changed their production, consumption and resource-use policies towards a more green approach. It is often argued that green industrialization can address both environemntal concerns and profitability, but also requires firms to incraese their level of investment. This may decrease firms' possibility to loose market competetiveness, at least in the short run and thus put forward serious challenges before them.

It is against this backdrop, this study was conducted to assess the feasibility of greening the country's RMG industry with a mapping of its investment eco-system by identifying possible strengths and constraints.

Both qualitative and quantitative techniques were applied to analyze data collected in between November 2017 to February 2018 through primary survey from 58 factories drawing from country's 3 industrial clusters, namely Dhaka, Narayanganj and Chittagong based on judgmental sampling technique. Data on four important areas of greening i.e. building and structural integrity, water use and wastewater treatment, energy use and work environmnt and workplace safety at the factory-level were collected and analysed to address the objective of asessing the fesibility of green ready-made garments industy in Bangladesh. In addition to the questionnaire survey, 2 Focus Group Discussions (FGDs), 8 Key Informant Interviews

(KIIs), and 3 Case Studies were also conducted to get better insights on the question of assessment of the feasibility of green RMG industry in Bangladesh.

The findings suggest that 46.55 percent of the sampled factories did not have their own buildings. This implies that the industry would require a substantive amount of investment on new constructions and retrofitting the existing firms to make required structural changes for greening.

The majority of the sampled factories were found to depend on groundwater sources to meet their water demands. Besides groundwater, rainwater harvesting and use of surface water are found to be other major sources of industrial water demand. It is understood that most of the firms did not use water efficient technologies and thus promoted a culture of misuse of scare water resources. In the Dhaka region, 17 out of 31 sampled factories were found to use water tracking system, while the figures were 11 out of 17 and 7 out of 10 factories in Narayangaj and Chittagong, respectively. Almost similar picture prevailed in the wastewater treatment polices by the selected firms. This indicates that there is a need to make the sector technologically more advanced and thus need to invest handsomely in its drive to green the sector.

The survey outcomes also indicate that about 97 percent of energy used by the firms comes from natural gas, a fast depleting resource for Bangladesh. Only 2 percent energy comes from the national grid system and the remaining 1 percent energy are extracted by burning diesel power. Most of the large generators used in the industry are natural gas-run. It is found that 66 percent of the sewing machines were servo motor-based, which require approximated 25 percent less power than clutch motors. It is also understood that 77 percent of the boilers did not have economizers, 29 percent with no condense recovery system, 30 percent used no feed water treatment method and 93 percent had no automatic blow-down system. In the lighting load, the study revealed that 72 percent lights used were LEDs, 24 percent Tube Lights, and 4 percent CFLs. There is thus ample scope to introduce energy-efficient techniques and tools, like sewing machines, lights, boilers, etc. that can minimize energy use and thus reduce energy cost for the RMG industry.

Finally, in the case of work environment and occupational health and safety, almost all the surveyed factories were found to comply with a basic minimum safety standard that is compatible with international labour rights and compliances regarding. It is to be mentioned here that after some recent incidents took place in country's RMG sector, the call for

strengthening safety and health issues got louder and most factories now follow a minimum safety standard.

Against the objective of the identification of possible gaps and assessment of investment requirements in any possible drive towards greening the country's RMG industry, the study comes up with some interesting pictures. Cost for sustainable sites was estimated to be in the tune of BDT 5188.65 million, while the cost of water efficiency, energy efficiency and indoor environment quality were found to be BDT 269.51 million, BDT 2780.28 million, and BDT 1,115.82 million, respectively. This brings in a sum total of BDT 9354.77 million to convert the sampled factories into green ones. It is thus understood that any drive to make country's ready-made garments industry into a green one has to be backed by a good amount of investment.

The study also has identified the possible economic and non-economic benefits from greening the industry, which are mostly in the form of reduction in production and selling costs, possibility of higher pricing of products and branding, etc. Despite much hue and cry, product prices receiving by the country's existing green RMG units are opined to be no different than their non-green counterparts. Although it may help factories to reap long term benefits from reduced production and other operational costs, but if greening of RMG sector is not immediately reflected with profitable product pricing, smaller to medium-sized firms won't find greening an economically viable option.

The future development and sustainability of Bangladesh RMG sector largely depend on the market and product diversification, including exploring the previously unexplored export destinations and extending production of non-traditional products, gradually moving towards high value addition items, etc. Considering increasing conscious consumerism across the world is on a rise and environmental concerns need to be fixed at all sources, green RMG industry is a demand of the time. This may attract more consumers throughout the globe and thus benefit sector and the economy in the long run. But such an initiative needs to be backed by favourable national and international policies and investment supports, particularly in areas like water use and wastewater treatment, energy and chemical use, ensuring occupational and health safety, protection of natural environment and health issue of the surrounding people. Against this scenario, this study is expected to provide required information and guidance to policy makers, as well as factory owners concerned with green RMG industry in Bangladesh.

1. INTRODUCTION

1.1 Background

The ready-made garments (RMG) industry is the single most important manufacturing sector for Bangladesh economy, both in terms of employment generation and earning of foreign exchanges from the last several decades. Currently this sector contributes about 83% % of country's export earnings, while the total workforce employed 4.1 million (EPB, 2018 and BKMEA, 2018). The sector is expected to expand further with time, mainly because of the expanding global demand and decreasing contribution of China, the major exporting country of RMG products in the global market. This may create a better opportunity for Bangladesh if the country can successfully grab the opportunities from China's moving out from the low and medium valued products. But with these opportunities, there are also challenges before Bangladesh's RMG sector, particularly keeping in mind the fast changing wage rates and labour standards, increasing demand for skilled and trained labour force, workplace safety, including environmental concerns, among others. Lately environmental concern across the world has emerged as a major policy attention. This can largely be attributed to increasing per capita income, higher level of education and awareness about the environment, changes in people's mind-set and preferences, etc. These have certainly created opportunities both for producers and consumers to behave more environment-friendly.

Manufacturing industries, including the RMG sector, have always been major users of energy resources that mostly come from burning of fossils fuels and use of water resources. This not only has created major environmental challenges the world has been facing, including climate change, but also put additional pressure on the fast depleting stock of such resources. Against this backdrop, the concept of green industrialization has emerged as an alternative way to address the concern by maintaining a balance between economic development and the natural environment by a country.

According to UNIDO (2013), green industry means economies striving for a more sustainable pathway of growth, by undertaking green public investments and implementing public policy initiatives that encourage environmentally responsible private investment, while the greening of industry is a method to attain sustainable economic growth and promote sustainable economies that include policymaking, improved industrial production processes, and resource-efficient productivity. Green industry thus can bring numerous benefits,

including economic, social and environmental, to any economy through increasing competitiveness of an industry, and helping it to reduce the negative impacts on environment and to preserve natural resources.

In Bangladesh, the RMG industry has left millions of people out of poverty and thereby making significant socio-economic developments of the country from the last few decades. Along with economic contributions, the industry also has created much environmental degradation, mostly in the form of degradation of land and water bodies, air and water pollutions and thus additional health and environmental costs particularly for the urban population. It is thus important that Bangladesh uses the opportunity created by the expanding global demand for its RMG products and also minimizes the environmental negative externalities creating by the sector to make the industry an environmentally sustainable and economically rewarding one with time. In this context, greening country's RMG sector may mainly be attributed to the following reasons:

(a) to embrace and keep peace with the global concept of the green industrialization, to prevent country's water bodies, air and land from further pollution or degradation, and to bring resources (such as water, energy, chemical) efficiency;
(b) to ensure structural safety and a healthier indoor environment for the workers and most importantly to the long-term sustainability of the industry in terms of the changing global eco-friendly business modality;
(c) and also, to face and cope with the natural hazards due to global warming-led climate change such as frequent and intense precipitation, flash-floods, an earthquake, etc.

The main challenges before greening the RMG industry may be underpinned from two perspectives:

(i) since converting RMG sector into a green industry needs a detailed assessment and understanding of the industry's strengths and weaknesses that can be addressed to make the industry not only a globally competetive one, but also environmentally sustainale; and
(ii) green industry means mobilization of a huge amount of investment, which may not provide much immediate benefits; so it is important that such an initiative is rewarded with some price incentive by the international community, as it may immediately make the sector less competitive and thus poses a serious challenge for the sector.

1.2 Green Industry: Concepts, Global Commitments and Realities

In the past few years, keeping with global mandate so as to protect the environment from discharging hazardous chemicals and carbon dioxide, many global and regional organizations, including several UN bodies have coined the concept 'green industrialization' and taken initiatives to align sustainable industrialization with the sustainable development commitments. The UNIDO has taken initiative at the *Rio+20 Summit* with a slogan of "green industry for a sustainable and economically viable future". It helps developing countries to secure resource efficient low-carbon growth path, while protecting the environment and ensuring access to clean technologies and promoting a sustainable pattern of production. The Agenda 2030 for Sustainable Development balances the three dimensions of sustainable development: the economic, social and environmental as core concerns of sustainable development, while the UNFCCC and UNEP in their works on combating climate change focus on low emission growth.

Similarly, the constitution of ILO sets forth the principle that workers should be protected from sickness, disease, and injury arising from their employment. The two conventions that are related to the textile and RMG industry under protection against specific risks are *Working Environment (air pollution, noise, and vibration) Convention, 1977* (No.148) that emphasizes on the need for keeping the working environment free from hazards due to air pollution, noise, and vibration and the *Chemicals Convention, 1990* (No.170) that provides for adaptation and implementation of a coherent policy on safety when it comes to the use and proper storage of chemicals at workplace. In this regard, green industry is one of the instrumental in implementing ILO standards on occupational health and safety as the green industry ensures occupational health and safety through the structural integrity of the workplace building, improved indoor air quality and best resources management practices.

In line with the global-level commitments and initiatives, number of changes has also been made by Bangladesh in its plans and policies related to sustainable industrialization and economic growth. The following important global, regional and national-level initiatives, plans and polices are briefly reviewed here to highlight the importance of green RMG sector in the context of Bangladesh. The Constitution of Bangladesh in its *Article 18A* emphasizes that "the State shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, biodiversity, wetlands, forests, and wildlife for the present

and future citizen". Similarly, *Bangladesh Environmental Conservation Act 1995* was initiated for the conservation of the environment, improvement of the environmental standards, and control and mitigation of environmental pollution**.** The National Water Policy 1999 was formulated to make solutions to the chaotic situation by bringing order and discipline in terms of the exploration, management and use of water resources in Bangladesh. In the National Water policy, water and industry considered on the ground of pollution of both surface and groundwater around various industrial centers by untreated effluent discharge into waterbodies are a critical water management issue. Country's Perspective Plan (2010-21) and 7th Five Year Plan (FY2016-2020) focuses on efficient energy use, finding energy mix for long-term, and exploring the possibility of increasing the role of non-traditional/renewable energy resources in the country. The *National Industrial Policy, 2016* focuses on 'environment-friendly industrial management' with a focus to reducing air, water, land pollution resulting from pollution and waste generated by industry and thus has suggested installing ETP, CTP in order to control environment pollutions by industry.

In recent years the government has also taken number of fiscal initiatives in the form of lowering the corporate tax for country's green RMG at 10 percent (reduced from previous 20 percent), whilst it is 12 percent for the non-green ones. Similarly, Bangladesh Bank (BB) has reduced 1% interest rate of its green transformation fund (GTF) for export-oriented textiles and textile products and leather manufacturing industries to encourage the use of the fund for green transformation in the country's industrial sectors.

If we look at the global level realities concerning green industrialization as a response to the international commitments made for responsible industrialization, the outcomes are found to be mixed in nature. It is estimated by the USGBC (2016) that benefits from green building in the United States alone, may reduce about 40 percent of the national CO_2 emissions and make properties more valuable with an increase of 4 percent of their values and also the return on investment from green building is rapid by virtue of lowered maintenance cost (i.e. almost 20 percent than typical commercial building, whilst green building retrofit projects typically decrease operation costs by almost 10 percent in just one year and), and energy costs. China's RMG industry has gradually undergone a green transformation and thus significantly reduced pollution emissions (Hou *et al*., 2018). But countries like Nigeria with poor institutional structure, financial and technical resources and lack of awareness among the clients, and

other stakeholdersare found to enjoy scanty benefits from green industrialization (Nwokoro and Onukwube, 2011).

1.3 Need for Mapping out Investment Ecosystem for RMG Industry in Bangladesh

Since there exists so far no indigenous policy or regulatory framework for greening the RMG industry of Bangladesh, hence it is crucial to map out the required investment ecosystems in the industry to grapes the reality on the ground in terms of defining the capacities and skills set needed for green Industry development in board aspects while ensuring the factory security retrofits and bringing out resources (energy, water and chemical) efficiency, building capacities for harmful substances and hazardous wastes, and applying the 3Rs (reduce, recycle and reuse) mechanism. And by doing so, it is highly expected that it will be possible to identify the bottlenecks and possibilities on the path of the fullest implementation of green RMG industry or at least environment-friendly RMG sector. In addition to these, most importantly, mapping out investment eco-system will surely help to undertake any government policy decision, whilst concerning the issues of green RMG sector in Bangladesh.

1.4 Objective of the Present Study

The overall goal of this feasibility study has been to find out the investment eco-system mapping by assessing the scope of implementing environmental sustainability from green industry point of view across the RMG sector of Bangladesh.

Main Objectives: Along with this goal, the following specific objectives are also included in this study:

(1) to find out the present condition of the RMG industries according to the national and international standards for green industry aspect.

(2) to identify the potential investment areas in the RMG sector of Bangladesh.

(3) to mapping out the required investment eco-system for capacity building and green industry development, ensuring the factory security retrofits and resource efficiency (energy, water and chemical) as well as ensuring the 3Rs (reduce, recycle and reuse) mechanism in the RMG sector.

2. THE STATE OF THE RMG SECTOR IN BANGLADESH

The RMG sector in Bangladesh, comprising mostly knit and woven garments, has remained the 2nd largest exporter in the international market just after China for a decade. The history of the readymade garments sector in Bangladesh is a fairly recent one, whilst the beginning of RMG in the Western world was initiated in the 1950s. However, in 1980 there were only 50 RMG factories in Bangladesh employing only a few thousand people in the early 1980s.

The RMG industry of Bangladesh, however, has been flourishing steadily since 2005 when the agreement on textile and clothing phased out of import quotas established under the Multi-fiber Agreement (MFA). Bangladesh's RMG industry with 4,286 running factories is now considered as a trade and industrial competitor in terms of international garment manufacturing by other countries of the region and beyond. Over one and a half decades, the ready-made garments (RMG) industry has been Bangladesh's key export industry and a major source of foreign exchange. It has also been playing a significant role in sustaining the average gross domestic product (GDP) growth of 6.38 percent since 2005, notwithstanding global recessions, political disturbances, commodity price shocks, and natural disasters (World Bank Database, 2018).

In the FY2017-18, export earnings from Bangladesh's RMG sector was US$ 30.61 billion, with a growth rate of 8.76%, where knitwear export constituted for US$ 15.18 billion and woven US$ 15.42 billion (EPB, 2018). At the same time, the contribution of the RMG sector to national export was around 83 percent. Nearly 4.1 million workers are directly employed, in which women constituted for 80 percent. Additionally, more than 15 million inhabitants are indirectly associated with the RMG industry. In this way, the industry continues to contribute to employment generation, poverty alleviation and empowering women from remote and disadvantaged areas. It is worth mentioning that the industry has helped a lot in achieving the country's Millennium Development Goals (MDGs), a milestone achievement in the history of Bangladesh and from this reality, it is highly expected that the industry will

continue playing a decisive role in achieving the country's Sustainable Development Goals (SDGs) set out by the UNDP.

China's gradual shift from RMG production has created a great room to catch up the world apparel market. So, it can be concluded that Bangladesh's RMG sector holds immense potential to grab China's leaving the market due to its emphasis on producing high quality and high value addition products, and on-going eco-friendly initiatives and social compliance approaches. In this regard, substantial evidences have already been produced that demonstrated the high potentiality of Bangladesh's RMG sector's room to grow further.

2.1 Challenges for Bangladesh RMG Sector

Though Bangladesh's RMG sector awaits a bright future, there are also challenges that can be broken down into two-time perspectives: first is the current and other one can be related to possible challenges emerging in the near future. The current challenges that are facing by Bangladesh's RMG sector and future challenges include:

(i) increasing cost of raw materials, hike in energy price and importantly investments that have recently been made in ensuring compliance in the factories are not reflected in the product prices. These have reduced the sector's competitiveness relative to other emerging RMG producing countries such as Vietnam, Cambodia, India, Myanmar, Ethiopia and other African countries[1].

(ii) inefficient port facilities and management that cause delaying in lead time, dependency on imported cotton, lack of RMG factories' own branding that depriving the factory owners to get the reasonable prices from global apparel market[2].

(iii) other possible challenges that the country's RMG sector in the near future many face include the fullest implementation of the eco-manufacturing production approach, taking into account the reality of the paradigm shift of worldwide various types gradual eco-friendly initiatives in the arena of social, economic, business and even in individual life style along with a shift to green technology, etc. with some degrees of implications for the sector.

[1] Some African countries have had zero-tariff facility under AGOA act which helps them to gain competitive advantages over Bangladesh in terms of exporting RMG products.

2 Bangladeshi RMG producers only get 16 percent of the prices of their products from the final global market prices due to the absence of their own brand.

In this regard, to sustain the sector in terms of more employment generation and to tackle looming state of country's unemployment and image building, reducing production-related environmental negative externalities and gaining production cost-efficiency, greening of Bangladesh's RMG is one of the challenging strategic moves.

2.2 Compliance Issues in the RMG Sector in Bangladesh

Maintaining compliance issues in the RMG industry is not only expected to promote workers' health, reduce workplace risks and ensure safety and the overall welfare of the workers and thereby increasing industrial productivity, but also it is crucial for gaining confidence from the rights conscious buyers and consumer groups, and adding social values to products while protecting or having less impacts on our natural environment. However, in the context of country's RMG industry, compliance issues are mainly related at two levels: environmental and social compliance.

Over the last couple of years, Bangladesh's ready-made garments has made remarkable progress in meeting social compliance issues that include not only workplace safety such as structural, fire and electrical safety, but basic workers' rights such as minimum wage standard, daycare centers for workers' children, maternity leave, overtime wage, minimum working hours and so on as per with the national and international labour standards and labor rights have also been improved. At the same time, in terms of environmental compliance, a good number of RMG factories have already converted their factories into green ones, while other factories are using eco-friendly and resource-efficient (water, energy, and non-energy materials) technologies and techniques, harvesting rainwater, installing effluent treatment plants (ETPs), installing solar power plants, utilizing resources effectively, and managing hazardous chemicals and wastes and so on and by doing this, they are in the process of emerging as an environment-friendly production industry. And in an effort to materialize social compliance issues, RMG entrepreneurs in Bangladesh have already poured into thousands of millions of dollars in the improvement of this sector. In doing so, the industry is now considered as a role model in the global RMG and textile arena.

2.3 Current Status of Bangladesh's Existing Green RMG Factories

Globally, the acceptance of green industry is on the rise taking into consideration of the catastrophic dangers of the global warming-led climate change and other environmental

threats. Green industry calls for a shift to cut down carbon emission and less natural resources-based production as a part of its response to global environmental challenges. As mentioned earlier, installing green building is a vital component for the green industry. And in this sense, on a global level, the number of LEED-certified green building is increasing day by day due to its cost-effective nature in terms of its lower maintenance, and fewer energy costs along with other environmental and health benefits. According to US Green Building Council (USGBC), worldwide more than 19.3 billion square feet of building space is currently LEED-certified, and approximately 2.2 million square feet achieve LEED certification each day as of 2017.

Table 1: Status of LEED certification in Bangladesh's RMG sector

Certification Level(out of 110points)	Platinum(80+points)	Gold (60-79points)	Silver (50-59points)	Certified(40-49points)	Total
No.	18	37	5	2	62
Rating system	New construction	Existing building	-	-	
No.	50	12			62

Source: Calculation based on USBGC directory database, 2017, accessed on 31 May, 2017.

From the above Table-1, it is seen that currently there are 62 green RMG factories in Bangladesh; among them 37 are gold rated, followed by 18 platinum, 5 silver and 2 certified. On the other hand, in terms of rating system, 50 green factories have been built as the new construction projects, whilst the rest 12 factories have been built on the existing building structures.

3. METHODOLOGY

Both qualitative and quantitative techniques were applied as the methodology for this study. Information was collected from both primary and secondary sources. For this purpose, a detailed primary survey in addition to a desk review of available secondary data and documents was conducted to understand the existing state of the RMG sector and assess the opportunities and challenges that are associated with any initiative of greening the RMG sector in the country. Further details on the study methodology are provided below:

3.1 Study Area

The study, as mentioned, mainly used primary data collected through questionnaire survey, focus group discussions (FGDs) and key informant interviews (KIIs) conducted on the respondents and other relevant stake-holders. For this purpose, factories from 3 industrial clusters namely Dhaka, Narayanganj, and Chittagong were selected purposively from over 2050 export–oriented RMG factories, based on a judgmental or purposive sampling technique taking into the budget and time constraints.

Country's export-oriented RMG factories are concentrated mostly in Dhaka, Narayanganj, Gazipur, and Chittagong districts. Some of the newly formed factories are also relocated in Mymensingh and Narshingdi regions. This study surveyed 58 factories from three stratums, namely Dhaka, Narayanganj & Chittagong. In the Dhaka stratum, factories are mostly located in Gazipur, Savar, Ashulia, Narshingdi, Tongi and Mymensingh regions. It is reported that 55.17% of the country's RMG factories are located in Dhaka region, followed by Narayanganj and Chittagong with respectively 27.59% and 17.24% of the factories. For this study purpose, these factories were further divided into three categories i.e. large, medium and small factories, based on their size as defined by *National Industrial Policy 2016* and Bangladesh Bank Circular[3]. Following this, 22 (37.93%) factories considered for this study were large, 17 (29.31%) medium and the remaining 19 (32.76%) small.

[3]Bangladesh Bank (BB) has updated its definition of micro, cottage, small and medium enterprises in line with the National Industrial Policy 2016. In National Industrial Policy 2016, large RMG factory is defined as the factory that has more than 1000 worker and medium RMG factory that has workers between 500 and 1000 (Chapter 3, subsection 3.3.1 & 3.3.3). But in case of small RMG factory, the definition does not match with the real scenario. That's why we have defined a factory as small category if the factory has workers not more than 500. However, some heavily capital intensive factory will not be covered by this self-defined definition.

Table-2: Location and category of factories surveyed

Location	Factory Category			Total
	Large (A)	Medium (B)	Small (C)	
Dhaka	13	8	11	32 (55.17%)
Narayanganj	6	6	4	16 (27.59%)
Chittagong	3	3	4	10 (17.24%)
Total	**22 (37.93%)**	**17 (29.31%)**	**19 (32.76%)**	**58 (100%)**

Values in parenthesis are in percentage.

3.2 Sampling Techniques

Considering the suitability, a judgmental/purposive sampling technique was applied for conducting the primary survey. It is understood that accessing data from most of the RMG factories in Bangladesh is extremely difficult for many reasons, including respective management's unwillingness to cooperate. In fact, it was one of the main reasons behind choosing a non-probabilistic sampling technique for conducting the study. For carrying out the survey, around 200 factories had been contacted initially, although responses from only 85 factories were received. Finally, data were collected from 62 factories. For analysis, information from 58 factories has been used; means data from the remaining 4 factories had to drop because of data discrepancy.

3.3 Sample Size

For the present study, 3 stratums of factories depending on their number of workforce size and production capacity were considered. These included small, medium and large sized factories that employ less than five hundred, in between five hundred to less than one thousand and 1000 and above, respectively.

Table 3: Defining of small, medium and large categories of RMG factories

Serial No.	Size of Factory	Number of employed workers
01.	Small	499
02.	Medium	500-999
03.	Large	1000 or above

As mentioned, the study used both quantitative and qualitative analytical techniques for assessing the feasibility of green industrialization in the RMG sector of Bangladesh. For this purpose, the study employed four different methods to collect data and information. These

include questionnaire survey, key informant interview (KII), focus group discussion (FGD) and case studies. Besides questionnaire survey on all 58 factories, a total of 8 KIIs, 2 FGDs and 3 case studies were also conducted.

Table 4: Techniques used for data collection and respective sample size

SN	Methods	Respondents	Sample Size	Tools Used
1.	Individual Interview	Key representatives from selected factories	58	Structured and standardized questionnaire (well pretested)
2.	Key Informant Interview (KII)	✦ Key policy makers from the government ✦ Specialists related to this sector ✦ Technical specialists related to this sector (energy efficiency)	8	Check List
3.	Focus Group Discussion (FGD)	Factory owners and mid-level management from factories of each selected cluster	2	Use FGD Guideline
4	Case study	3 factories	3	Format of case study

3.4 Training to Investigators and Field Pre-testing

Total 8 field investigators and 2 field supervisors were trained and employed for smoothly conducting the primary data collection from the three regions: Dhaka, Narayanganj and Chittagong. Field testing was conducted to assess the appropriateness of the draft questionnaire and other qualitative tools of final data collection. Five field visits to selected factories in Dhaka and Narayanganj were made by the research team. Based on the observations came out from the field testing, required modifications were incorporated in the draft questionnaire and other survey techniques used.

3.5 Collection of Field Data

Two teams were formed for conducting the survey. A well-designed field movement plan for effective implementation of the survey was developed and all the team members were briefed about the field action plan in advance. Prior to field survey conducted, necessary documents were provided from the BKMEA. The survey was conducted from November 2017 to February, 2018 in the 3 industrial clusters.

3.6 Monitoring, Supervision and Quality Control

Each field team was guided and managed by a field supervisor. Field supervisors were responsible for ensuring management of each team at the field level. They also ensured quality controlling through random checking. In addition, the team leader and other consultants also visited the study areas and made discussions with the concerned factories. Representatives from AFD and Ministry of Commerce also visited the sampled factories.

3.7 Data Processing and Analysis

Collected data were coded, edited and cleaned and then processed and analyzed. Data analysis techniques included the use of descriptive data analysis techniques like percentage, ratio, figure, table, etc. in addition to estimation of values like costs, benefits and investment requirements. No advanced analytical tool like econometric model was used as the study demanded assessing the existing state of the RMG sector of Bangladesh and the feasibility of greening the sector and there is no scope to use such techniques and tools for this purpos

3.8 Ethical Consideration

The study team tried to maintain ethical considerations in the form of showing identity cards, brief description about the study and its objectives, not to interrupt any factory's personal/internal matter, showed respect to the respondents, being honest and fair in data collection, no pressure to participants, maintained anonymity and confidentiality. Participants/respondents were encouraged to share their views voluntarily. It was conveyed that collected data would remain the property of BKMEA. Finally, it was communicated that collected data would only be used for research purpose and no individual identity would be made public.

4. BASIC CHARACTERISTIC OF THE INDUSTRY

4.1 Workforce:

This study found total 88908 workers and total 11327 staffs in the surveyed factories where 4 million workers are employed in the Ready-Made garment industry[4]. Around 81.59 percent of workers were working in large factories followed by 11.62 percent in the medium categorized factories. The rest of the 6.99 percent of workers were only in the small categorized factories.

Among the managerial workforce, 77.04 percent staffs were working in the large categorized factories followed by 15.14 percent in the medium categorized factories. Rest of the 07.82 percent staffs were working in the small categorized factories.

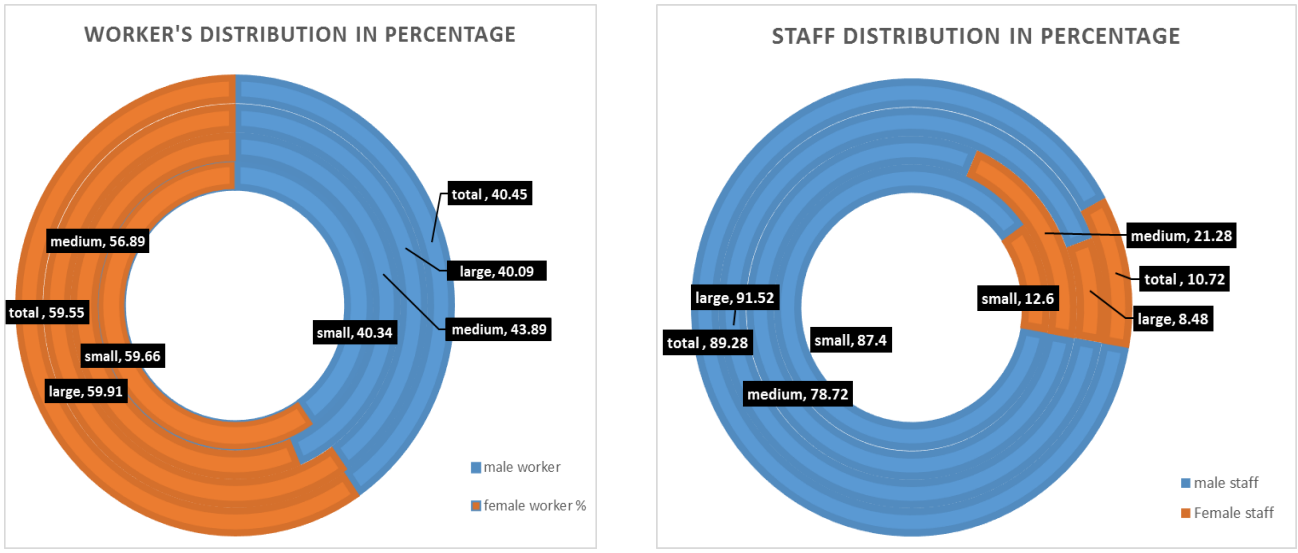


Figure-1: Gender distribution of workforce

An interesting fact was seen in the gender distribution in both case of worker and staff. Among the worker, majority (about 59.55 percent) was female while males were major (about 89.28 percent) in staff level workforce.

Regarding the gender distribution of workers in factories, around 59.91 percent of workers were female in large categorized factories followed by 59.52 percent in small categorized factories. It was slightly less in case of medium-categorized factories which was 56.98 percent. On the other hand, male outweighed the female significantly in case of staff level workforce. Around 10.72 percent of female staff were working in factories where 21.28

[4] http://www.bgmea.com.bd/home/pages/aboutus.

percent in medium categorized factories followed by 12.60 percent in small categorized factories. Only 8.48 percent of females were working in large categorized factories as staff.

4.2 Building ownership:

It was seen from the survey that there was a reflective scenario regarding the building ownership. About 46.55 percent of surveyed factories had no own building. While majority (18 factories) of the large factories were operating their business in the owned building, majority (17 factories) of the small categorized factories were operating business in rented building. In case of medium categorized factories, 6 reported that they were in rented building while 11 factories had own building.

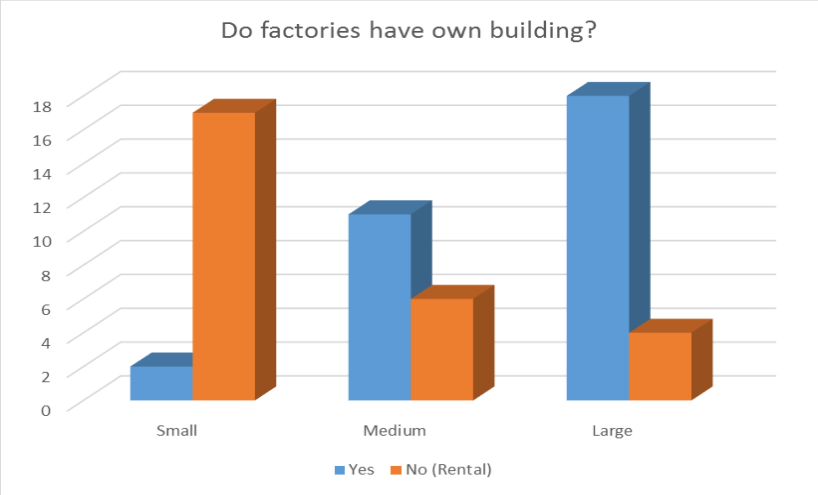


Figure-2: Building Ownership of factories

4.3 Yearly sale turnover:

The survey study revealed that the last years' (In 2016) mean sale turnover of the readymade garments was USD 22.7 million. Significant amount of export was done by large-categorized factories which were about 62.26 percent.

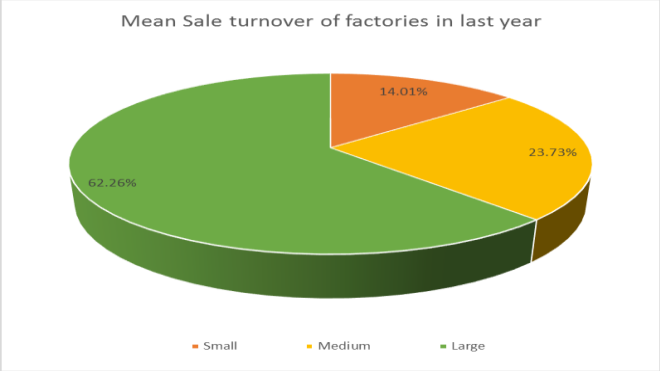


Figure 3: export turnover of the factories

In the meanwhile, small and medium categorized factories were able to achieve mean sale turnover of USD 9,088,266 and USD 15,400,000 respectively. It was also clear from the survey that the range of maximum and minimum sale turnover of large categorized factories were USD 146,000,000 and USD 2,707,482 while it was for small categorized factories USD 35,000,000 and USD 66265 respectively.

4.4 Having different section:

It was seen from the survey that almost all the three categorized factories had all sections like knitting, cutting, sewing, finishing, dyeing and other means printing and dye finishing except dyeing section in small categorized factories. Among factories, composite factories had all these section as aforementioned. In general, the total factories reported that they had different section as - about 34.48% in knitting, 84.48% in cutting, 93.10% in sewing, 94.83% in finishing, 18.97% in dyeing, and 13.79% in dye-finishing and printing section.

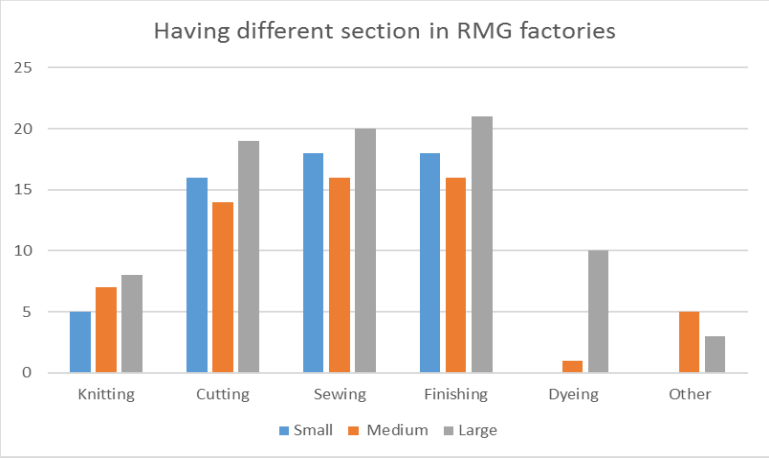


Figure 4: Section distribution of factories

4.5 Production hour and capacity:

From the survey it was evident that operation hour in sewing factories were usually 8 hours in a day sometimes 10 hours depending on the work load. But the dyeing and washing sections' operation hour is 24 hours a day where it was operated by managing roaster. In the survey, 46 factories reported that they were producing knitwear products and 5 factories reported to manufacture sweater. 9 factories have reported to produce woven products.

Table-5: Production Capacity

Factory Category	Section	Mean	Sum	Minimum	Maximum
Small	Dyeing*				
	Knitting*	42513.63	170054.5	2.5	90000
	Printing**	8000	8000	8000	8000
	Garments**	182837.50	2925400	4400	600000
	Weaving	200000	200000	200000	200000
	Other	85000	170000	80000	90000
Medium	Dyeing*	300	300	300	300
	Knitting*	34034.33	204206	32	104000
	Printing**	370000	1110000	60000	650000
	Garments**	607866.70	9118000	50000	2400000
	Weaving	115000	115000	115000	115000
	Other	700000	700000	700000	700000
Large	Dyeing*	559.06	4472.5	221	1350
	Knitting*	325.71	2280	26	780
	Printing**	1182058	5910291	290.61	3600000
	Garments**	1432000	3.01e+07	40000	4000000
	Weaving				
	Other	228800	457600	218400	239200
Total	Dyeing*	530.28	4772.5	221	1350
	Knitting*	22149.44	376540.50	2.50	104000
	Printing**	780921.20	7028291	290.61	3600000
	Garments**	809911.50	42100000	4400	4000000
	Weaving	157500	315000	115000	200000
	Other	265520	1327600	80000	700000

All data in monthly basis.

*Knitting and Dyeing data are monthly ton basis; ** Printing garments data are monthly pcs basis.

Two factories reported that they produce other types of products like lingerie items The mean installed capacity of total RMG factories was 22149.44 ton per month in knitting, 530.28 ton per month in dyeing, 780921 pcs per month in printing, 809912 pcs per month in final garments and 265520 pcs per month for other types of product like lingerie irrespective of factory category).

5. FEASIBILITY OF GREEN RMG SECTOR IN BANGLADESH

The feasibility of a greening the RMG industry is Bangladesh under the present study was assessed keeping in mind four important sections of the RMG industry i.e. building and structural integrity, water use and management of wastewater, energy use, work environment and workplace safety where there is a need to undertake greening initiatives. The study outcomes on the above-mentioned sectors are assessed below:

5.1 Building and structural integrity

The 58 factories drawing from three categories of RMG units (i.e. 22 large, 17 medium and 19 small units) from Dhaka, Narayanganj and Chittagong have the following building and structural integrity related characteristics:

Table 6: Overview of the building & structural integrity of the surveyed factories

Features	Large	Medium	Small	Total
No. of factories surveyed	22	17	19	58
Site area (sft)	3312256.44	2616325.963	300937.053	6229519
Building footprint (sft)	1116548.95	1759807.449	202385.373	3078742
Gross floor area (sft)	4428838.48	8106603.325	611579.93	13147022
Building type				
Single building	10	15	12	37
Campus	7	1	1	9
Campus, Shed	5			5
Single building, Campus			1	1
Single building, Shed		1	3	4
Single building, Shed, Campus			2	2

Source: Primary survey, 2017-18

It is to be mentioned here that almost all factories nowadays have the RAJUK/local authority approved architectural drawings for their buildings, which are based on some standard norms. This makes it easier today to assess a building structural integrity and construction related matters that are very important in making a factory green certified. Based on the above findings (Table 6) it can be said that all types of buildings chosen for the study had building footprints and floor area proportional to their site areas. Similarly, single buildings dominate the building type for all categories of buildings. Of the total 58 factories, 32 are congested and the remaining 28 factories have required open space (Table 6). Congested factories are

those which do not follow the relevant building laws and rules in designing the building layout and construction of the establishment. The congested factories do not have enough space according to compliance requirement.

Table 7: Types of the factories surveyed

Type	No. of Factory
Congested	32
Open	26
Total	**58**

Source: Primary survey, 2017-18

In addition to the basic structural characteristics of the selected factories, their improvement options possibilities based on the floor area ratio (FAR) and maximum ground coverage (MGC) are assessed below:

Table 8: Floor area ratio (FAR) and maximum ground coverage (MGC)

Study Area	Total	Improvement option	Improvement percentage
Narayanganj	16	6	37.5%
Dhaka	32	14	43.8%
Chittagong	10	4	40.0%
Grand Total	**58**	**24**	**41.4%**

Source: Primary survey, 2017-18

Considering Bangladesh is one of the most densely populated countries in the world and the RMG factories are mostly concentrated in the unplanned urban peripheries of Dhaka, Narayanganj and Chittagong cities, the average percentage of open space kept in the existing factories is found to be quite satisfactory. From the survey data, it is understood that 41.4% of the total factories had open space in their existing factories, thus indicating some level of structural suitability of the factories.

Table 9: Landscape of the factories surveyed

Study Area	Total Factories	Landscape Existed	Percentage of Landscape
Narayanganj	16	7	43.8%
Dhaka	32	17	53.1%
Chittagong	10	4	40.0%
Total	**58**	**28**	**48.3%**

Source: Primary survey, 2017-18

If we look at the possibility of seeking green certification by the small categories of factories based on their existing structural capacity, retrofitting comes out to the main investment area for the small factories. It is also estimated that the cost of retrofitting related work is 30-40% higher in any existing factory than any new construction. Under the current cost structure, construction cost for any new factory ranges from Tk. 2500 to 3500 per square feet. It varies time to time in terms of market price of the construction materials. In this situation, if a new factory of 20,000 square feet is constructed, then the construction cost shall be closer to Tk. 5,00,00,000 to 7,00,00,000 while the retrofitting for a same size existing factory may cost Tk. 8,00,00,000 to 15,00,00,000. In addition, there is also a design related consultancy fee that ranges from Tk. 25,00,000 to 50,00,000. Thus, in can be said that costly retrofitting for the small and medium-sized RMG factories in Bangladesh would be a major building block for factory owners.

Table 10: Retrofitting opportunities of the surveyed factories

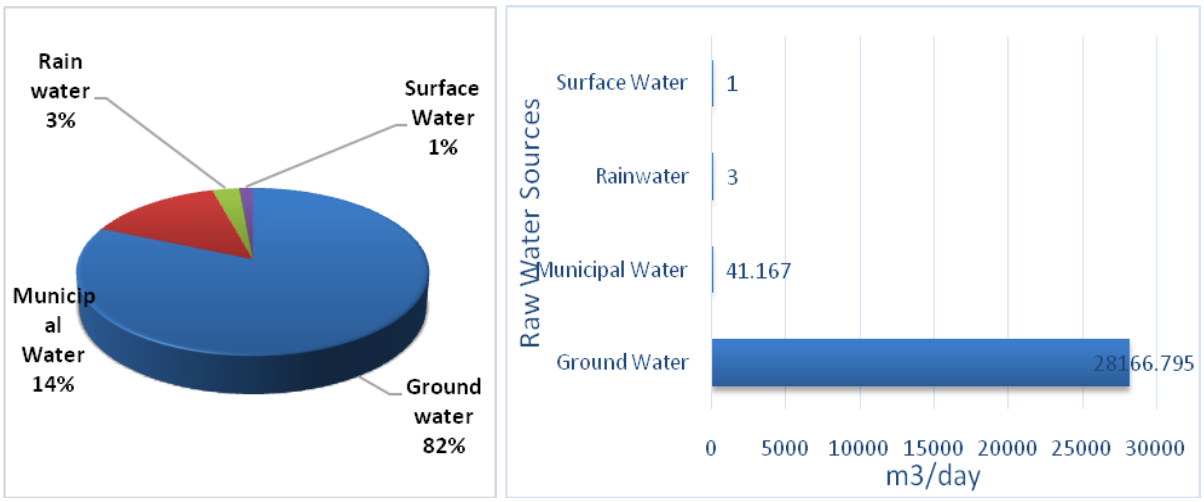
New Construction factory	Existing Factory
(20,000 square feet approximately)	(20,000 square feet approximately)
Design consultancy fee: 25,00,000/= to 50,00,000/=	Design consultancy fee: 25,00,000/= to 50,00,000/=
Construction work: 5,00,00,000/=to 7,00,00,000/=	Retrofitting work: 8,00,00,000 /= to 15,00,00,000/=

5.2 Water use and management of wastewater by the RMG sector

5.2.1 Use of water resources by RMG sector in Bangladesh

Managing industrial water use is very important for the management of any country's water resources. However, industrial water consumption pattern in many countries, like Bangladesh is fully depended on groundwater sources. The survey findings presented in the Figure-5 below shows that 82% of total water used by RMG factories comes from groundwater sources, while 14% comes from municipal water and a very few from rainwater and surface water sources. Figure 5 (b) shows the daily water supply scenario by the RMG industry from the perspective of major sources of water supply. Both the figures speak the overwhelming dependency on groundwater sources for meeting the industry's water demand.

Figure 5: (a) Total Raw Water Sourcing Areas of RMG Industry in Bangladesh (%) and (b) daily needs



The bar diagram (Figure-6) presented below illustrates the water usages for different purposes by the RMG industry in the three selected regions. It is observed that the Dhaka region used slightly higher quantity of water for domestic purpose; while Narayanganj and Chittagong were found to use process water and utility water, respectively. To find out the weaknesses of the water use efficiency by the RMG sector from the current water use pattern by the three regions and for different purposes, it can be said that despite almost similar water use pattern by all regions, process water remains to be a significant part of the sector's existing water use pattern. Contribution of regional cluster for each sectoral water use is also illustrated in the figure below:

Figure 6: Patterns of current water use for different purposes by the RMG industry in three selected regions of Bangladesh

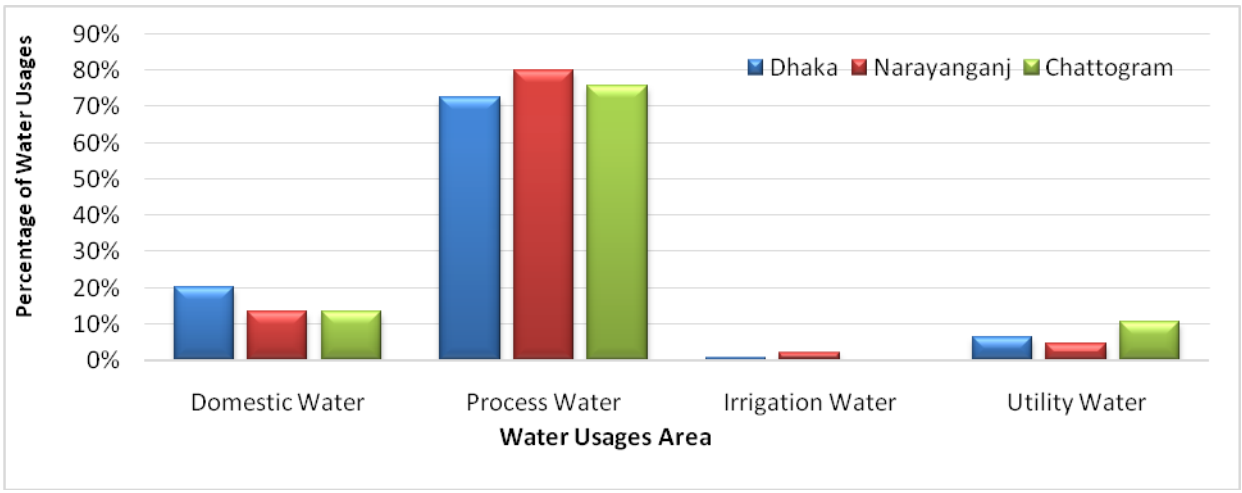
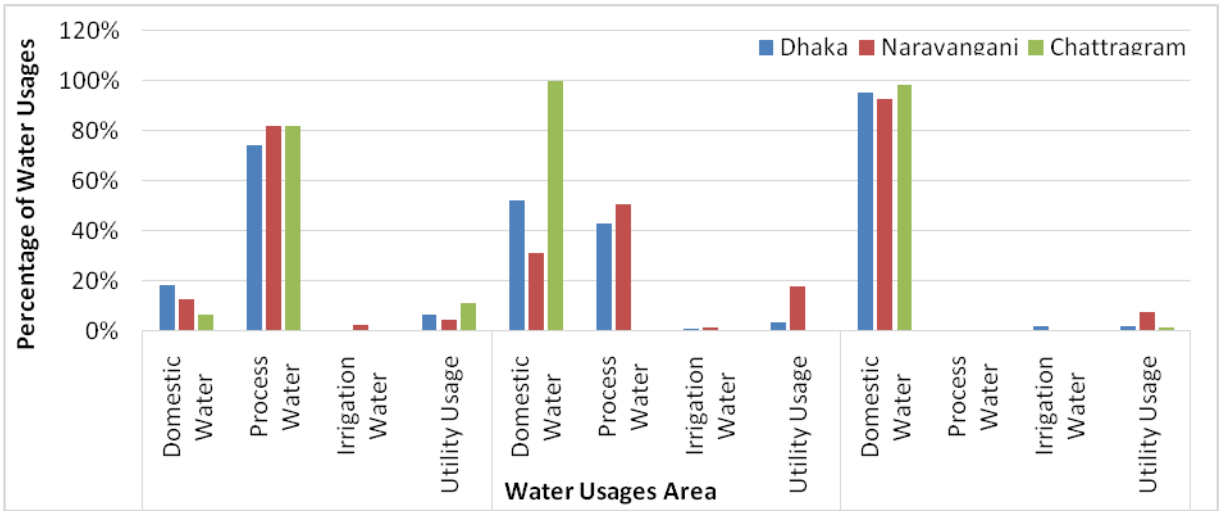


Figure-7 shows total water usages by different areas across regions in the RMG sector. Domestic, process and utility water usage is the highest water consumption area for every category of factory in Dhaka, Narayanganj and Chittagong regions. In case of large factories, Dhaka region consumes the maximum share of domestic water, while Chittagong consumes the highest share of domestic water for its medium and small factories. The condition of Dhaka is much better than the other regions in the use of process water. Therefore, there are huge opportunities for Dhaka, Narayanganj and Chittagong regions to reduce their current water consumption patterns and make their industries more water use-efficient.

Figure 7: Total water usages by different areas across the regions in RMGs sector



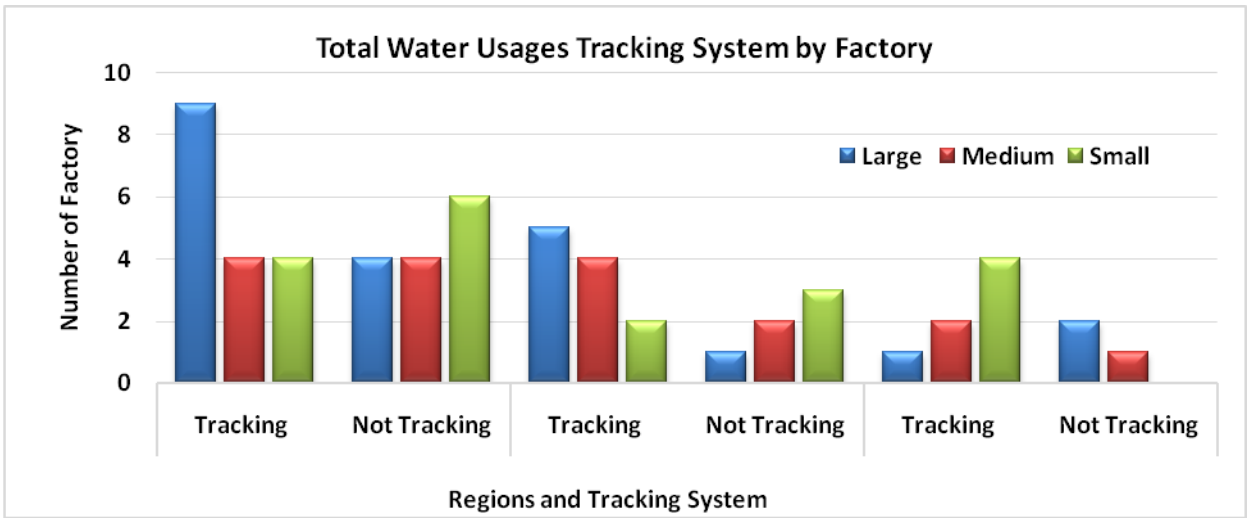
5.2.2 Water use efficiency

Water is one of the most important resources used by the RMG sector of Bangladesh and it is also a major source of contamination of natural water bodies in the country. Considering the fast depleting sources of water availability in one hand and degradation of water bodies in the other, there is thus a need to undertake measures to ensure water efficiency for the industry. Water use efficiency means the reducing usages of water and reducing wastes, including wastewater. According to the United States Environmental Protection Agency (EPA), "water efficiency is the smart use of water resources through water saving technologies and essential steps that can be taken around the industrial perspective. Using water efficiently will help ensure supplies today and for future generation".

The water consumption tracking system of the RMG sector as shown in Figure–8, entails identifying the "tracking" and "not tracking" through the factory categories across the regions. From the point of view of water usages tracking system, it plays a very vital role in reducing water consumption and the remaining wastewater. The outcomes of the survey

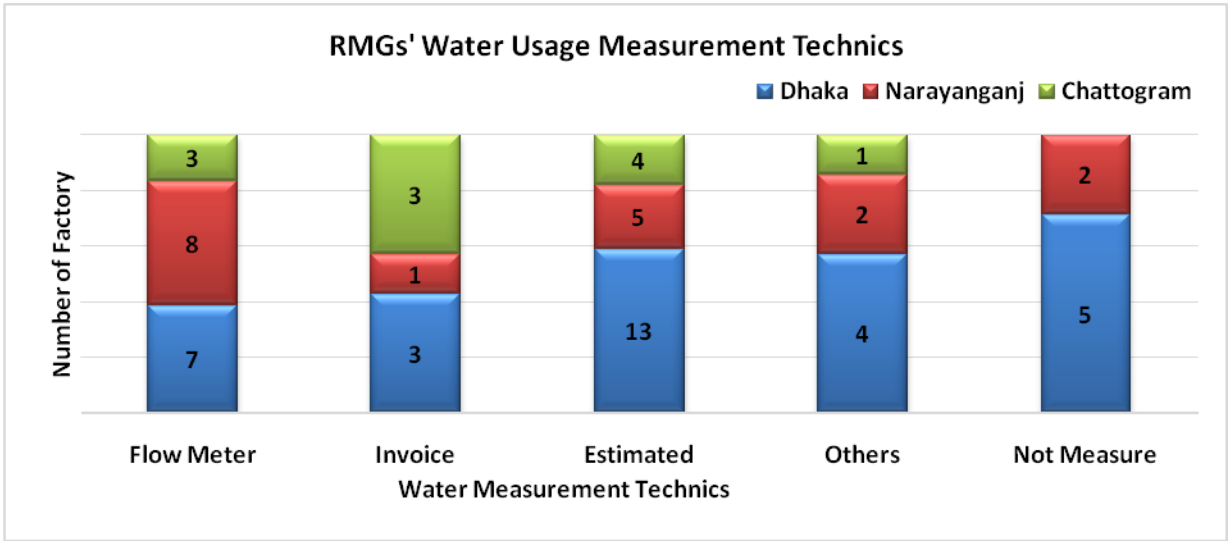
suggest that Dhaka region's water tracking system had large, medium and small sized factories.

Figure 8: Total water usages tracking system



Water measurement importance of this sector is expected to enhance the water use efficiency and cutting down environmental challenges. The RMG sector uses and pollutes significant amount of water across every production process as well as it pollutes adjacent wetland and waterbodies. Thus managing water resources is an important task to explore water use efficiency techniques. The most significant RMG water usage measurement techniques are illustrated in Figure–9.

Figure 9: RMGs' Water Usage Measurement Techniques



5.2.3 Water quality

Both ground and surface water quality in Bangladesh have been declining due to anthropogenic reasons in which industrial wastewater is understood to be a major causes for water pollution. The RMG industry in Bangladesh is also one of the most water consuming as well as water polluting industries in Bangladesh, especially for the industrial clusters of Dhaka, Chittagong and Narayanganj regions. With time, rising water demand for apparel industry and their wastewater discharge are expanding. This speaks the volume of importance that needs to be given to address both the inefficient water use pattern and wastewater generation by the RMG sector of Bangladesh.

5.2.4 WTP soft water performance

Table-11 presents the current status of the raw water use by the RMG industry in Bangladesh. Of 15 factories, water hardness levels by 12 were in acceptable level, while the remaining 3 failed to meet the standard. On the other hand, if we consider the TDS level, 16 factories were found to meet the standard, while only one factory failed to do so. In regards to pH, out of 18 factories 17 met the standard and only one factory failed doing so. From the table presented below and by considering all the parameters it can be said that hardness level of raw water was in critical situation which is thought to hamper factories' production process due to their unawareness. It is also necessary to mention that most of the factories do not maintain any Water Treatment Plant (WPT). So they cannot measure the parameters of raw water.

.

Table 11: WPT Soft Water Performance

WTP Soft Water Performance					
Paramerer	**Average Current Value (In)**	**Average Current Value (Out)**	**Soft water (for wet process)**	**KPI Status (DoE)**	**Factory Performance**
Hardness (mg/l)	4.13 ***(12)***	100.6 ***(3)***	Max. 10	80	
TDS (mg/l)	495.4 ***(15)***	800 ***(1)***	Max. 500	93.75	
pH	7.5 ***(17)***	7.7 ***(1)***	5.5-7.5	94.44	
Iron (Fe) (mg/l)	0.22***(11)***		0.1	100	

Looking at the following Table-12, it is understood that amount of water that is used for cooling towers and boilers have failed to meet the standard. Especially the level of hardness, TDS and pH were in poor situation which is understood to hamper performance of cooling

towers and boilers and also decrease the lifetime of these machineries. So if we ensure the performance of water used for cooling towers and boilers' blow-down, it would help to increase performance and durability of cooling towers and boilers by used by RMG sector.

Table 12: Cooling Tower Recirculation and Boiler Blow-down Key Performance

Cooling Tower Recerculation and Boiler Blowdown Key Performance						
Parameter	Average Current Value (In)	Average Current Value (Out)	LEED Standard	Recerculation water (for wet process)	KPI Status (DoE)	Factory Performance
Hardness (mg/l)	7.16 ***(6)***	133.14 ***(14)***	1000	Max.100	30	
TDS (mg/l)	259 ***(3)***	2539 ***(12)***		Max.850	20	
pH	6.85 ***(3)***	10.1 ***(13)***	7.5-10	7.5-8.5	18.75	
Iron (Fe) (mg/l)	.012 ***(13)***	.03 ***(1)***			92.86	

5.2.5 Wastewater discharge by Bangladeshi RMG industry

The RMG manufacturing sector is the major industrial water user in Bangladesh. A lot of chemicals are used for cleaning and dyeing purpose. Untreated industrial wastewater can be very harmful for human health and environment. According to ECR – 1997, the functioning of ETP is the mandatory to get the environmental clearance certificate for industrial units. There are many efforts; it is being vigorously pursued to control the wastewater discharge standards. Despite significant improvements, wastewater continues to remain a major concern for the RMG sector in Bangladesh.

Table 13: ETP Key Performance Analysis

ETP Key Performance Analysis							
ETP Parameter Name	Average Current Value (In)	Average Current Value (Out)	DoE Standards	ZDHC Standards	KPI Status (DoE)	Factory Performance (DoE)	Factory Performance (ZDHC)
TSS (mg/l)	48 ***(3)***	0	150	50			
BOD(mg/l)	26 ***(7)***	0	50	30			
COD(mg/l)	99 ***(7)***	0	200	150			
pH	7.8 ***(8)***	9.6 ***(1)***	6-9	6-9			
DO (mg/l)	5.8 ***(9)***	0	4.5-8	N/A			N/A
EC(Ms/cm	2500 ***(5)***	0	4200	N/A			N/A
TDS(mg/l)	1297 ***(9)***	0	2100	N/A			N/A
Temperature (0C)	32 ***(7)***	0	40 & 45	35			

Table 13 above shows that most of the factories' ETP meet the wastewater discharge parameters set out by the national standards. This is of course a positive indication

considering the volume of waste water released by RMG industry in one hand and the fast degrading state of the wetlands and adjacent land resources in the industrial clusters of the country.

5.3 Energy Use

5.3.1 Energy consumption in the RMG industry:

The role of energy in industrial development is vital. It is almost unimaginable in today's industrial development to have a day without the access to energy resource. Industry worldwide is a major consumer of commercial energy resources and the same is true for the RMG sector. Although the per capita energy consumption in Bangladesh is one of the lowest in the South Asian region, industrial energy consumption continues to remain far higher than most other sectors for its economy. With time, access to secured energy resources by industry has been getting improved and the case of RMG sector is not exceptional. Industry is also the biggest producer of fossil fuel-burned emissions that causes environmental challenges. Thus the need to have a secured access to energy resources by the RMG sector in the country with a care for the environmental concerns need to be addressed by the industry to reap the immense possibility that are expected to come on its way in near future.

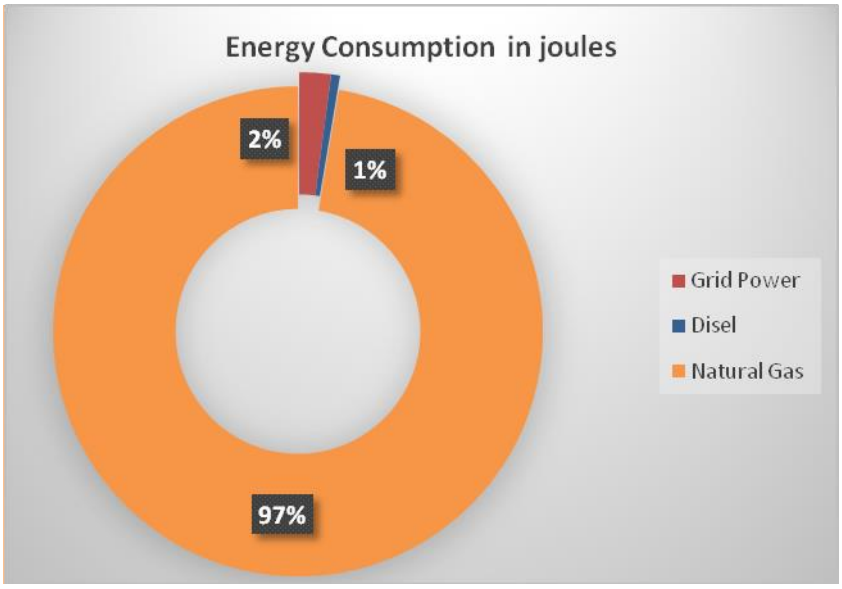


Figure 10: Energy Consumption Scenario

The present energy consumption scenario by the RMG industry in Bangladesh is dominated by the use of three major energy sources: grid power, diesel power and natural gas. Most composite factories in the country are run 24 hours and like to rely on smooth energy supply.

In Figure 10, it is presented that approximately 97% of the current energy consumption is dependent on the use of natural gas. As the price and availability of natural gas for industrial purpose until now are more flexible, natural gas becomes the main energy source for generators and boilers in the RMG sector. Grid power has been a major energy source for small and medium sized factories. With changes in country's energy and power supply situation, things are expected to see further changes.

As the consumption of natural gas is high in RMG factories, so the overall cost of natural gas consumption is also higher for the sector. The current cost of the gas consumption by the RMG factories in the country is approximately Tk.17.92 million annually, while the cost of energy from grid power is approximately Tk.4.17 million.

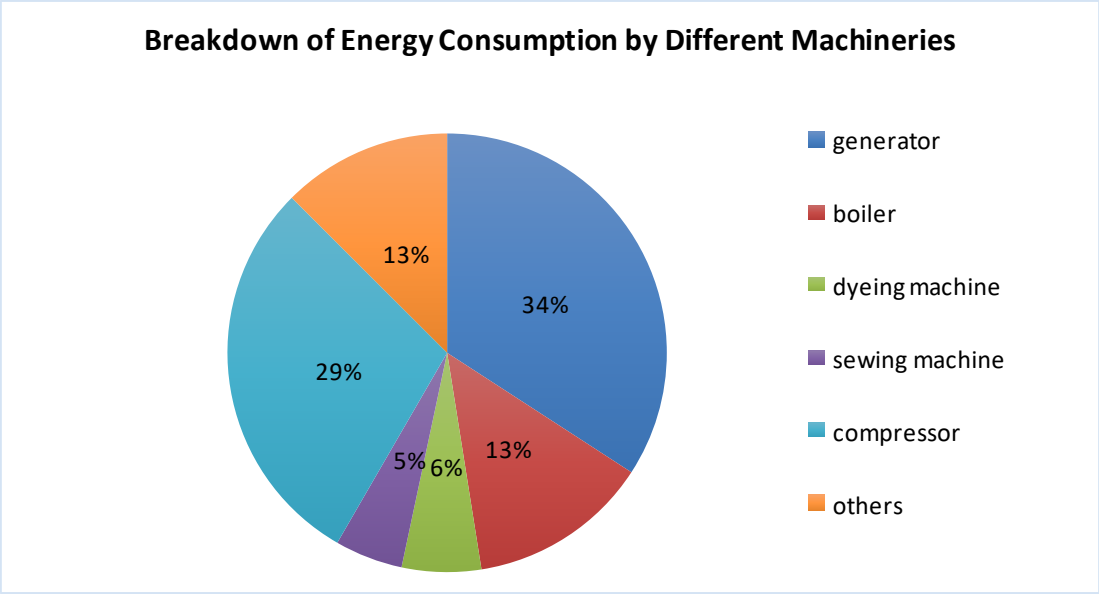


Figure 11: Breakdown of energy consumption by different machineries

Heavy machineries used in the RMG Industry such as generators, boilers and air compressors are the major loads for the energy consumption by the sector. As we can see in Figure11, about 34% of the sector's total energy is consumed by generators, which is followed by air compressors with 29% and steam boilers comprise 13% of the total energy used. Dyeing and sewing machines consumed about 6% and 5% of the total energy consumed by the sector, respectively. Other machines such as cutting machines, washing machines and lights, fans, air conditioning units consumed about 13% of the total energy used by the country's ready-made garments industry.

5.3.2 Machineries and energy scenario in the RMG industry

The RMG industry in Bangladesh mostly uses diesel and natural gas-run generators as their back-up source for energy. As shown in *Table 14*, it is found that generator capacity below 500KW is mostly diesel fuelled, while 501-1000KW generators mostly use both diesel and gas. Almost all large generators use natural gas as their fuel. Most of the factories in the country choose gas as their primary fuel rather than diesel as access to and cost of natural gas in the country is easier and cheaper.

Table 14: Generator type based on fuel and range

Capacity	**1-500KW**	**501-1000KW**	**Above 1000KW**
Gas	1	13	11
Diesel	60	12	2

Almost every garment unit uses generators as an alternative power source. Composite garments factories mainly use generators as their primary source of energy. It is understood that approximately 74% industries in the country use generators as their primary source of energy, while the remaining 26% comes from grid and other sources. It is also understood that most of the generators used in the sector are of good condition. Their maintenance schedule was found to be satisfactory. The quality of air filter and fuel filter were good. Besides, the inspection program on generator took place almost in every month to check their efficiency levels and overall conditions.

Practically the exhaust gas of generator can be further used to run other machines such as exhaust gas boilers and absorption chillers. In saves a huge amount of energy every year. The study also found that 51% of the generators using primary source have waste heat recovery system. As a waste heat recovery opportunity, which is also known as cogeneration technology, exhaust gas of generators can be used for boilers and chillers. Different studies showed that a 1MW generator can produce much exhaust gas to run a boiler of 750 kg and a chiller of 250 RT. So we can put a system wherever possible to use much exhaust gases produced by industrial generators.

Table 15: Boiler Technical Scenario

Boiler Technical Scenario	Yes	No
Statistics of Economizer in Boiler	23%	77%
Condense Recovery Statistics	71%	29%
Statistics of Feed Water Treatment	70%	30%
Statistics of Blow down System	7%	93%

Similarly, an economizer is a heat exchanging device which use heat from flue gases to raise the temperature of inlet feed water. As a result less fuel is consumed and the overall efficiency can be improved. A boiler's overall efficiency can be improved up to 12% by installing economizers. It was also found that 77% of the boilers had no economizers, while the remaining 23% has this energy saving device.

Condense recovery is a process to reuse the hot water extracted from steam that has been used. This hot water later gets mixed with feed water and higher water temperature can be achieved. As a result less quantity of fuel is needed to heat the water to get desired steam output. Besides, the hot water from steam used have remarkably less TDS (Total Dissolved Solids) and other impurities. So it almost needs no further water treatment to use again. We can understand that, only 71% boilers have condensed recovery system while the remaining 29% water extracted from used steam get wasted.

Feed water treatment is very important process for boiler safety operation. Normally water contains dissolved and undissolved salts, solid particles, etc. While we put directly normal water in boiler to produce steam without proper treatment, this salt and solids form scaling on the body of the boiler. This scaling is responsible for corrosion of boiler tube and reduction of heat transfer. As a result it can be lead to major problem and low efficiency. In this study it is found that 70% of the boilers had feed water treatment plants, while the remaining 30% used normal water without any kind of treatment process.

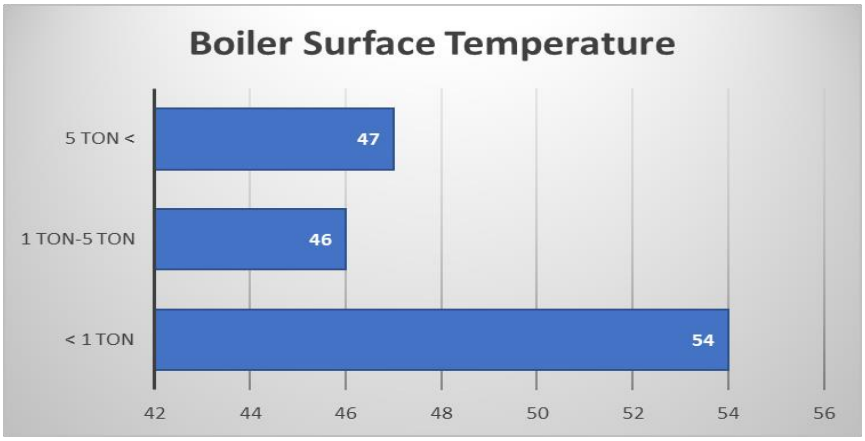


Figure 12: Boiler surface temperature

Boiler surface insulation used in the RMG sector is very important to restrict the boiler heat to be extracted. Because the more dissipated by boilers, the more heat energy get wasted. From the analysis it is observed that average temperature of the boilers whose capacity is less than 1 ton is 54°C, between 1 to 5 tons is 46°C, and more than 5 tons is 47°C. A boiler surface temperature needs to be kept within 10 degree plus around the room ambient temperature to reduce energy loss. Here to reduce energy loss from the surface we can recommend good surface insulation system.

Table 16: Air compressor types

Type of air compressor found	
Piston Type	19%
Rotary Screw Type	81%
Availability of inverter technology:	
Yes	55%
No	45%

Air compressor is one of the important most techniques used in garments factories. Most of the factories use rotary screw type of air compressors than piston type air compressors. Generally the capacity of rotary screw air compressors is higher than that of piston type air compressors. In this study it is found that approximately 81% of the compressors were rotary screw air compressors, while the piston type air compressors was only 19%. Most composite factories with knitting section are found to choose rotary screw type compressors over piston type compressors. Also it is found that traditional piston type compressors use no inverter technology. So it is good to replace piston type compressors with screw type compressor.

Again, approximately 55% of the compressors are found to use inverter technologies. Using inverter technology in compressors proved to be more efficient and cost effective. Although inverter sizes vary with the size of induction motors, air compressors with more capacity also have bigger inverter size.

Another technology i.e. air vessels, commonly referred to as receivers or tanks are used to store compressed air before it enters into the piping system and or equipment. In simpler terms, air receivers act as a buffer mechanism between the compressor and the fluctuating pressure caused by the changing demand. Air compressors can be run without a vessel in theory, but not having one in the air system that can increase loading and unloading cycles on compressors making them to work harder. It is important to remember that load/unload cycles depend on demand fluctuations within the facility. In this study, no waste heat recovery system was found. Generally in a compressor, about 85% of total energy is lost due to heat dissipation and other system loss. Different study and research proved that this heat could be used for other process, such as boilers' pre-water heating, dyeing process, etc. by proper recovery.

From the present study it is also understand that only 30% pumps used in dyeing factories use inverter technology. Inverter technology can save up to 50% of the energy in a system. So inverter technology can be recommended for the remaining 70% of the dyeing factories to save energy from pump use.

Similarly, sewing machines are widely used in the garments industry. The old modelled sewing machines use clutch motors, while the newer models use servo motor. It is understood that servo motors consume approximated 25% less power than clutch machines. In this study it is found that 66% of the sewing machines used were servo motors. It means that the remaining 34% of the sewing machines can be replaced with the servo motors.

5.3.3 Energy usage intensity (EUI)

The EUI measured for each productive section of a garments factory has been calculated as ratio of energy consumption of each section with production output. A higher value of EUI means a section is less energy efficient. Generally, the readymade garments industry has three common sections: cutting, sewing and finishing. Depending on the business types some other sections could also be included like knitting, printing & embroidery, washing, and dyeing & printing. It was found that most of the factories had just the cut to finish section

including knitting section. Dyeing, printing and washing sections were available in the medium & large composite factories only.

Table 17: Energy Usage Intensity (EUI)

Product (Unit)	For T-Shirt			Woven Shirt		
	Large	Medium	Small	Large	Medium	Small
Knitting (KWH/Ton)	668.9364	202.3373	-		-	-
Dyeing (KWH/Ton)	449.0303	-	-		-	-
Washing (KWH/Ton)	32.77653	-	-		-	-
Printing & Embroidery (KWH/Pcs)	0.121669	0.0211	-	0.291145	-	-
Sewing (KWH/Pcs)	0.185194	0.242757	0.1612	0.027	-	0.27715
Cutting (KWH/Pcs)	0.02138	0.010932	0.01129	0.16952	-	0.0222
Finishing (KWH/Pcs)	0.05156	0.033564	0.074834	0.47232	-	0.15694

Table 17 above shows the energy usage intensity for small, medium and large factories by product categories. It is found that most common products are knit T-shirts and woven shirts. For knitting section large factories had EUI value of 668.9364, which is followed by medium factory with 202.3373. Although large factories have bigger production units, but their power consumption method and awareness are not good enough.

In the case of dyeing and washing factories huge electricity and water are required to accomplish the operation processing. Only large-scale factories possess dyeing and washing units. The EUI values found for the large dyeing and washing units were 449.0303 and 32.77653, respectively. Most of the designs and logos printed on t-shirts and shirts are carried out in printing and embroidery section. The study found a few factories which have this section. It is estimated that all types of factories have almost similar EUI value, but it's slightly higher for large woven factories with 0.291145.

Usually sewing, cutting and finishing are known as garments section. These three sections always present together in a factory. In these three sections sewing sections have higher EUI compared to other two sections, as sewing machines are compulsorily needed. For t-shirts medium sized factories have higher EUI value of 0.242757 compared to the large and medium factories. It is found that medium sized factories are less concerned about sewing section compared to the large and small factories. Besides, most large and small factories also

prefer servo motors over clutch motors for their sewing machines, which is the least concerning issue for medium factories.

For both knit t-shirts and woven shirts EUI of cutting section are almost same, but slightly higher for woven large factories with a value of 0.16952. After cutting and sewing, products are delivered to finishing section for their final touch before going for packing. The main equipment in finishing section is iron machine which could be either steam driven or electrically powered. But this study found that almost 95% of the iron machines run on steam generated by boilers, which is more efficient compared to electricity powered iron machines. The overall EUI is found satisfactory for finishing section in almost all types of factories.

The mean carbon dioxide emission equivalent (tCO2e) was seen the highest in the large factories and the lowest in the small factories. The larger factories are found to have a significantly higher carbon emission rate as they are typically known to contain wet processing units. However, if small and medium factories are compared, the difference is not as significant.

5.3.4 Energy management scenario

The energy management scenario in the RMG industry can be reflected through Figure 13. While most factories have a hold on the most basic aspects of management when it comes to machinery usage, but as technological advances come in, there is a lack in know-how of energy management.

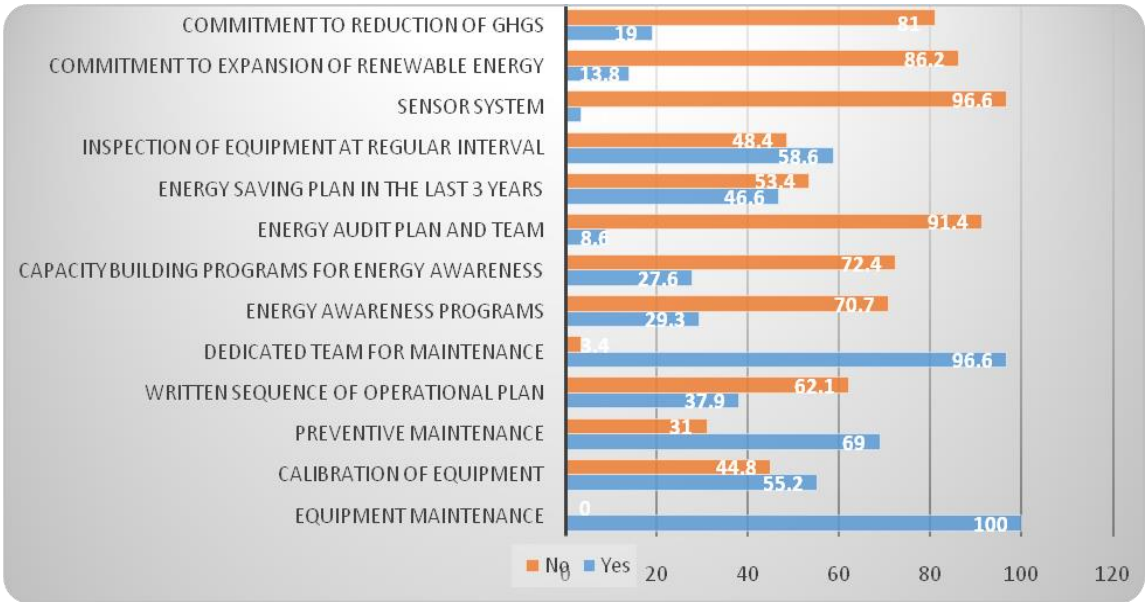


Figure 13: Energy Management Scenario

Based on the study outcomes, we can say that almost all factories have a dedicated team for maintenance (96.6%), preventive maintenance is being done by most factories (69%), and all equipment is usually calibrated (55.2%) and inspection is done on a timely manner (58.6%). However, very few factories have a written operational plan (37.9%).

The landscape of the RMG industry changed has also brought newer opportunities and challenges. This requires technical manpower upgrade, and currently there exists a lack of skilled and technical manpower in the industry. Only 27.6% of the technical manpower is susceptible to training programs, and even then the trainings conducted are internal in nature, not accredited ones. Similarly, for lower management, there is a little awareness about trainings when it comes to energy efficiency (29.3%). Minuscule amount of factories conduct energy audits (8.6%), and even after the energy audit is done by them, most factories in this range do not have a functional energy audit team. Energy saving plan has also been done by some factories (46.6%), and there is very little commitment to expansion of renewable energy technologies (13.8%) and a commitment of reduction of greenhouse gas emissions (19%).

Large factories are seen to have a hold on their management higher than that of medium and small factories. However, small and medium factories require more attention when it comes to energy management. Factories are acquiring new technologies, but there is a lack of proper implementation in the industry. There is a struggle towards understanding new technologies, and studies suggest that the energy usage and production in Bangladesh are inefficient due to outdated technology and economic constraints to achieve maximum efficiency. Thus there must be sector specific changes to the energy policy framework in the RMG industry of Bangladesh.

5.4 Work environment and workplace safety

5.4.1: Compliance issues and factory certification

Work environment and workplace safety concerns are some of the major compliance issues that the RMG industry in Bangladesh, particularly after the famous Rana Plaza accident happened in 2013, has been addressing quite smoothly as the overall progress in this context is remarkable. It is of course an additional cost burden for the industry, but considering international labour standards and labour rights issues in mind, the RMG sector needs to address these concerns with due attention. This section has been dedicated to understand the issues concerned with an objective to understand their current status and identify possible loopholes that need to be addressed in case if factories are considered for greening.

Table 18: State of factory certification

Has your factory received any certificate on the following?	Large	Medium	Small
ISO 14001	55.0%	41.7%	11.1%
Occupational health and safety	30.0%	20.0%	11.1%
A written environment policy	95.0%	90.0%	88.9%
Environment risk management plan	65.0%	66.7%	33.3%

The highest ISO-140001 certification rate of 55 percent is observed in the large factories, followed by the medium 41.7 percent and small 11.1 percent. A written environment policy is observed high among all categories of factories. The medium-sized factories have the higher rate (66.7%) of environmental management plan compared to the large (65.0%) and small (33.3%) categories of factories.

Table 19: State of the factories meeting the fresh air requirements in different working zones

Working Zone	Large Factories	Medium Factories	Small Factories
Office space	47.6%	47.1%	27.8%
Finishing	85.7%	82.4%	100.0%
Dyeing	38.1%	11.8%	0
Go down (raw)	76.2%	64.7%	50.0%
Sewing	90.5%	88.2%	100.0%
Knitting	42.9%	41.2%	22.2%
Washing	28.6%	11.8%	11.1%
Godown (finished)	47.6%	58.8%	50.0%

It is observed that for the large factories, about 90 percent of their sewing sections met the fresh air requirements followed by the finishing (85.7%), godown (raw) (76.2%), office space (47.6%), godown (finished) (47.6%), knitting (42.9%), dyeing (38.1%), and washing (28.6%) sections. In the case of the medium-sized factories, about 88 percent of the sewing sections met the fresh air requirements followed by the finishing sections (82.4%), godown (raw) (64.7%), office space (47.1%), godown (finished) (58.8%), knitting (41.2%), dyeing (11.8%), and washing (11.8%). In case of the small factories, the highest percentage of fresh air requirement was observed in the finishing (100.0%) and sewing (100.0%) sections, followed

by godown (finished) (50.0%), godown (raw)(50.0%), office space (27.8%), knitting (22.2%), and washing sections (11.1%).

Table 20: Meters at sewing section by the surveyed factories

Item	Large	Medium	Small
CO_2	22.2%	12.5%	12.5%
Temperature	94.4%	62.5%	75.0%
Particulate matter	27.8%	0	0
Humidity	100.0%	62.5%	25.0%
Sound	61.1%	50.0%	37.5%

In the case of the large factories, almost 100% of the factories were found to installed humidity meters followed by temperature meters at 94.4% percent, sound meters at 61.1%, Particulate Matter at 27.8%, and CO_2 meter at 22.2%. In the medium categories of factories, the highest percentage of installed matters was temperature and humidity (100.0%) meters, followed by sound (50.0%), and CO_2 (12.5%) meters. In small factories, the highest percentage of factories installed meters was temperature (75.0%), followed by sound (37.5.0%), humidity (25.0%), and CO_2 (12.5%).

Table 21: State of the factories having permanent entryway system

Type of Answer	Large	Medium	Small	Overall
Yes	86.4%	52.9%	42.1%	62.1%
No	13.6%	47.1%	57.9%	37.9%

It is essential for every factory to have permanent entryway system at least 10 feet (3 meters) long in the primary direction of travel to capture dirt and particulates entering into the building. From the survey, it was observed that 86.4 percent large factors have rubber mats, compared with the medium-sized factories having 52.9 percent rubber mats, while 42.1 percent was found in the case of the small factories.

Table 22: State of waste segregation facilities by the surveyed factories

Type of Answer	**Large**	**Medium**	**Small**	**Overall**
Yes	95.5%	64.7%	78.9%	81.0%
No	4.5%	35.3%	21.1%	19.0%

From the above table, it is observed that the majority (95.5%) of the large factories had the segregation of all types of solid waste facilities, followed by the medium (64.7%) and small factories (78.9%).

Table 23: Types of safety measures taken by the factories

Type of Safety Measure	Large	Medium	Small	Overall
Free aisle	95.2%	87.5%	72.2%	85.5%
Bucket	100.0%	93.8%	100.0%	98.2%
Axe	95.2%	100.0%	94.4%	96.4%
Hand gloves	95.2%	100.0%	100.0%	98.2%
Sprinkler	57.1%	6.3%	16.7%	29.1%
Smoke Detector	100.0%	93.8%	88.9%	94.5%
Hose pipe	100.0%	93.8%	100.0%	98.2%
Blanket	95.2%	100.0%	100.0%	98.2%
Spade	90.5%	100.0%	88.9%	92.7%
Extinguisher	100.0%	100.0%	100.0%	100.0%
Fire alarm	95.2%	93.8%	94.4%	94.5%

From the Table- 23, it is found that most of the factories had the required and necessary fire safety measures; while all the factories surveyed (100.0%) had the fire extinguishers. The survey findings also suggest that the service ability of theses factories was also found to be quite satisfactory.

6. FEASIBILITY OF THE GREEN RMG INDUSTRY IN BANGLADESH

Recently, the number of green factories is increasing at a significant rate as the global retailers are looking for eco-friendly apparel manufacturers. Consumers around the world are showing growing interest on buying green products considering the effect of production and consumption on the environment. The green initiatives taken by the RMG sector in Bangladesh in recent years has improved the global image of the RMG industry significantly. Green factories have taken the sector to a new height in terms of environment-friendly manufacturing and compliance issues for the country. Most importantly, it promotes the Bangladeshi branding around the world. Though the cost of setting up a green factory is more than that of a regular one, but its long run payback is worthy enough to overcome the initial cost. It is reported that a green factory uses 40 percent less energy, 41 percent less water and emits 35 percent less carbon compared to a regular RMG factory. One of the obvious advantages of green industrialization in recent year is the increasing trend of investment taking place by attracting more foreign direct investments in the country.

Green industrialization plays as a key role to ensure sustainable industrial development. Though green industry was a new concept in recent past, but the infliction of this concept is been rising widely throughout the world. The green industrialization process mainly focuses on air, water and energy issues that help to achieve the Leadership in Energy and Environmental Design (LEED). Thus it automatically ensures long term economic benefits as well as environmental sustainability.

At present, there is no viable alternative to go green approach in terms of market potentiality and resource efficiency. As the availability of resources are limited and the negative externalities that are generated everyday through ever expanding economic activities, including from the industrial activities are destroying nature's assimilative capacity, if we fail to take immediate steps in making a balance between economic activities and minimization of resource misuse and generation of wastes, then the question of sustainability and long term profitability will be under serious threat. It is thus important that necessary steps are taken to explore the possibility of reaping the benefits from green industrialization.

The prospect of green industry in Bangladesh is huge as there is no viable alternative to sustainable business. The future development and sustainability of Bangladesh's RMG sector largely depends on the market and product diversification. The sustainability of competitive

position of this sector in the global market depends on how successfully this diversification can be done. In this sense, green industrialization can attract more consumers throughout the globe considering consumer preferences towards green products are increasing fast. In contrast, the market will be remaining squeezed among the traditional geographical locations. Another approach to explore market potentiality is cost minimization and thus ensuring higher profit margin. Green industrialization process can exercise proper management practices to arrest misuse of water, energy, chemical and other resource use. Although this process may raise the installation and operation costs in short run, but with production efficiency, cost minimization and sustainability in the long run will supplant costs. Further, green initiatives also ensure reduction of wastewater, conservation of natural resources, improvement of air and water quality and protecting biodiversity and ecosystems. This process makes the indoor environment healthy and comfortable and thus can ensure higher level of worker satisfaction and motivation to contribute more. Moreover, less absenteeism of workers for healthy and safety working condition also minimizes production cost indirectly.

Keeping mind the basic objective of this study to undertake the feasibility of greening the ready-made garments industry of Bangladesh by analyzing its strengths and identifying possible gaps that can be filled-up to make the industry a more green one, both technical and market feasibilities are conducted and this section has reported the findings from these analyses.

6.1 Technical feasibility for green RMG industry in Bangladesh

Technical feasibility is the study of a project in terms of its inputs, processes, outputs, fields, programmes and procedures that are required to undertake possible changes in any factory. An assessing of the green industry feasibility without a clear understanding of the technical requirements that are essential would be a difficult task. Thus the study makes the following detailed assessment of the technical feasibility based on the outcomes of the survey on 58 factories of three categories from 3 regions:

Table: *24* Assessment of technical feasibility by the RMG industry for greening

Green RMG Sub-sectors	**Required Technological Supports**	**Availability of Technologies**	**GAP/Comment**
Building and Structural Integrity	Greening a factory require a well documentation in several steps to build	Bangladesh National Building Code (BNBC) meets the requirement for	Most of the factories maintain well documentation and follow the BNBC in

Green RMG Sub-sectors	Required Technological Supports	Availability of Technologies	GAP/Comment
	structure, environment friendly building materials and conventional building strategy which is available in country.	process. Standard environment friendly building materials are also available in Bangladesh. Furthermore, the building strategy is now using modern machineries as well technology.	building structure. Small factories require some retrofitting support as well proper monitoring whether they follow the BNBC procedure.
Production Techniques	For greening a factory requires such technology which will ensure the efficient use of resources like energy, water, chemical etc. as well as ensure the productivity.	Modern machineries & equipment are available for different process of RMG Industry like Knitting, Dyeing, Cutting, Sewing, Finishing, ETP etc.	Most of the factories are not still up to the mark in terms of green/modern technology. On the other hand factories are not maintaining documents.
Work Environment & Work Place Safety	Equipment of ducting channel with air injection fan unit for fresh air solar controlled Low E Glass ISO 1401 and OHSAS 1801 training facility Air temperature meter, radiant temperature meter, hygrometer Rubber mat and eco-friendly chemicals	Available in Bangladesh but all duct channel equipment are imported Solar controlled Low E Glass is available in Bangladesh but the price is three times higher than the regular Glass and it has also to import. ISO 1401 and OHSAS 1801 training provider is available locally Air temperature meter, radiant temperature meter, hygrometer all measuring equipment are imported Rubber mat and eco-friendly chemicals are available locally.	Some equipment are needed to be imported from abroad.

Green RMG Sub-sectors	Required Technological Supports	Availability of Technologies	GAP/Comment
Water Use and Management of Waste Water	Efficient toilet fixtures for domestic usages; Efficient water basin fixtures; Water valves, fitting and pipes; Filtration/Fire Sprinkler system; Rainwater conservation and preservation technologies; Water Trigger Nozzles; Chemical auto dosing and low liqueur ratio technologies; Stream line Installation; Water flow meter; ETP inlet and outlet flow meter.	95% factories excluding the efficient fixtures and fittings; Stream line installation technologies are available; 31% factories meet the water metering requirements; Maximum number of factories does not use the ETP outlet metering.	Lack of toilet and water basin fixtures and fittings; Lack of sufficient capacity of using the 3Rs mechanism to reduce the groundwater extraction; Lack of rainwater conservation and preservation technology; Lack of system leak detection; New and emerging technology.
Boiler	Economizer Automatic blow down	Without economizer Manual blow down	Economizer should be used with each boiler more than approximately 1 ton. Automatic blowdown reduce boiler risks and increase overall efficiency.
Air Compressor	Inverter	Rotary screw type compressor without Inverter.	Inverter helps compressor to consume less energy by allowing it to operate at variable speed.
Lighting	LED Light	Mostly use Fluorescent light sources.	LED reduces energy consumption but provides the same luminous.
Cooling Management	Air Conditioning system with VRF technology	Air Conditioner with R22 or similar types refrigerant	Use only refrigerants that have an ODP of zero and GWP of less than 50 for Refrigerant.
Cogeneration	EGB Absorption Chiller Heat Exchanger	EGB and absorption chiller found in few factories	Exhaust gas from generator could be used for running EGB/Absorption chiller, thus reduce energy consumption.

Green RMG Sub-sectors	Required Technological Supports	Availability of Technologies	GAP/Comment
			Jacket water from generator could be used for heat exchanger.
Renewable Energy	Solar Energy	Grid Power Natural Gas Diesel	As per LEED criteria, to achieve the minimum credit for renewable energy, 1.5% of total energy should be generated from renewable energy sources.
Machineries	Servo Motor Inverter Technology	Servo Motor Clutch Motor Machines without inverter.	Servo motor is practically more energy efficient than clutch motor. Induction motor in heavy machineries could be used with inverter technology for less energy consumption.

A brief summarization of the above table can make it easier that in number of areas like green production techniques, safety equipment, modern technologies for water use and conservation and other technical supports for boiler, air compressor, lighting, cooling machine, technologies for renewable energy and rainwater harvesting, etc. the industry needs additional supports as the cost of such measures may create additional burden on the industry and thus makes its less competitive.

6.2 Market feasibility for green RMG industry in Bangladesh

A market feasibility study may ideally undertake issues related to the present market structure, future market possibilities, competition, potential changes in demand and pricing and projection related to sales and revenue, etc. It is basically conducted to understand the market possibilities before launching a new product or undertaking any initiative that requires positive market feedback or may have the possibility of backfire from the market. For the present study of the possibility greening the RMG industry of Bangladesh, a detailed market feasibility assessment has been carried out and the outcomes are presented below:

Table-25: Market feasibility of green RMG industry in Bangladesh

Market Feasibility	Current Status	Expected Outcomes
Market potentiality	Strong market potential exists with growing concern of both market expansion and product diversification	Lead market competitor China is leaving market share and Bangladesh will focus on this. A substantial market expansion could be attained
Competitiveness	(i) There is a positive relationship between green industrial investment and the competitiveness of RMG products to the global buyers (ii) 'go green' is economically feasible but not financially (iii) green industry incremental cost increase up to 20 percent to 22% percent (iv) For the economic sustainability of a green industry, going green will incur 15% to 20% more investment that may varies project to project at the same depending on certification level	As Producers are concerned on Greening and if buyers give the proper valuation of green product then in price and cost competitiveness, Bangladeshi RMG products will be leading in world apparel market
Pricing	• Global apparel retailer's believes are lying on energy efficient manufacturing process rather green production which will be more efficient and competitive • This buyers are not paying premium price for maintaining the green production method	Strong negotiation and price bargaining with global buyers through RMG producers' association and government could stable the price oscillation and make sure proper pricing of green manufactured products
Branding	Green manufacturing technology and production process in the factories is creating an image based on trust, awareness, uniqueness, and appeal to the globally celebrated apparel brand retailers	Possibility of high value addition by greening the RMGs which will create positive brand value to global consumers

6.2.1. The price-cost competitiveness of the RMG industry in Bangladesh

The price-cost competition of an industry defines how efficient the factory is to produce quality output with optimal costs; and for this, they could grab the highest export all over the world. The buyers are price sensitive and they always seek for comparative low prices with the best qualities. As a result, the RMG industry has to get the competitive advantage rather

than the comparative advantages from their exports. Producers' have to consider the production costs to get optimal revenue from exports.

In trade off, every buyer wants to buy his or her products at lower price from the world market. Since the first export of Bangladesh RMG industry, it is delivering the products with the lowest price. However, in recent years there seems an anomaly in leadership of price competitiveness. The cost competitiveness indicates the export of goods in less cost of production than the other exporter countries all over the world.

The cost of production depends on how cheap the mode of production of an economy. If the cost of per unit production increases it will affect the final price of that good. As a result, the producer will fail to compete with low cost production and thus they will be considered as *less cost competitive* and vice versa.

As Bangladesh RMG industry is labor intensive and there is an abundance of labor forces with reasonable price, the cost of production is comparatively lower than other countries. Nevertheless, because of the developing economic conditions and increasing life standard of country people, the minimum wage rate has increased. This could affect the cost competitiveness of Bangladesh RMG producers.

The study reveals a positive relationship between green industrial investment and the competitiveness of RMG products to the global buyers. The owners of the green factories claimed that green industrialization have a prosperous future in world trade. They consider it as an ethical industrialization considering the environment that ensures the safety of the environmental ecosystem by saving money and exaggerating human well-being. The green industrialization has also importance for a sustainable industrialization towards a sustainable development from the government's end. It is also found that from the business point of view, green industry is not a viable option for all categories of firms. In the short run, green industries are cost consuming with a long payback period. It is understood that 'go green' is economically feasible, but not financially, because green industry incremental cost increase up to 20 percent to 22% percent. Thus, in the short run, the production cost of green industrial goods may become high and in the long run may start declining.

The textile and readymade garments industry market is mainly driven by price. Most of the final consumers are not so much concerned about how the product has been made rather than its quality and price. Nevertheless, the buying firms or brand promoters ask for the most

complaint factory to source their product. The scenario has changed a little bit at present day. Consumers are now expressing their concern about the environment and social norms. Therefore, producers can add a special level on their product to charge more prices through proper marketing and negotiation.

6.2.2 Pricing of green RMG products

Role of associations in product pricing

Associations can impose a rule that member factories have to practice green mechanism in their production process. Associations may argue to the global apparel buyer to increase the product prices that will motivate more and more factories to be motivated to embrace green industry as part of their commitment towards sustainability. The industry associations may also take initiative for promoting purchase of green products, encouraging measures that improve green supply chains, and better informing consumers on carbon and waste issues. Besides increasing price from the global buyers, associations may also offer other measures in the form of awards and discounts in yearly membership to members who achieve green building certificates to encourage and motivate them to take steps in greening their factories.

Marketing for better price for green RMG products

Green marketing became popular in Europe in the early 1980s. Companies advertise and promote recyclable, refillable and ozone and environment –friendly products. These companies applied green marketing strategies to promote consumer goods, industrial goods and even services (Li, 2008). It is understood that in a long-range view, the cost of production does not necessarily increase through the adoption of green factory management, instead it decreases long run cost and thus profit margin. While adopting green production management, factories attempt to minimize waste of all types and other negative externalities, and thus generate positive social benefits. There is ample scope for Bangladesh's RMG sector to undertake initiatives for making green production strategies.

More awareness building programs have to be taken to raise responsiveness about the green concept among the entrepreneurs. Required policy and financial supports from the government can be incorporated to pave the way for making this strategy successful. In the same time, the education quality has to be increased to a certain level. More technical and skilled manpower and financial analyst will be required for retaining the trend in future.

Furthermore, the labor right related i.e. working condition and workers right should be included in the greening practice which is so far absence in existing format. Most importantly, buyers have to come forward to make this movement effective. For this reason, a strong commitment from the buyers' forum is necessary to get the fair price for a product made by the green factory.

6.3 Branding

Green garments manufacturing is created from resources that are environment-friendly and sustainable. Consumers are likely to prefer those companies that produce and supply green products as they contribute to preservation of the environment and ensure sustainable use of environmental resources. Thus in today's world for any export-oriented sector like the RMG in Bangladesh, creation of brand names is very important as it may help them to ensure higher global demand and also create opportunities for negotiating better prices. Going green in the RMG sector in the country thus is an issue that needs to give high priority.

According to the study, Bangladesh knitwear sector is maintaining the environmentally friendly technology and manufacturing process to supply the garments to the global apparel retailers. Through maintaining green manufacturing process Bangladesh knitwear sector add value to the brand value of those retailers to taking care of the environment and people.

It is found that Adidas, Gap, Esprit, H&M, Nike, Puma, C&A, Primark and others global apparel brand marketers are making firm commitments to partially or totally eliminate the use of toxic chemicals in clothing manufacturing by the end of 2020. The green manufacturing process in the Bangladesh Apparel industry leads to sustainability and competitiveness to the factories, Global apparel brand retailer and other respective stakeholders of the industry.

Bangladesh apparel industry through adopting the green manufacturing technology and production process in the factories is creating an image on the basis of trust, awareness, uniqueness, and appeal to the global apparel brand retailers.

7. SCORING FOR LEED CERTIFICATION AND THE CURRENT STATE OF BANGLADESH'S RMG SECTOR

Country's RMG industry under the present study is assessed based on the LEED v4.1 certification process. Unfortunately, no factory taken under this study is found to meet all the pre-requisites which are mandatory for LEED certification[5]. The LEED pre-requisites are given below:

Table-26: List of the pre-requisites for LEED certification for the Bangladeshi RMG units

Sl	Major Areas	Pre-requisites
1	Sustainable Site	Site Management Policy
2	Water Efficiency	Indoor Water Use Reduction Building-Level Water Metering
3	Energy and Atmosphere	Energy Efficiency Best Management Practices Minimum Energy Performance Building-Level Energy Metering Fundamental Refrigerant Management
4	Materials and Resources	Ongoing Purchasing and Waste Policy Facility Maintenance and Renovations Policy
5	Indoor Environmental Quality	Minimum Indoor Air Quality Performance Environmental Tobacco Smoke Control Green Cleaning Policy

Table-27: Current status of the factory according to USGBC guideline

	Large		Medium		Small		Total	
	Owned	Rented	Owned	Rented	Owned	Rented	Number	Percentage (%)
20-29	2	2	8	4	2	16	34	58.62
30-39								
Certified (40-49)	12	2	3	2		1	20	34.48
Silver (50-59)	4						4	6.90
Gold (60-79)								
Platinum (80-110)								

[5] Excluding those factories that already have LEED certification.

	Large		Medium		Small		Total	
Total number	18	4	11	6	2	17	58	
Percentage (%)	31.03	6.90	18.97	10.34	3.45	29.31		100.00

Large factories are in good position among the large, medium and small factories. About 60% of the factories needs more renovation work to be certified into green industry. 34.48% factories are in certified level, 6.90% are in silver certification level. These factories can be platinum certified if they can put extra cost in water consumption and energy use sections, while 70% of the medium factories are below certification level.

For small factories, 94% factories are found to be below the certification level. These percentages can be upgraded into certified, silver or gold level through some major renovation and investments.

For the existing building operation and maintenance certification, factories do not have the written document for site management, refrigerant management, facility management and renovation policy and indoor air quality management program. The study found that most of them are not aware about the policy and the mitigation process of environmental degradation. Many of the factories do not have the metering system for water, electricity and indoor operations.

Gap analysis for converting existing factories into green factories

The study also identifies the gaps to be converted into green factory based on the existing condition of the sample factories of all the 3 categories and the requirement set by USGBCLEED certification and finally has come up with the following findings:

- large factories are in advantageous position over medium and small factories in terms of converting green ones. These factories can be platinum certified if they can put extra cost in water consumption and energy use sections;
- maximum small factories are below certification level. This percentage can be upgraded into a certified, silver or gold level through some major renovation and investments;

It is worth mentioning that having own building is crucial to convert the factory into a green one but it is found that around 47 % of the sample factories do not have own building. At this backdrop, there is needed an arrangement of special loan for the factory to buy the land.

8. INVESTMENT MAPPING FOR GREEN RMG INDUSTRY IN BANGLADESH

This section is based on the measurement and pricing of quantities on field information and/or reasonable assumptions for different overheads. The tables in this page provide a general analysis of the minimum costs required towards greening the RMG industry in Bangladesh. The tables are not absolute benchmarks but are designed to guide the stakeholders in their general understanding of the relative significance of different cost elements and cost varying factors.

8.1 Investment mapping for greening the RMG industry

Based on the information collected from the 58 selected RMG factories, the following investment mapping has been estimated with an objective to understand the gap-based need assessment. The analysis includes estimation of potential costs from all three categories of firms i.e. large, medium and small sized RMG units along with a total estimated investment.

Table 28.Investment Mapping for Greening the RMG Industry

Total Estimated Investment for Sustainable Sites					
	Potential Areas	**Average Cost (Large)**	**Average Cost (Medium)**	**Average Cost (Small)**	**Total estimated investment in million BDT**
	Site maintenance	96550143.38	66589946.93	4347868.235	3338.74
	Rooftop insulation/5 year	2512235.14	1611015.96	535725.99	92.84
	Building renovation cost	24358611.64	42463160.27	3957281.9	1332.95
	Operation cost (Average)	7750467.34	13511005.54	1259135.15	424.12
	Total Cost for Sustainable Sites	**131171457.5**	**124175128.7**	**10100011.28**	**5188.65**
Total Estimated Investment for Water Efficiency					
Water Efficiency Indicators	**Potential Areas**	**Average Cost (Large)**	**Average Cost (Medium)**	**Average Cost (Small)**	**Total estimated investment in sample factory (in million BDT)**
Indoor Water Use Reduction	Dual Flash and Low Flow Tap for Efficient Water Usages	534,204.55	119,558.82	76,578.95	15.24
	Efficient Water Fixtures	249,295.45	55,794.12	35,736.84	7.11
	Regular Monitoring for Water Consumption	25,000.00	25,000.00		0.975
	Awareness Building for Efficient Water	200,000.00	200,000.00	200,000.00	11.6

Total Estimated Investment for Sustainable Sites					
	Potential Areas	**Average Cost (Large)**	**Average Cost (Medium)**	**Average Cost (Small)**	**Total estimated investment in million BDT**
	Consumption				
Outdoor Water Use Reduction	Proper Monitoring of Water Valves, Fitting and Pipes to Reduce Water Leakages	1,000,000.00	800,000.00	700,000.00	48.9
	Developing Rainwater Conservation and Preservation System	500,000.00	500,000.00	500,000.00	29
	Reuse WTP Backwash Water	65,000.00	65,000.00	65,000.00	3.77
	Car Wash	15,000.00	10,000.00	15,000.00	0.785
	Installation of Water Trigger Nozzles for Cleaning Purpose in Washing/Dyeing Areas	10,000.00	10,000.00	10,000.00	0.58
	Insulation Stream Line for Reducing Water Consumption	2,500,000.00	2,000,000.00	1,200,000.00	111.8
	Auto Chemical Dosing System for ETP	1,000,000.00	1,000,000.00		39
Water Metering	Installation of Central Water Meters	3,000.00	3,000.00	3,000.00	0.174
	Installation of Water Flow Meters Meters	10,227.27	6,705.88	3,789.47	0.41
	ETP Inlet and Outlet Flow Meters	3,000.00	6,000.00		0.168
Total Estimated Investment BDT for Water efficiency		**6,114,727.27**	**4,801,058.82**	**2,809,105.26**	**269.51**
Total Investment for Energy Efficiency					
Energy Indicators		**Average Cost (Large)**	**Average Cost (Medium)**	**Average Cost (Small)**	**Total investment in Million BDT**
	Sewing Unit (Servo Motor)	11122727.27	4705882.353	3563157.895	392.4
	Economizer (Boiler)	650000	282352.9412	0	19.1
	Insulation (Boiler)	1159090.91	294117.6471	0	30.5
	Feed water Treatment (Boiler)	4545.46	11764.71	136842.11	2.9
	Automatic Blow down (Boiler)	75454.55	64705.88	12105.26	2.99
	Compressor	354545.46	89411.77	50526.32	10.28
	LED Lights	299337.27	254344.71	10526.32	11.11
	Solar Panel (Renewable Energy)	90140625	3784323.53	1127566	2068.85
	Metering System	886727.27	415529.41	1127565.79	48
	Pump (Inverter with PID Controller)	40909.09	39705.88	173263.16	4.87
	Air Conditioning System (VRF Technology)	5857272.73	910000	0	144.33

Total Estimated Investment for Sustainable Sites					
	Potential Areas	**Average Cost (Large)**	**Average Cost (Medium)**	**Average Cost (Small)**	**Total estimated investment in million BDT**
	Co-generation (EGB, Absorption Chiller, Heat Exchanger)	1490909.09	394117.65	313157.9	45.45
Total Estimated Investment BDT for energy efficiency		**112082144.1**	**11246256.48**	**6514710.755**	**2780.78**
Total Investment for Indoor Environment Quality					
		Average Cost (Large)	**Average Cost (Medium)**	**Average Cost (Small)**	**Total investment in Million BDT**
	Purchasing facility management and renovation	12500	8000	5000	0.51
	Solid waste management facility management and renovation	15000	100000	60000	3.17
	Ducting channel with air injection fan	39234250	4877095	220000	950.24
	thermal comfort	4877095.05	1404001.09	1214736.36	154.24
	green clothing	220000	102000	57000	7.66
Total Estimated Investment BDT for indoor environment		**44358845.05**	**6491096.09**	**1556736.36**	**1115.82**
Total Estimated Investment for green industry in BDT		**293727173.9**	**146713540.1**	**20980563.65**	**9354.76**

From the above table (Table 28) it is understood that on an average a large firm may require approximately 294 million taka for undertaking an initiative to convert the exiting factory into a green one. In the case of the medium and small factories, the figures are: about 147 million and 21 million TK, respectively. It is thus understood that greening the non-green RMG factories would first require investing a good amount of money for the sector. So if firms are not financially benefitted through price rationalization from the buyers end, it would not be possible for many to think about the issue quite seriously.

Table: 29 Summary of the investment mapping

Potential Areas	Average Cost (Large) (in million BDT)	Average Cost (Medium) (in million BDT)	Average Cost (Small) (in million BDT)	Total Estimated Investment (in million BDT)
Total Cost for Sustainable Sites	131.17	124.18	10.10	**5188.65**
Total Estimated Investment BDT for Water efficiency	6.11	4.80	2.81	**269.51**
Total Estimated Investment BDT for energy efficiency	112.08	11.25	6.51	**2780.78**
Total Estimated Investment BDT for ind oor environment	44.36	6.49	1.56	**1115.82**
Total Estimated Investment BDT for green industry	293.73	146.71	20.98	**9,354.77**

The total estimated cost for sustainable sites is estimated to be Tk.5188.65 million, which can mainly be attributed to new construction and retrofitting of the existing structures. Similarly, the total estimated cost for water efficiency is Tk. 269.51 million, energy efficiency is Tk. 2780.78 million, and for indoor environment quality is Tk.1115.82. This brings in a sum total of Tk. 9,354.77 million to convert the sample of the study into a green industry.

8.2 Potential areas of investment

The study also has tried to identify the major gaps that need to be fulfilled for undertaking any attempt towards greening the country's ready-made garments industry. The flowing tbale presents the summary of the research findings on the potential investment requirements by the RMG factories of for their major areas of greening initiatives:

Table-30: Potential investment areas

Building & Structural Integrity	Small and rented factories are structurally vulnerable.	Small and rented factories need more investment for structural integrity.
Energy Use and Efficiency	• Installing economizer, condense recovery system, water softener plant and automatic blow-down, air compressor and water pump with inverter technology in the boiler. • Replace existing clutch motor with a servo motor in the sewing section • Installing chiller, separate sub-meter for energy tracking, solar or others renewable energy source	• Installation of economizer have become more economical as energy prices are increasing and smaller, lighter and more durable economizers have been developed. • Exhaust gas from generator could be used for running EGB/Absorption chiller, thus reduce energy consumption. • Jacket water from generator could be used for Jacket water chiller/heat exchanger for heating purpose. • Induction motor in heavy machineries could be used with inverter technology for less energy consumption.
Water Use and Waste Water Management	• Lack of efficient fixtures and fittings • Lack of sufficient capacity (3Rs) to reduce the use of groundwater; • Lack of rainwater conservation and preservation; • Lack of system leak detection; • Lack of proper chemical management. • New and emerging technology.	• Water mapping is needed to comply with green industry requirement. • Some conventional water fixtures and fittings can be replaced • Water consumption can be reduced by process modification. • Fill drain process applied. • Use unused hot water in boiler feed tank.
Work Environment & Work Place safety	• Lack of ducting channel with air injection fan facility in top and mid-level management rooms • Solar controlled Low E Glass for thermal comfort • Insufficient Training on ISO 1401 and OHSAS 1801 • Waste management	• Import of ducting channel with air injection fan • Import of solar controlled Low E Glass for thermal comfort • Training of ISO 1401 and OHSAS 1801 for mid and top level management by locally.

9. CONCLUSION AND RECOMMENDATIONS

9.1 Major Findings

Ownership of buildings and different section of factories

Building ownership is one of the perquisites for the entrepreneurs to convert their factories into green ones. From the study, it is found that 46.55% of the studied factories did not have own building, The sampled factories reported different sections as - about 34.48% knitting, 84.48% cutting, 93.10% sewing, 94.83% finishing, 18.97% dying, and 13.79% dye-finishing and printing sections. It is quite difficult for those factories that are housed in rented accommodation as conversion of green buildings and structural changes are essential for making a factory green one.

Water efficiency

Bangladesh RMG industry is overwhelmingly dependent on the use of groundwater to meet its water demand. In the study, it is found that 82% of the RMG factories were solely dependent on groundwater whilst others used groundwater combined with harvested rainwater and processed water. When it comes to region wise water consumption source pattern, factories in Dhaka region consumes the maximum share of domestic from groundwater, whilst factories in Narayanganj and Chittagong used the maximum amount of processed water for domestic purpose. Similarly, for water tracking systems Dhaka region was found to have the number of factories using water tracking system is 17 (large: 9, medium: 4, small: 4) out of 31 factories, whereas in Narayanganj region, the number is 11 out of 17 followed by 7 out of 10 factories. In the case of water treatment plants (WTPs), out of 15 factories, 12 factories were found to use water hardness level is found to be in an acceptable level and 3 are found to fail meeting the standard. With regard, out of 18 factories, 17 factories meet the standard and only one factory is not able to meet the standard. In the case of Iron, 11 factories meet the standard. It is also observed that the hardness level of raw water was in a critical situation which had been hampering their production process due to their unawareness. It is also necessary to mention that most of the factories do not have WTP plant. Use of ETP is of great importance in the case of the RMG factories having dying, dye-

finishing and printing sections in achieving environmental compliance regarding wastewater quality. In the study, out of 10 factories, the ETP performance, considering all parameter, was found to be satisfactory.

Energy efficiency

The use of boiler is a widely used steam generating systems in the RMG industry, account for a significant portion of the total energy consumption. Installment of economizer, a mechanical device, in boiler greatly helps in reducing energy consumption by capturing the waste heat from boiler stack gases (flue gas) and transferring it to the feed water and thereby raises the temperature of boiler feed water and then lowering the needed energy input or ensures energy efficiency. From the study, it is found that 77% of the boilers used have no economizer. Installing of condense recovery systems in boilers is more efficient than the traditional or regular ones means that condensing boilers help in reducing energy consumption, lowering energy cost, and also reducing CO_2 emissions. It is found that 71% of the boilers had no condensed recovery system. The use of feed water treatment methods remove scaling, corrosion which ensures the efficiency of boilers and improves steam quality. It is found that among the sampled factories, 30% boilers were not used with feed water treatment method. Although automatic blow-down system is more efficient than the manual ones in reducing water, energy and chemical costs through improving boiler performance, it is known that 93% of the boilers had no automatic blow-down system.

Air compressor that requires every stage of manufacturing in the RMG industry is one of the major energy consumers. Using rotary-screw air compressor requires fewer volumes of less-pressure air compared to piston compressor and thereby, a rotary-screw air compressor is much more energy efficient than that of a piston compressor. From the study, it is found that among the sampled factories, 81% used rotary screw type air compressors, whereas only 19% used piston type. Although inverted air compressor technology is considered to be more energy efficient technology globally, it is understood that in the sampled factories more than half (55%) of the air compressors had inverter technology. By using inverted technology in water pump may help overall energy efficiency by reducing the amount of energy consumption. It is found that in the dyeing section, 30% of the water pumps used had inverted technology.

In the case of factory's production techniques like sewing machine, where use of servo motors helps to consume less energy than clutch motors. The study comes up with the findings that 66% of the sewing machines used servo motors, while 34% used clutch motors. It is more efficient to use chiller than air conditioner system wherever possible. Practically using chiller is more efficient wherever the total cooling load is more than 100 tons. In the study, it is found that only 6% of the factories had cooled more than 100 tons. Using LED's over conventional lights such as CFLs, Tube Lights is more efficient. From the study it is found that in the lighting system, 72% lights used were LEDs, 24% CFLs and 4% Tube Lights. The major benefit of using sub-metering allows tracking the energy consumption in different areas of systems, but the study finds no advanced sub-metering system used by the sampled RMG factories in Bangladesh.

Work Environment and Workplace Safety

Like structural integrity, water use and energy consumption, results on work environment and workplace safety show that overall all the factories surveyed maintained basic compliance standards in the cases of fresh air requirement in different sections of factories' operation zones such as office space, finishing, dyeing, godown (raw), sewing, knitting and washing, fire safety measures, having permanent entryway system to capture is capture dirt and particulates entering into the building were found to be quite satisfactory. Most of the larger factories are found to have installed CO_2 meters, temperature meters, particular matters, humidity meters and sound meters compared to the small ones. Thus, in the case of work environment and workplace safety, the overall industry picture is better than energy use keeping in mind the green industry conversion.

9.2 Recommendations

Bangladesh's RMG industry is currently going through some sort of green industrialization revolution that is expected to bring benefits at least in the long run in terms of production efficiency, ensuring occupational health and safety of the labour including other occupants, protecting and preserving natural environment and also protecting the health of the people of the surrounding communities. But there also exists some challenges, particularly for the firms who are medium and small sized in nature in order to make the green revolution in the industry a successful one. In this sense, the study comes up with some specific recommendations to overcome the possible hurdles faced by the RMG firms on the path of

green industrialization based on the results of the field survey, FGDs, and KIIs. These are as follows:

Policy Guidance: The Government of Bangladesh may formulate a policy guideline for green industry development alongside the existing laws, rules and acts related to environment, water, electricity and energy and global standards concerning country's ready-made garments industry.

Fiscal Incentives: In order to harness the process of ongoing green industrialization, the government may allow duty-free import of the required green technologies and equipments. Incentives can also be provided to the factories which import energy efficient machineries or replace the old machineries with modern ones. Tax benefits can be provided to attract foreign direct investments in the arena of green technologies in the country's proposed 100 special economic zones (EPZs).

Financing: Allocation of sufficient amount of money in the Bangladesh Bank's Green Transformation Fund (GTF) can be made, whilst making it more accessible at affordable rates and also under easier terms and conditions for the interested RMG factories wishing to convert into green ones. The central bank may also take initiatives to impart basic knowledge about the green industry and its necessity among the concerned bank officials.

Regulatory and Compliance Issues: Government may create an institution to support the green industry development initiatives at the macro-level. The trade bodies concerning the RMG industry can provide necessary trainings and monitor the progress at the factory-level. The government may also set standards for green industry in line with international standards.

Branding and Pricing: The Ministry of Foreign Affairs and Ministry of Commerce of the Government of Bangladesh may facilitate the development of green industry by arranging awareness programs in the target markets. In order to ensure the fair price for the environment- friendly products, an effective dialogue between factory owners and buyers is of urgency to resolve the issue of proper pricing of the green products. Countries trade bodies also need to play a key role in this context, while the policy and research think-tanks can organize dialogues and raise the issue at all possible levels.

Capacity Development: The government should facilitate the creation of a pool of domestic experts (architects, structural engineers, civil engineers, electrical and mechanical engineers,

among others) to reduce the dependency on the foreign expertise. In this context a coordinated understanding between industry and educational institutions may make the task easier.

Recommendations to be implemented at the enterprise level

Installation of water tracking system needs to be used to find out water efficiency within different areas of the industrial process. Similarly, installation of water metering system in every industrial production section as well as other related sections needs to be implemented at the factory level to achieve water efficiency. Installation of water treatment plants is another area where factories need to give importance to remove various possible containments including bacteria, hazardous chemicals and other toxins to acceptable levels for safely discharging into the environment. Factories also need to install economizers, condense recovery systems, feed water treatment plants and automatic blow-down systems in boilers, while renewable energy sources such as solar energy can be encouraged to reduce the overwhelming dependency on national grid for electricity. EGBs, absorption chillers, and heat exchanger technologies can be used for cogeneration purpose. Installation of inverter technologies with air compressors and water pumps, use of VRF technologies instead of conventional air conditioning systems and advanced energy metering for tracking energy consumption in different sections also need to be reinforced at the factory level**.** Use of LED in place of conventional lights such as CFL and tube light can also minimize energy misuse**.** The entrepreneurs may also consider the green industry initiative as an investment rather than cost generating tool. For this purpose, they can audit their factories by certified energy auditors to find out energy saving scopes and make appropriate plans accordingly.

REFERENCES

Bangladesh Environment Conservation Act, 1995. Retrieved from: http://extwprlegs1.fao. org/docs/pdf/bgd42272.pdf

Chen, W., Chen, J., Xu, D., Liu, J., & Niu, N. (2017). Assessment of the practices and contributions of China's green industry to the socio-economic development. *Journal of cleaner production*, 153, 648-656. Doi doi:10.1016/j.jclepro.2016.11.065

DCED (2012). Green Industries for Green Growth. Retrieved from https://www.enterprise-development.org/wp-content/uploads/Green_Industries_for_Green_ Growth.pdf

EPA. (n.d.). Global Greenhouse Gas Emissions Data. Retrieved from https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

Ge, Y., & Zhi, Q. (2016). Literature Review: The Green Economy, Clean Energy Policy and . *Energy Procedia*, *88*, 257-264. doi: 10.1016/j.egypro. 2016.06.159

GOB (1999). National Water policy, 1999. Ministry of Water Resources, Government of the People's Republic of Bangladesh. Retrieved from http://warpo.gov.bd/sliderdetails/c3674f 62057bce14eb6a6a349000bba6.pdf

GOB (2009). Bangladesh Climate Change Strategy and Action Plan, Ministry of Environment and Forests, Government of the People's Republic of Bangladesh. Retrieved from Bangladesh%2520Climate%2520Change%2520Strategy%2520and%2520Action%2520 Plan%2520(BCCSAP).pdf

GOB (2009). Industrial Policy, 2016. Ministry of Industry, Government of the People's Republic of Bangladesh

GOB (2012). PERSPECTIVE PLAN OF BANGLADESH 2010-2021(Final draft), General Economics Division Planning Commission Government of the People's Republic of Bangladesh.Retrievedfrom:http://bangladesh.gov.bd/sites/default/files/files/bangladesh.gov.b d/page/6dca6a2a_9857_4656_bce6_139584b7f160/Perspective-Plan-of-Bangladesh.pdf

Hou, J., Teo, T. S., Zhou, F., Lim, M. K., & Chen, H. (2018). Does industrial green transformation successfully facilitate a decrease in carbon intensity in China? An environmental regulation perspective. Journal of Cleaner Production, 184, 1060-1071.

Humana, C. (2017). How green buildings can help fight climate change. Retrieved from https://www.usgbc.org/articles/how-green-buildings-can-help-fight-climate-change

Hutt, R. (2017). 9 things you absolutely have to know about global warming. *World Economic Forum. Retrieved from https://www.weforum.org/agenda/2017/04/climate-change-things-to-know/*

ILO (n.d.). International Labour Standards on Occupational Safety and Health. Retrieved from http://www.ilo.org/global/standards/subjects-covered-by-international-labour-standards/occupational-safety-and-health/lang--en/index.htm

Nelson (2014). IT PAYS TO BE GREEN: CORPORATE SOCIAL MEETS THE BOTTOM LINE. Retrieved from http://www.nielsen.com/us/en/insights/news/2014/it-pays-to-be-green-corporate-social-responsibility-meets-the-bottom-line.html

Nwokoro, I., & Onukwube, H. N. (2011). Sustainable or green construction in Lagos, Nigeria: Principles, attributes and framework. *Journal of Sustainable Development*, *4*(4),166. doi:10.5539/jsd.v4n4p166

PDB (n.d.). Development of Renewable Energy Technologies by BPDB. Retrieved from http://www.bpdb.gov.bd/bpdb/index.php?option=com_content&view=article&id=26)

SREDA & Power Division (2015). "Energy Efficiency and Conservation Master Plan up to 2030".

Ministry of Power, Energy and Mineral Resources, Government of the People's Republic of Bangladesh. Retrieved from http://sreda.gov.bd/files/EEC_Master_Plan_SREDA.pdf

UNDP, Bangladesh. Sustainable Development Goals (SDGs). Retrieved from http://www.bd.undp.org/content/bangladesh/en/home/sustainable-development- goals.html

UNFCC.(n.d.). Climate Get the Big Picture. Retrieved from *http://bigpicture.unfccc.int/# content-the-paris-agreement*

USGBC (2016). Benefits of Green Building. Retrieved from https://www.usgbc.org /articles/green-building-facts

USGBC (n.d.). Projects in Bangladesh. Directory database, 2018, Retrieved from https://www.usgbc.org/profile

Wikipedia, Textile industry in Bangladesh. Retrieved from https://en.wikipedia.org/wiki/Textile_industry_in_Bangladesh#Readymade_garment_(RMG)_industry