Technical study

Rainwater Harvesting System

Opportunities and Challenges in Apparel Industry

Final Report 15 August, 2021

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ERI has worked with 400+ textile and RMG factories at different levels of engagements under nearly all major sustainability programs in Bangladesh namely WB/IFC's PaCT/ PaCT II program, STWI program, Impact Economy's AIC program, NCCI's 3e program, Pyoe Pin, Strategic Alliance, and GIZ financed programs as well as its own NEST in Bangladesh and three international destinations- India, Myanmar, and Ethiopia. We were the lead training provider for GIZ's Chemical management program and worked with its low-interest financing SREUP program as well as HELD project for the textile sector of Bangladesh.

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WaterAid Bangladesh, a country programme of WaterAid was established in 1986 to improve access to WASH for marginalized communities living in poverty. With over 30 years of experience, WaterAid Bangladesh is one of the country's leading WASH organizations, working with communities and using affordable appropriate technologies to help meet their water and sanitation needs. WaterAid has successfully developed and implemented model approaches for providing sustainable community-managed WASH services and facilities for people living in poverty in different hydro-geological contexts. WaterAid has supported and implemented projects in all the divisions of the country. WaterAid projects concentrated mostly in districts of Rangpur, Sylhet, Khulna, Dhaka divisions of the country addressing the coastal and hilly area contexts along with the rural and urban contexts of WASH. The influencing and enabling programme of WaterAid work all over the country, taking a more learning, advocacy and influencing role on policy-level issues involving multiple domestic and international stakeholders.

Rain Water Harvesting System: Opportunities and Challenges in Apparel Sector Study Initiative

The dependence of the industrial sector especially the extreme dependence of textile and leather sectors on high water consumption leading to the depleting groundwater levels and worsening of surface water quality especially in and around Dhaka and other cities in Bangladesh, and imposing substantial pressures on the environment. In this context, rainwater harvesting as an efficient and sustainable new technology along with decentralized facilities and advocating policies is being considered as an alternate solution to address the problem since the capital-intensive water management system fails to deliver the desired benefits.

The key objective of this study is to generate meaningful knowledge on rainwater uptake prospects, constraints, and the way forward in the apparel sector with the aim to underpin the chronological development of RWH in Bangladesh with a full and comprehensive assessment of its impact and potential.

Executive Summary

A study was conducted to generate meaningful knowledge on rainwater uptake prospects, identify the opportunities, barriers and challenges, and the way forward for the adoption of the rainwater harvesting system (RWHS) by the apparel small and medium enterprises in Bangladesh. The approach followed in carrying out the assessment includes landscaping analysis/desk review and stakeholder consultations to collect qualitative data through a structured questionnaire, email communications, over-the-phone interviews, and factory visits. Along with the factories, the study considered four other stakeholders, namely: policy and/or regulatory bodies, funding institutions/financial service providers, training providers/academic institutions, and brands that could shape the adoption of the RWHS. In addition, a “representative” factory to implement RWHS was determined from the information collected from 7 factories with RWHS and 16 factories without RWHS, and detailed financial analysis including environmental and social benefits was identified. An Excel-based Estimation Tool was developed to roughly estimate the cost of implementing RWHS at a particular factory, annually collectible rainwater, GHG emission reduction, ROI, etc. to develop a business case.

The study revealed that with the current water licensing agreement, regulations, water pricing, etc., implementation of the RWHS might not get due importance based on the financials alone especially for the factories outside the EPZ; and in practice, it is almost entirely determined by the image the factory needs to build to attract buyers or to meet their requirements. It appears that a comprehensive approach involving all stakeholders shaping the policy, financing and technical support, and training is needed to implement RWHS to make it attractive and feasible.

The study also revealed a number of barriers and challenges at each of the mentioned levels, which are summarized under five major categories, and presented below along with the possible remedies:

5 Major Categories:

1. **Awareness and knowledge at the factory level**
2. **Policies and enforcement of regulatory measures**
3. **Financing**
4. **Institution**
5. **Brands**

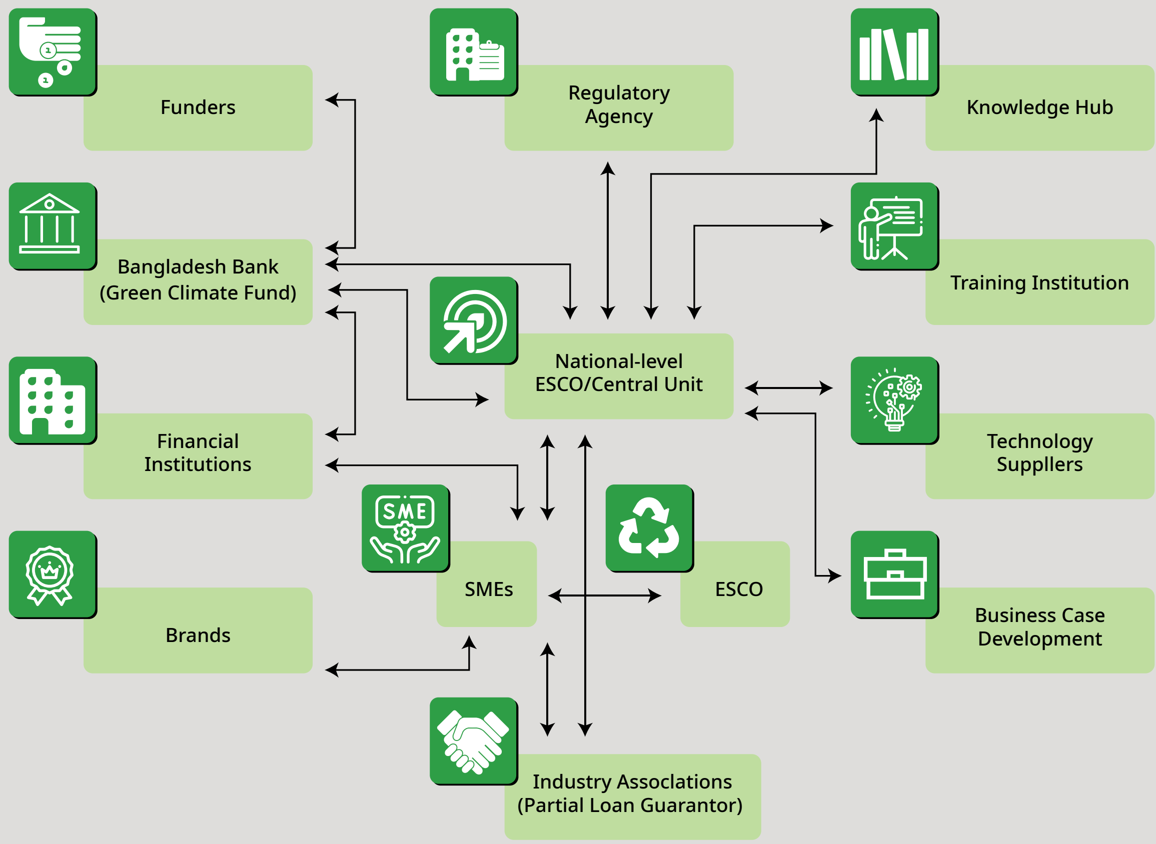
Barrier In	Major Contributing Factors	Possible Remedies
Awareness and knowledge at the factory level	• Water is considered a “free” or very low-priced resource • High payback period for RWHS • Limited knowledge of low-interest financing and requirements, or not-so-interested to avail it • Environmental and/or social considerations are surpassed by financial returns • Fail to make a holistic assessment of the investment’s payback that needs to consider future resource price hikes, increased productivity, increased compliance, strict regulations, etc. • Low share of water cost got little attention compared to higher cost-saving measures • Existing building constructions/drainage system was not initially planned for incorporating RWHS • Inadequate engagement of decision-makers	• Raise awareness about the value of water, social and environmental consequences of depleting the water sources, and possible regulatory measures restricting water usage • Provide a simple assessment tool to roughly estimate the financials for implementing the RWHS • Provide sources of low-interest financing, and qualified service and training providers • Provide institutional/brand support to easily avail financing and technical support • Ensure all new constructions are designed with provision for RWHS • Help to develop a business case by any of the stakeholders including factory itself, brands, financial institution, trade bodies like BGMEA/BKMEA, promotors of RWH like WaterAid, RAiN Forum, 3rd party nstitutions/ consultants, donors (through funded projects), etc.
Policies and enforcement of regulatory measures	• Absence of regulatory measures for water utilization • Not considering water as a natural resource as others e.g. gas, coal, minerals, etc. • Need for a proper policy like the Bangladesh National Building Code (BNBC 2020) or review of the policy to address current needs • Need for stimulating economic or non-economic incentives or duty-structure • Creating awareness about the value of water on a national level	• Review or formulating and/or strengthening policy, regulatory and legal frameworks as well as enforcing and implementing capabilities including a detailed plan for enforcing regulatory measures for water utilization • A comprehensive plan that includes preferential tax incentives e.g. stimulating economic or non-economic incentives or duty-structure • Accelerate the Zero Liquid Discharge (ZLD) initiative[1] • Incorporation of RWH as a condition for renewing or issuing Environmental Clearance Certificate, when applicable • Make separate RWHS for new constructions mandatory and ensure the compliance • Incorporating the value of water and benefits of RWH in the curriculum to create awareness in all generations especially in the younger generations

1. BNBC 2020 requires that for new constructions, a buildings of total floor area > 4000 m2 shall have its own rain water harvesting system (Sec. 4.3.5.1) and every building proposed for constructing on plots having extent of 300 sqm or above shall have facilities for conserving and harvesting rainwater (Sec. 7.4.1). These conditions practically enforce all new constructions in the apparel industry to have RWHS. However, the selection of an enforcing agency is hanging for years. Some details in sec. 2.5.6.

Barrier In	Major Contributing Factors	Possible Remedies
Financing	• Low awareness of the funding window and associated mechanisms among the majority of smaller and medium-sized RMG companies • Complex application process and loan processing • Stringent requirements or conditional loan tagged with other requirements e.g. safety measures • Preference for borrowers with strong financial strength only • Not-so-clear guidelines or instructions about loan processing • Many of the RMG factories are family owned and do not follow standard accounting and auditing rules to qualify for loans[2]	• Elimination of complexity in application and loan processing through developing clear guidelines and training of lenders • Setting rational requirements or conditions for a loan that is achievable and attractive to borrowers • Inclusion of organizations like BGMEA, BKMEA, or BTMA to support getting loans for financially not-so-strong business units
Institution	• Non-existent or not-so-strong knowledge hub for awareness-raising, knowledge enhancing, and information sharing mechanism • Need for support especially for not-so-strong business entities • Need for one-stop service • Need for showcasing and implementing business models	• Strengthening existing organizations such as RAiN Forum that eventually leads to one-stop service for awareness-raising, knowledge enhancing, information sharing, showcasing, financing, training, and implementing business models • Support financially not-so-strong business entities in getting financing by acting as a partial guarantor, when needed
Brands	• Not all buyers give enough importance to RWHS in their factory evaluation process	• Brand's no-cost technical support e.g. assessment and design of RWHS • Encourage RWH through some financial mechanism e.g. early payment, partial advance payment, etc.

Currently, all stakeholders like apparel SMEs, financial institutions, technology suppliers, regulatory bodies, industry associations, and brands are more or less operating independently . However, bringing all the stakeholders to operate collectively under a framework could synergically achieve significant benefits for all, especially by getting appropriate institutional level support from the BGMEA, BKMEA, or BTMA in terms of financing, knowledge sharing, training, etc. as well as help in getting low-interest funding could easily accelerate progress in multiple areas including the implementation of RWHS. It is found that RWHS could easily be incorporated in the comprehensive implementation framework that was proposed in the USAID/EHS+ study to accelerate and streamline the clean technology adoption process in the Bangladesh textile sector [1].

2. ToR for "GIZ-supported Project: "Support safety retrofits and environmental upgrades in the Bangladeshi Ready-Made Garment Sector (SSREU)", Project number: 2015.2233.3 (Sec. 2: Identified Bottlenecks).



Proposed Model for Accelerating Adoption of RWHS and Clean Technology

The framework requires a Central Unit which could be an existing organization or could be a new entity formed by the GoB, who as a knowledge hub would collect and share all the relevant information, as a non-banking financial institution gets low-interest funding from donors through Bangladesh Bank, gets and aggregates demands from SMEs, procures materials and services in bulk from manufactures/service providers through an open tender at the lowest possible cost, makes financing easier for the SMEs by incorporating organizations like BGMEA, BKMEA or BTMA as a partial loan guarantor.

To assess the experience of implementation and operation of RWHS, information from 7 factories of different sizes, types, and clusters that already have implemented RWHS was collected. The information showed that except for the factory inside the EPZ, RWHS was not financially viable for the rest. However, they implemented it either to meet buyer's requirements or to increase their image to the buyers; indicating that with the current water pricing and regulations, buyer requirement was the major influencing factor for implementing the RWHS. Please note that management or leadership would always be inclined to invest in interventions with a quicker payback.

Information was also collected from 16 factories comprising over 60% RMG unit and the rest were composite and spinning without RWHS. A "Representative" factory was developed from the information while giving proper weightage to the distribution of the nearly 6350 textile and RMG units in Bangladesh. An Excel-based Estimation Tool was developed which could be used for estimating savings and the payback period for a typical RWHS installation. The analysis again validated the finding from the factories with RWHS. The table below shows the result of the "Representative" factory:

Description	Reservoir Construction Materials	
	RCC	Brick
Cost of RWHS (BDT)	1,450,000	1,205,000
Savings from RWH (BDT)	32,700	32,700
Payback Period (year)	44	37
IRR (%)*	0.94	2.49
GHG Emission Reduction (tCO2e)	2	2

It is quite evident from the study that with the current water pricing, licensing agreement, and policy and regulations; implementation of the RWHS might not get due importance based on the financials alone especially for the factories outside the EPZ as the payback period is too high. A comprehensive approach involving all stakeholders including BGMEA, BKMEA, BTMA and Brands shaping the policy, regulations and requirements, financial, technical and training support are needed to make the implementation of RWHS attractive and feasible.

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Acronyms

3e	Energy Efficiency Engagement
AIC	Apparel Innovation Consortium
BDT	Bangladeshi Taka
BGMEA	Bangladesh Garments Manufactures and Exporters Association
BMD	Bangladesh Meteorological Department
BNBC	Bangladesh National Building Code
BUET	Bangladesh University of Engineering and Technology
BUTEX	Bangladesh University of Textiles
BWMSP	Bangladesh Water Multi-Stakeholder Partnership
DoE	Department of Environment
ERI	Engineering Resources International Ltd.
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GoB	Government of Bangladesh
HELD	Higher Education and Leadership Development
IC	Impact Economy
IDCOL	Infrastructure Development Company Limited
ISO	International Organization for Standardization
MoEF	Ministry of Environment, Forest and Climate Change
MSP	Multi-Stakeholder Partnership
NCCI	Nordic Chamber of Commerce and Industry
NEST	Need for Environmentally Sustainable Textile
NG	Natural Gas
PaCT	Partnership for Cleaner Textile
PwC	PricewaterhouseCoopers
RCC	Reinforced Cement Concrete
RMG	Readymade Garments
RWH	Rainwater Harvesting
RWHS	Rainwater Harvesting System
SDG	Sustainable Development Goals
SME	Small and Medium Enterprise
STWI	Sweden Textile Water Initiative
WARPO	Water Resources Planning Organization
WDF	Washing, Dyeing and Finishing
WRG	Water Resource Group
ZLD	Zero Liquid Discharge

1. Introduction

1.1 Water Scenario of Bangladesh

Water in combination with land, air, and energy is the foundation of life, societies and economies. Valuing water provides the basis for recognizing and considering all costs and benefits provided by water, including their economic, social and ecological dimensions (Bellagio Principles, 2017).

Out of total water available on earth, only about 2.5% is fresh water while only about 0.4% is accessible and usable, and about 0.003% is potable.

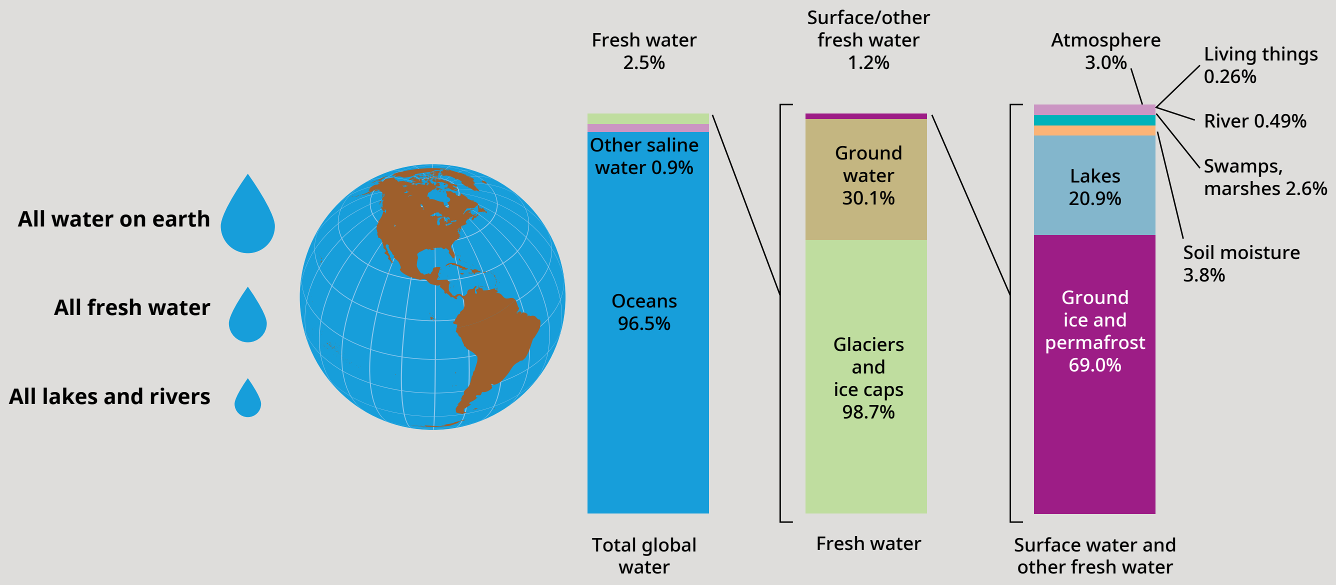


Figure 1: World's Water Scenario[3]

For centuries, the apparent abundance of water in this region has created the mindset that water is a free commodity, hence until recently, its wastage or governance hardly got any attention, especially in the industrial sector, more specifically in the textile and RMG sector.

The sustainability of the environment, social and economic growth, and development of Bangladesh is highly influenced by the availability and quality of water. The adverse impact of climate change has accelerated the already rapidly deteriorating situation. Currently, the country is facing more challenges around water security than ever before due to increasing demand by the growing population as well as climate impact, inappropriate land use, and waste management. The rapid growth of the industrial hubs in Dhaka and other cities in Bangladesh is also imposing substantial pressures on the environment since most of the industries, especially the textile and leather industries are heavily reliant on high water consumption. Bangladesh largely depends on its rivers for maintaining a proper water cycle, however, man-made changes, industrial pollution, and

3. https://www.usgs.gov/special-topic/water-science-school/science/how-much-water-there-earth?qt-science_center_objects=0#qt-science_center_objects
https://water.usgs.gov/edu/gallery/watercyclekids/earth-water-distribution.html

neighboring activities upstream have caused exploitation of the river water system. As a result, the overall natural water flow has deteriorated to an alarming extent. On the other hand, the alarming rate of groundwater depletion, which can potentially cause environmental hazards such as land subsidence, prolonged waterlogging, alteration in vegetation, etc.; worsening of surface water quality, water pollution, and wetland degradation are causing serious pressure on water supply system, not to mention the huge adverse impact on the economic and social conditions. In the future this water crisis will be more intensified; consequently, new strategies for water development and management are needed to face national, regional and local water scarcities. Implementation of alternative water sources including rainwater is, therefore, a prime requirement to face future challenges.

As capital-intensive water management system fails to deliver the desired benefits , the focus should now be on efficient and sustainable new technologies, decentralized facilities, and advocating policies.

In 2013, the Government of Bangladesh introduced Bangladesh Water Act4 to ensure effective water governance including groundwater, which is considered free for any use. Adopted in 2015, Sustainable Development Goal 6: Ensure availability and sustainable management of water and sanitation for all sets the foundation for policy-level interventions for the water-related activities where Target 6.a particularly addresses water harvesting.

4. Bangladesh Water Rules 2018, was prepared and finalised following Bangladesh Water Act, 2013 addressing Rights to Water, National Water Policy, Ground Water Conservation and Management, getting permissions/NOC for ground water extraction, etc. Water Resources Planning Organization (WARPO) of Ministry of Water Resources was the lead coordinator, and WaterAid Bangladesh took a number of initiatives to influence the process and provided a number of recommendations on the draft.

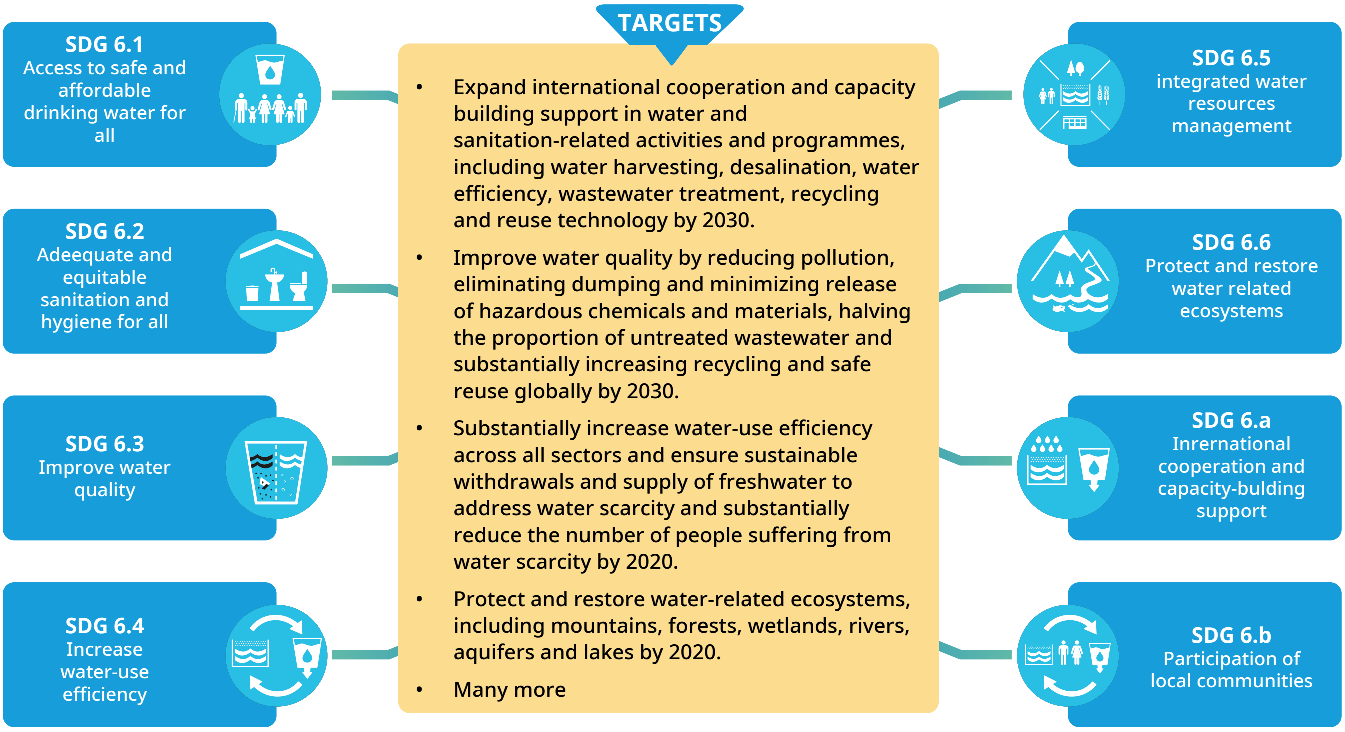


Figure 2: Sustainable Development Goal 6 and Targets

Bangladesh is privileged by the huge quantity of rainfall almost throughout the country during the monsoon, generally varying between 150 cm and 350 cm per month, that usually lasts from May to October with occasional rainfall in November [2]. This could reduce the dependency on groundwater, alleviate the demand on the upper aquifers and supplement the ground water source at least for six months [2]. As a result, among all alternative water sources, rainwater harvesting- a simple and low-cost technique that needs minimum specific expertise or knowledge and is adaptable to a wide variety of conditions could be promoted with innovative technologies and policies as the most potential solution to the pressing condition of water security in Bangladesh. This technique is also feasible than other alternative sources as the treatment and distribution cost is less. Moreover, a study on potential private sector investment in safe water finds rainwater harvesting as a high potential domain for investments from both industries and financial institutions.

The general benefits for industries of rainwater harvesting that reduces the burden on groundwater- one of the most valuable water resources for its quality and quantity are well known. However, there is a lack of credible evidence, including detailed financial/economic analysis, to stimulate the private sector to adopt rainwater harvesting. The opportunities and challenges for rainwater harvesting should, therefore, be assessed for strategic water planning in the industrial sector along with the better quantification of energy and climate factors for the proper development of the system, while considering creating awareness among industry sector professionals and policy makers, and promoting RWH country-wide as an integral part of it. In addition, examining the effectiveness of the adoption of aquifer recharge could also be explored.

The success of any such initiative, however, depends on identifying the opportunities and barriers in terms of technology, policy, financing mechanism, and brand's involvement along with the business unit's own internal management process and capability that shapes their decision-making process in the implementation process. Large-scale adoption requires intervention in the form of innovative business models involving all key stakeholders. As a result, an opportunity assessment is essential in this regard to streamline the process for achieving implementing RWHS that is practical, profitable, and sustainable.

1.2 Bangladesh Textile Sector

Bangladesh textile sector with over 6300 business units including nearly 4500 Ready-Made Garments (RMG) units has been the driving force of the Bangladeshi economy for decades. The sector contributed USD 34.1 billion to the economy in the fiscal year 2018-19, which was 84.2% of total export, and employs around 4 million workers, over 80% of whom are women. The target set by the Bangladesh Garments Manufacturers Association (BGMEA) in the pre-pandemic situation was to reach USD 50 billion by 2021 and USD 66.25 billion by 2030.

Source: Approved PPF Application from GCF (5 November 2018) [3], BGMEA, BKMEA website

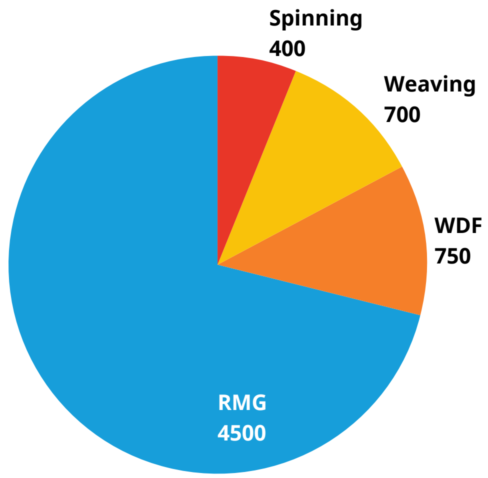


Figure 3:
Production units inBangladesh Textile sector (approximate numbers)

Source: Approved PPF Application from GCF (5 November 2018) [3], BGMEA, BKMEA website

The textile sector is highly water-intensive and is also ranked the #1 polluting industry in Bangladesh [3].

As a water-intensive sector, the growth and the sustainability of the RMG sector as well as its substantial contribution to Bangladesh's economic and human development is highly dependent on how it manages its water risks. The expected growth of the RMG sector will intensify competing water uses with domestic and agricultural water use, and will exacerbate the current gap between water supply and demand and declining water quality. The industry's reliance on groundwater means there will be higher costs of water abstraction , either from deeper pumping or from securing freshwater from other sources due to higher scarcity.

A study estimated that the overall water use of the textile and apparel industry is around 1.5 billion m3 (BCM) per year in 2009 . This estimation was based on factory water consumption of 300 L/kg fabric and annual textile production of 5 million tons [4]. Another recent study estimated the water consumption at 1.82 (BCM) in 2016 [5].

An STWI water governance mapping report anticipated that textile water demand will be increased by 270,3 % compared to 2014 to 3.959 BCM per day for the lower estimate and 8.382 BCM per day for the upper estimate, creating a water demand gap between 2.495 to 5.282 BCM per year. Higher future domestic and agricultural water demands that have a higher priority than industrial water, means that there is a higher risk of water shortage to the textile industry by 2030 and higher costs of water abstraction [6]. Another estimate based on Business as Usual (BAU) provided textile water demand from 4.013 billion liters per day (BLD) in 2014 to an additional water supply of 6,788 MLD, which was based on the assumption that textile water demand is roughly twice the domestic water demand and per capita water demand [7].

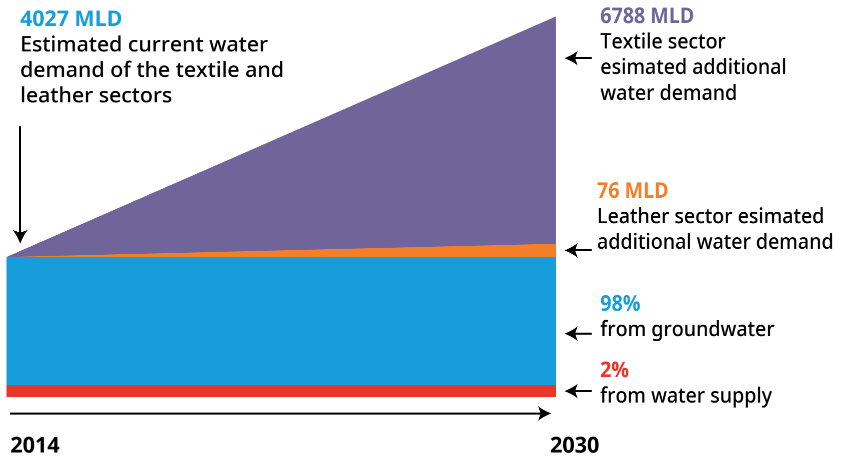


Figure 4: Projection of Textile Water Demand

Source: (Source: Ref. [8]) and the related costs are

Figure 4 above is based on projected textile sales reaching $66.25b by 2030 therby needing an additional 6788 MLD of water over and above the existing demand. Similarly leather sales is projected to be $8.25b in 2030 requiring an additional 76 MLD of water. The total water usage for textile and leather, based on the above numbers, is expected to reach 10891 MLD by 2030 as compared to 4027 MLD in 2014, an increase of over 250%. The gragh also shows the current scenario where 98% of the input water comes from groundwater.

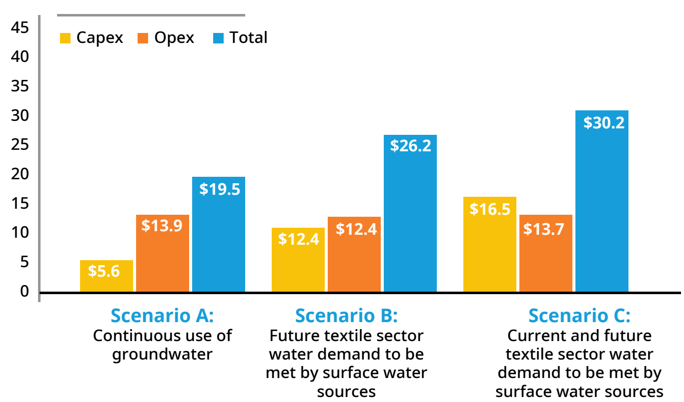


Figure 5: Projected Water Related Costs for the Textile Sector to Year 2030 (Billion USD)

Source: Ref. [8]

Figure 5 above depicts the estimated costs to supply the future demand of water based on 3 scenarios. Scenario A assumes Business as Usual (BAU) where the textile and leather industry would continue to rely primarily on groundwater; Scenario B assumes that only the future need is met through surface water; and finally Scenario C assumes that all current and future water needs be met through surface water. Even though Scenario C is the most expensive option, it is the only long term solution, or at the least, an option that lies between

Scenario B and C needs to be adopted if we want to have any chance of protecting our groundwater. One also needs to bear in mind the significant demand on groundwater that will be posed by the explosive population growth of Dhaka and other megacities in Bangladesh.

Figure 6 shows the various initiatives that industry could adopt to become more water efficient and the related costs vis-à-vis the water savings achieved. A quick glance shows that the industry could achieve up to 25% savings through various interventions, as illustrated in the graph above, before the costs increase exponentially. In other words, the marginal rate of return on the invested capital decreases significantly if water savings greater than 20-25% is to be achieved.

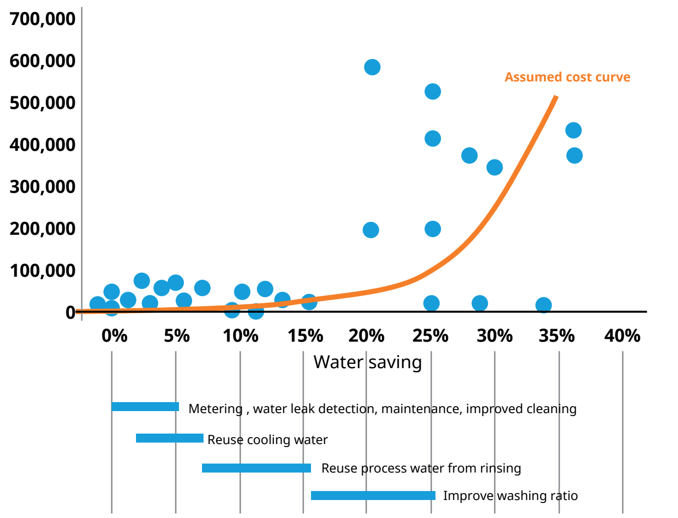


Figure 6: Indicative Cost Curve for Interventions which Reduces Water Abstraction (USD)

Source: Ref. [8]

All these estimates, though somewhat higher in numbers as significant improvements in water consumptions e.g. from 300-400 liter/kg to 120-170 liter/kg in many of the WDF units have already been achieved, nevertheless, paint a very grim picture of the future unless appropriate measures are taken immediately.

The effect of such a high rate of water use is already showing its sign of extreme danger. Because of the inefficient use of resources, lack of awareness, and absence of adequate groundwater policies, every year the groundwater level is declining with an average rate of 2.5 m in areas where most textile and apparel industries are located. Currently, the average depth in the groundwater table in greater Dhaka is reported to be 78.0 m from the ground level which is projected to reach 132.0 m by 2030 with an annual depletion rate of 5.1 m [9] [10].

It is quite evident that falling groundwater tables combined with the projected increased water abstraction rates are likely to threaten industrial production. As a result, any means of saving water as well as an alternate source of ground water that is feasible, practical, and profitable should be explored. Accordingly, the feasibility as well as the barrier and challenges of implementing RWHS, which is one of the simple and low-cost techniques, has been considered for the Bangladesh textile and apparel sector.

2. Program Description

2.1 Objective

The key objective of this study is to generate profound knowledge on rainwater uptake prospects, constraints, and the way forward in the apparel sector. This study will aim to underpin the chronological development of RWH in Bangladesh with a full and comprehensive assessment of its impact and potential through analyzing impacts and challenges of existing RWHS in apparel industries, developing a costed business plan, to name a few (details in Annex 6.1). Following are the key analysis, which is an integral part of the study:

- A life-cycle cost-benefit analysis approach for Rainwater harvesting
- Social and environmental benefits in monetary terms in the calculation
- Developing a decision support tool with Economic, Environmental and Social criteria on RWH options for green investment in apparel industries

In addition to the general information and operating conditions of the RWHS, the issues and the factors in the higher management level e.g. leadership that influence the implementation of RWHS would also be investigated.

2.2 Methodology

The current study requires a systematic collection of primary and secondary data from a sample of representative factories in the apparel industry along with the interview with key informants from the industries, relevant government agencies, and academic/research institutions to better understand the bottlenecks and solutions for RWHS. In addition, a literature review is also required to identify the developments done and/or knowledge gathered in this area.

An exploratory approach, therefore, has been chosen for this study since no comprehensive studies that include all components of the current assignment have been conducted for the apparel sector in Bangladesh. Both quantitative and qualitative data were collected through structured questionnaires, email and over phone communications, and open discussions.

The details of the methodology are described in Annex 6.2.

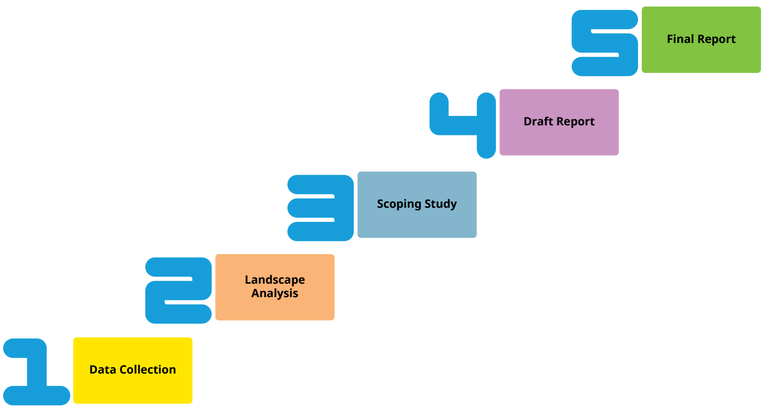


Figure 7: Methodology
The details of the methodology are described in Annex 6.2.

2.3 Mapping the Landscape

Using an exploratory approach through literature review, ERI database, and stakeholder consultations, the landscape of the study was identified. Out of about 6300 textile units including nearly 4500 apparel units in greater Dhaka and Chattogram, information was collected from 16 factories without RWHS and 7 factories with RWHS in multiple clusters. The details are shown below:

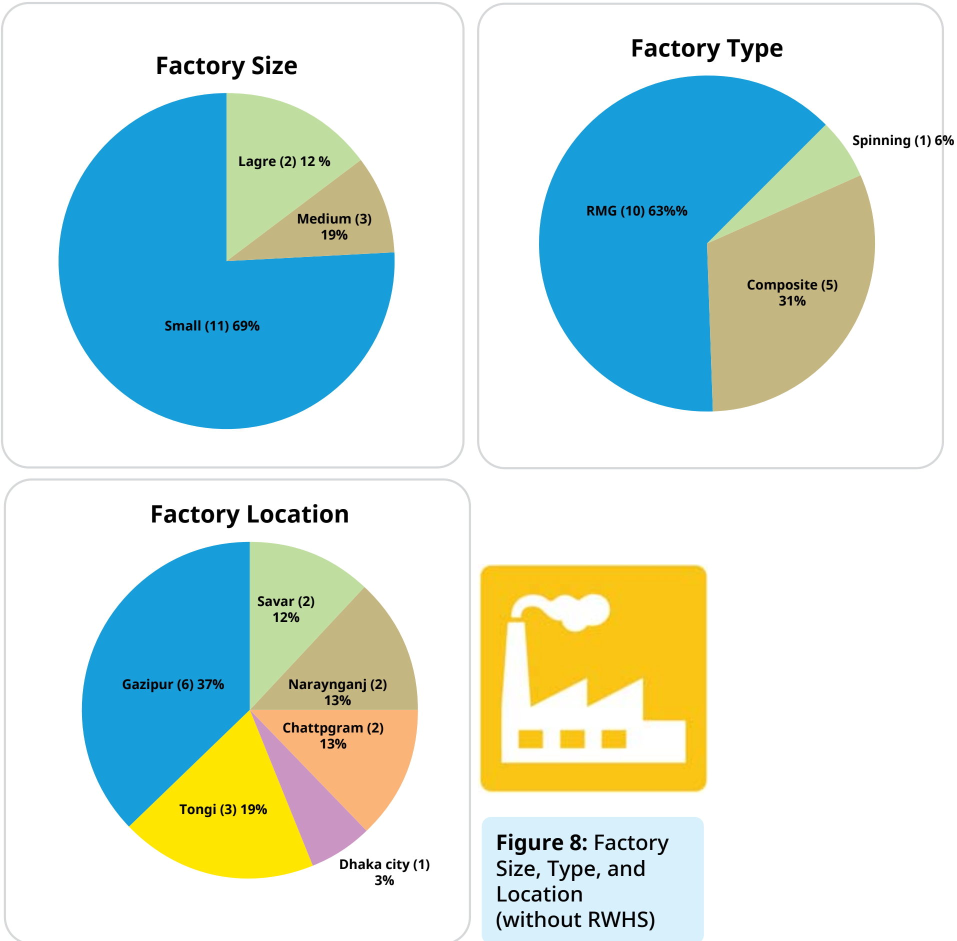


Figure 8: Factory Size, Type, and Location (without RWHS)

2.4 Previous Works

The intense literature review revealed that no such comprehensive study on RWHS in the textile and apparel sector in Bangladesh was conducted in the past. The only study that came close was the case study done by WaterAid Bangladesh in 4 factories in Narayanganj with existing RWHS where the potential of RHWS as well as aquifer recharge, return on investment (ROI), construction feasibility factors, and environmental and social benefit were investigated [11].

The study considered the water price at BDT 37.35/m3, which applies only to a limited number of factories inside the EPZ. The study also took ground water treatment cost without the capital cost of treatment plant (WTP) at BDT 9/m3, which is much higher than the industry standard of about BDT 3-5/m3. With an average investment of BDT 3 - 4 million and the life span of the RWHS for 60 years, the study found the payback period at 5 – 10 years. While most of the factories are located outside the EPZ where the actual cost of water is between BDT 3 – 7/m3, the payback period of these factories would be several folds higher than estimated figures. As a result, the RWHS would not be a lucrative investment based on the financials alone. The study, however, rightfully identified the other factors especially the better image of the factory to the potential buyers, which would play a major role for the factory management considering the implementation of the RWHS; as well as the environmental and social benefits of RWH.

The study also made several recommendations including stronger environmental regulations, capacity enhancement through training and knowledge sharing, incorporating RWH options in new constructions, sustainable water management in the education curriculum, financing for green initiatives, to name a few.

Another study report by PwC titled “Business Case Behind Safe Water ” [12] based on the safe water scenario described by 16 Bangladeshi stakeholders interviewed for this study addressed the scope of RWS in the Bangladesh domestic and industrial sectors focusing on the potential business cases for potable water. The report didn’t mention how many or if any of the stakeholders were from the apparel industry or the findings are applicable beyond safe water and/or to the apparel industry’s domestic and/or process use. The biggest difference lies in the viability of the project is the several-fold higher water pricing for safe water. The report, however, has some common elements that could shed some light on the current study.

The report states that “The manufacturing industry was predominantly interested in investments in rainwater harvesting, effluent treatment plant, and pretreatment water plant and water use efficient machines”. However, while discussing the “Barriers in implementing water-related business models” the report states that the “Infrastructure for water is typically capital intensive, long-term with high sunk cost. In addition, a long payback period fails to attract investments from the private sector and financial institutions”; and concluded that

"Owing to weak water governance and low awareness amongst consumers, the private sector is not showing interest for investment in water products or services". The report also stated that "The industries which are operating ETPs are mainly acting motivated by compliance and brand requirements". While implementation of an essential element e.g. ETP needs motivation or push from compliance authority and/or brands, it is a no-brainer that implementation of RWHS, which is optional for existing installations and has high investment and long-payback period, would be kept on the shelf for the most part.

The report rightfully mentioned that water is generally an undervalued and underpriced resource in the national context, and recommended for way forward that "The government need formulate a framework to design pricing strategy for industries ". All of these are fully matched with the ground-level reality.

Multiple other studies/reports addressed RWHS as a part of sustainable manufacturing practices [9] [13] [14] or alternate sources of water [8], as well as explored the value of water[5] [15].

2.5 Stakeholders Consultations

Several relevant stakeholders were identified and consulted to get their views on the prospect, opportunities, and challenges of RWH in the apparel industry in the context of water pricing, policy, SDG goals, awareness-raising, capacity development, etc.

SL.	People/OrganizationConsulted	Designation
01	Asif Ibrahim	Director, BGMEA, and Vice-Chairman, New Age Group of Industries
02	Ashraful Alum Ratan	Secretary, RAiN Forum, and Principal Architect, Idyllic Design.
03	Dr. Mohidus Samad Khan	Associate Professor, Department of Chemical Engineering, Bangladesh University of Engineering and Technology (BUET)
04	Dr. Tanvir Ahmed	Associate Professor, Department of Civil Engineering, BUET
05	Dr. Mohammad Abbas Uddin Shiyak	Assistant Professor, Department of Dyes and Chemical Engineering, Bangladesh University of Textile (BUTEX) Managing Director, Assoconsult Ltd., Environmental Activist
06	Architect Mubasshar Hussain	MD, VITTI Sthapati Brindo; Member Secretary, Bangladesh Poribesh Andolon (BAPA), Environmental Activist
07	Architect Iqbal Habib	Ministry of Environment, Forest and Climate Change (MoEF)
08	Department of Environment (DoE) H&M	Major Brand
09	Bestseller	Major Brand
10	Decathlon	Major Brand

4. Based on the Benchmarking Study conducted by IFC/PaCT for its member textile companies, the average cost of water efficiency measures amounts to 0.15 USD/m3, and that for rainwater harvesting amounts to 0.08 USD/ m3. the net cost of replacing groundwater by assuming a hypothetical set of options for a factory. If 15% of water can be saved from water efficiency improvements, 10% of water can be substituted with rainwater and surface water could be used for 30% of the year, then the net cost of substituting groundwater would amount to 55.91 BDT/m3.

2.5.1 BGMEA BGMEA and the factories are aware of the positive impacts that RWHS brings to the environment. Awareness-raising, capacity building, incentives, and proper policy mechanisms could make the implementation of the RWHS a favorable choice for the apparel industry.

Currently, BGMEA/BKMEA has no program or activities that directly address the adoption of RWHS. BGMEA is, however, one of the key partners of the Water Resources Group 2030 working on improving water resources management through collaborative transformative actions. Through the MSP, BGMEA has worked on "Valuing Water", MAR (Managed Aquifer Recharge), ISPP (Incentivizing Sustainable Production Practices), etc. WARPO has drafted an industrial water use policy for Bangladesh where BGMEA was closely associated with technical insights and supported the initiative. The draft, which has been finalized after multiple stakeholder consultations, has been submitted to the Ministry of Water Resources in 2020 for finalization (details in sec. 2.6).

The comprehensive implementation framework that was proposed in the USAID/EHS+ study to accelerate and streamlined the clean technology adoption process in the Bangladesh textile sector[1], where adoption of RWHS could easily be integrated; BGMEA, BKMEA, or BTMA could take the leading roles in this respect and involve relevant stakeholders to formulate the proposal with possible details. As GoB has not yet adopted the idea of a national ESCO; the first step could be to come up with a proposal with sufficient details that is convincing enough for the policy makers i.e. relevant government institutions; and possible donors.

BGMEA

2.5.2 RAiN Forum

RAiN forum extensively works on awareness-raising, capacity development, and assessment and implementation of the RWHS, and found that improved water management, awareness campaigning to enhance social responsibility, developing better techniques and low-cost RWHS, showcasing success stories, initial support for low-cost or no-cost assessment to implement RWHS, incentives, proper policy, dissipating knowledge and information through media are some of the major elements to get the RWHS required traction for the large scale implementation in the apparel industry. Engaging young generations especially those who are in their teens via some school or college programs would be highly beneficial in enhancing knowledge about future water scarcity and creating awareness in water conservation and RWH in the long run.

2.5.3 Brands

Three major brands in Bangladesh, namely: Bestseller, H&M, and Decathlon were consulted to get information about their business policy, goals, support, requirements, and initiatives that could influence their sourcing factories in implementing RWHS, and how the sourcing factories are responding to their buyer's initiatives. H&M already has a plan to have 50% of their Tier 1 and Tier 2 factories install RWHS, when feasible, by 2022. The feasibility of the installation is done by H&M. They also consider the presence of RWHS in the performance evaluation of their sourcing factories.

Bestseller and Decathlon, on the other hand, are in the process of incorporating the RWHS of the sourcing factories in the evaluation process and are highly encouraging the factories to actively consider installing the system.

2.5.4 Department of Environment (DoE) of the MoEF

Department of Environment (DoE) of the Ministry of Environment, Forest and Climate Change (MoEF) were contacted to collect information on the government initiative on Zero Liquid Discharge (ZLD), plan or policy level activities on ground water extraction and water pricing, rules and regulations for aquifer recharge through RWH, etc., that could impact the implementation of RWHS in the textile and apparel industry.

DoE only evaluates the proposals submitted by the factories for the implementation of the RWHS but there is no official initiative to encourage its implementation. So far, no one has come up with any proposal for aquifer recharge. DoE is extremely cautious about it and not giving any permission to any industry as the risk and the devastating effects of aquifer contamination are too high. Although a 2015 reference6 says," Bangladesh DoE (Department of Environment) recently issued a zero liquid discharge (ZLD) regulation to deal with the problem of effluent, mandating all textile mills to install zero liquid discharge effluent treatment plant (ZLD–ETP) systems. The initiative is focused on incorporating learning from best practices, technologies and policy initiatives to support effective implementation of the ZLD mandate in Bangladesh"; however, the consultations with the authorities from DoE reveals that the department is considering incorporating Zero Liquid Discharge (ZLD) in the policy level; and it is still in the very initial stage. It is felt that the policy level intervention for ZLD i.e. detailed regulatory reforms and preparation for implementation, which could expedite for immediate benefits needs much more attention. Regulating water usage not only reduces its consumption that translates into reduced pollution, which is killing the water bodies and posing an immense threat to human life and health, and eco-system; it also significantly reduces energy consumption, and encourage factories for looking into low or no water-consuming modern and clean technologies.

To encourage the factories in adopting RWHS as well as clean technologies, a comprehensive plan that includes preferential tax incentives and gradual elimination of subsidies should also be discussed at the policy level.

6. http://www.ipekpp.com/pdf/Achievements/Achievement_BGMEA_textile_exposure_visit_FINAL.pdf

2.5.5 Academic Institutions (BUET and BUTEX)

Professors from both academic institutions emphasized increasing awareness-raising and external interventions to some extent to encourage factories in implementing RWHS. BUET could provide training as well as all technical support for designing and implementation while BUTEX could provide technical support, if any, for using rain water in the manufacturing process e.g. dyeing or washing. The professor from BUTEX highly encouraged implementing RWHS and using the water for the process as the rain water would not only reduce the WTP cost, its purity would provide better results in the manufacturing process. As a result, the factory should consider using rainwater as much as possible in the process than for domestic or other purposes.

2.5.6 Environmental Activists

Nationally recognized environmental activists, Architect Mubasshar Hussain and Iqbal Habib, who was actively contributed to drafting the BNBC 2020 to make RWH mandatory for all new building constructions are strong proponents of RWHS. They are, however, fully aware of the ground-level challenges especially at the factory-level, and rightfully indicated that while in the developed countries, such codes are developed and administered by standard bodies like ISO, it had to make a government regulation in Bangladesh to enforce its implementation, otherwise, there is a strong possibility that it won't be implemented at all in most cases. Also, even though the BNBC 2020 is in place, the selection of the implementing authority for building code is still hanging for years indicating the lack of enforcing capacity and/or initiative at the policy level. Both of them are also trying convincing relevant government bodies to incorporate global water scenario, looming water crisis, environmental impacts, benefits of RWH, etc., in the secondary school curriculum to raise long-term and sustainable awareness for the conservation of water resources among the generations to come.

2.6 Policy-level Interventions

Currently, Bangladesh is taking a unique initiative to value water at a national level, which has been formalized through the 8th Five-Year Plan and will focus on the valuation of the water e.g. water pricing and water auditing to limit its unsustainable use. The plan will also focus on improved management of water pollution, exploration of options for harvesting rainwater, developing a strategy for managed aquifer recharge and introducing natural and artificial aquifer recharge systems using rainwater harvesting for groundwater recharge, exploring technologies for RWH, improvement of a compliance monitoring system for industries and development projects and its effective implementation, on-line water quality monitoring, to name a few. The strategic objectives and targets of the water sector for this plan are aligned with Vision 2041 and Bangladesh Delta Plan 2100 to support sustainable water resources management leading to sustainable economic development, and sustainable investment and operational choice.

In the task of valuing water [15] as followed.

- **Value and protect all sources of water, including watersheds, rivers, aquifers, and associated ecosystems for current and future generations.**
- **Increase investment in institutions, infrastructure, information, and innovation to realize the full potential and values of water.**

The analysis was done by considering the cost of the alternative to ground water such as surface water, harvested rainwater, and reducing water demand by water efficiency measures. The analysis revealed that when considering the option that there are no alternatives for groundwater, the value of groundwater for the textile industry differs widely among factories that range from 9 BDT/m3 to 234 BDT/m3, and on an average between (-3.07) BDT/m3 for the rainwater harvesting measures and 120 BDT/m3 in case there is no substitute. The analysis clearly demonstrates the case for RWH when valuing water is considered.

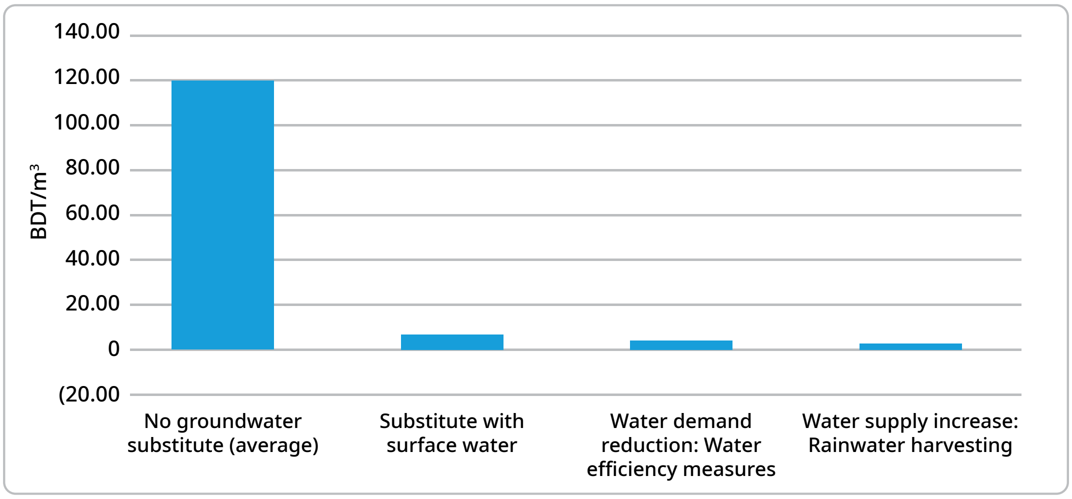
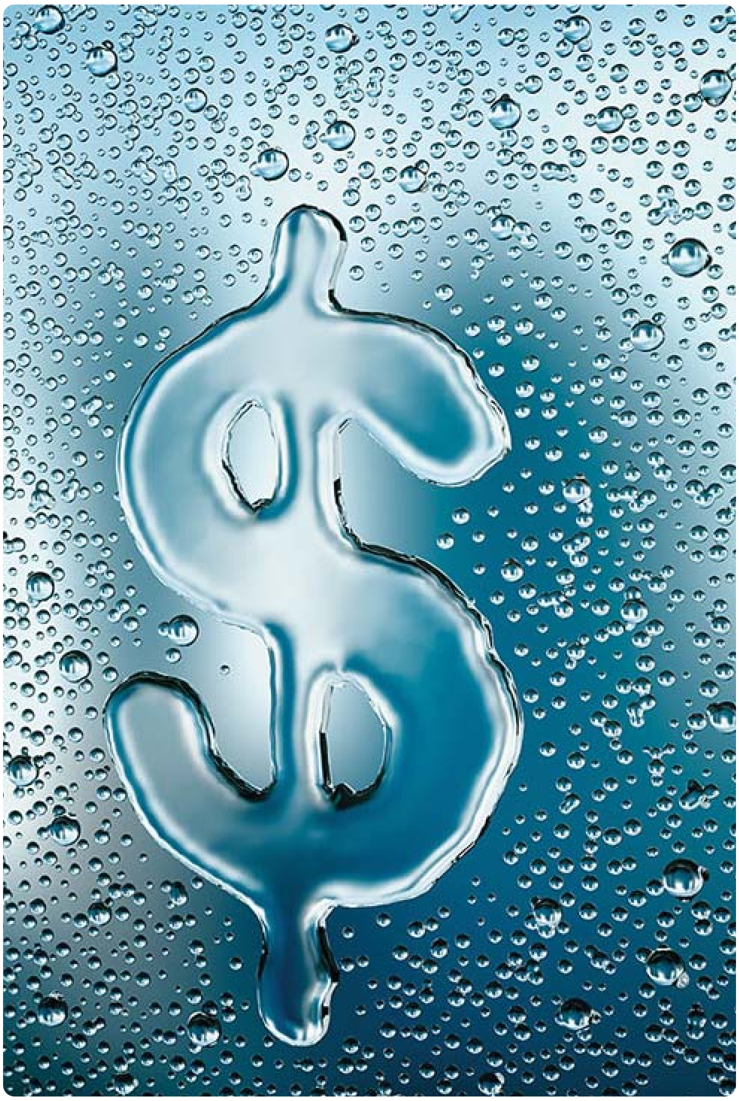


Figure 4: Net cost of reduced groundwater availability across replacement options

As part of this process, the High-level Panel on Water (HLPW)7 has made key recommendations and adopted key principles to value water through identifying and taking into account the multiple and diverse values of water to different groups and interests in all decisions affecting water. The Bangladesh Water Multi-Stakeholder Platform (BWMSP), a 2030 WRG MSP, has also sought to apply such principles in its initiatives.

GoB also took up the task of understanding the applicability of Valuing Water in Bangladesh; finding practical and consensual ways to streamline Valuing Water into the existing policy and regulatory framework; and driving the implementation and enforcement of the same.

To support this initiative and explore the potential application of Valuing Water to Bangladesh's context. Based on the position paper on Valuing Water prepared by the 2030 Water Resources Group (2030 WRG), a Pro Forma for Study Proposal on a Study to Develop Operational Shadow Prices for Water to Support Informed Policy and Investment Decision-Making Processes was developed, which is being implemented by the Water Resources Planning Organization. One of the three possible approaches to Valuing Water is the cost-based approach that infers the value of water based on costs incurred to mitigate damage or replace the ecosystem services, or avoided costs if the ecosystem services are maintained. Given the identified relevance of Valuing Water, the Government of Bangladesh has included the above-mentioned strategic objectives and targets of the water sector in the 8th Five-Year Plan



Based on the position paper and with the support of the High-Level and Technical Valuing Water Committees of the BWMSP, Bangladesh's Ministry of Water Resources has initiated a project to develop operational shadow prices for water to support informed policy and investment decision-making.

7 8th Five Year Plan, GoB, Sec. 4.6.1, page 322.

Some other steps being taken are:

- Raising awareness: The High-Level and Technical Valuing Water Committees are also developing an interactive awareness-raising campaign on the value of water, along with a knowledge hub to share information, connect experts, and coordinate research to further improve our understanding of the value of water

- Initiating the implementation process: Given the inclusion of the targets on Valuing Water in the 8th FYP, the High-Level and Technical Valuing Water Committees will convene to discuss how to best support the implementation of these targets

Adopting Valuing Water as an integral part of policymaking and investment decisions would help Bangladesh enabling sustainable water management, and thus sustainable long-term economic growth and equitable access to water for all.

In addition, WARPO in 2020 has submitted a final draft on "Industrial Water Use Policy" to the Ministry of Water Resources for finalization. Once the policy is approved, which is targeted to achieve SDG 6.6, Bangladesh would be the first country in the world to have an "Industrial Water Use Policy". The policy would address some extremely important issues in valuing water that includes

The policy would address some extremely important issues in valuing water that includes

- **Water allocation and pricing mechanism that internalizes environmental externalities**
- **Signaling the scarcity**
- **Shadow pricing of water**
- **Industrial water billing**
- **Pricing of industrial water ensuring its efficient use and reward conservation**
- **Optimizing water allocation**
- **Regulatory abstraction**
- **Setting Water Use Efficiency (WUE) target**
- **Setting up an environmental grading system to categorize the environmental performance of the industries**
- **Water Stewardship Standard Development**

The proposed policy recommends the use of alternative water sources for long-term water security and suggests industries to actively seek alternative water sources for their industrial production/processing with emphasis on RWH. It states that:

- **Buildings of industrial production sites shall strictly follow the rainwater harvesting directive of the Bangladesh National Building Code**
- **Industry owners shall provide collection/catchment surface, conveyance system, storage, and delivery with proper filtering/disinfection for rainwater harvesting within their respective production site(s)**

2.7 Financing

Bangladesh Bank[8] has been at the forefront in encouraging green economic growth through a combination of policy and institutional initiatives, which directly and indirectly encourage green investments by high polluting industrial sectors, such as leather and textiles. In 2009, Bangladesh Bank established a revolving refinance scheme of BDT 2,000 million from its own fund for lending to borrowers through commercial banks and non-banking financial institutions (NFIs) who are interested to invest in "Renewable Energy and Environmentally Friendly Financeable Sectors" that includes Green Industry and Water Management and Conservation. Over time, Bangladesh Bank issued Green Banking Policy Guidelines for the commercial banks in 2011 and Green Lending Policy Guidelines for NFIs in 2013.

In January 2016, a new longer-term refinancing window named Green Transformation Fund (GTF), with USD 200 million was launched to facilitate access to financing in foreign exchange by the export-oriented textile and leather sectors to import capital machinery and accessories for the implementing environment-friendly initiatives. The categories relevant for the RMG industry are water use efficiency in wet processing; water conservation and management; waste management; resource efficiency and recycling; renewable energy; energy efficiency; heat and temperature management; air ventilation and circulation efficiency; work environment improvement initiatives; and other fields as identified by Bangladesh Bank from time to time.

Among the number of initiatives taken by the Bangladesh Bank, currently, there are two major financing mechanisms available that offer low-interest funding[9].

2.7.1 Energy Efficiency & Conservation Promotion Financing (EECPF) Project

This project comprises the fourth pillar among the necessary interventions of the Energy Efficiency & Conservation Master Plan up to 2030. The project fund was created with support from JICA. The three executing agencies that are implementing EECPF Project are SREDA, Infrastructure Development Company Limited (IDCOL), and Bangladesh Infrastructure Financing Fund Limited (BIFFL). IDCOL and BIFFL are the implementing financial institutions that extend low-interest loans. Both implementing financial institutions are provided the loan fund through the Finance Division of the Government of Bangladesh. EECPF Project utilizes a two-step loan or financial intermediate lending instrument.

8 Environmental Compliance Opportunities in the Bangladeshi Ready Made Garments Industry: Lessons from the Green High Achievers, Economic Dialogue on Green Growth, Adam Smith International, September 2018.
9 www.idcol.org, www.sreda.gov.bd, www.biffl.org.bd, https://www.jica.go.jp/bangladesh/english/index.html

Some of the challenges faced by both lenders and borrowers are:

1. Change the existing groundwater licensing arrangements
2. Incorporation of RWH as a condition for renewing or issuing Environmental Clearance Certificate
3. The DoE regulatory bodies should be decentralized and strengthened to monitor RWHS of the industries if the stallation of RWHS is made mandatory
4. Valuing water: While valuing water is not equal to the pricing of water, it can be a useful tool to determine equitable and incentivized pricing schemes for water.
5. Align existing incentives and provide more targeted incentives toward a cleaner textile and apparel industry
6. Explore other kinds of positive incentives that reward the industry's initiative to be more water smart and innovative
7. Green incentives should be better aligned with industrial incentives beyond environmental requirements, such as tax rebates for the adoption of greener technologies, tax exemption for import of cleaner technologies, and so forth
8. Broader stakeholder engagement in building the capacity of the textile and apparel industry toward sustainability
9. Establish a one-stop-service knowledge hub to promote research and wider dissemination of RWH related information, case studies, etc., to all stakeholders. A convenient platform for regular communications and interactions among the textile and apparel units, service providers, etc., along with a database with regular updates after necessary scrutinization and verifications of information could be developed
10. Support training and capacity building initiatives on rainwater harvesting
11. Make separate RWH lines for new constructions mandatory
12. Making scientific knowledge of sustainable water management mandatory to all relevant professional disciplines
13. Regulatory clauses in BGMEA/BKMEA policy to support, implement and monitor RWHS
14. Multiple sessions with top management from business associations like BGMEA, BKMEA, etc., as well as major brands, textile and apparel units, and technical and training service providers could be brought together to make the case for RWH.

2.7.2 Loan fund for pre-finance under "Program to Support Safety Retrofits and Environmental Upgrades in the Bangladeshi Ready-Made Garments (RMG) Sector Project (SSREU)"

This project comprises the fourth pillar among the necessary interventions of the Energy Efficiency & Conservation Master Plan up to 2030. The project fund was created with support from JICA. The three executing agencies that are implementing EECPF Project are SREDA, Infrastructure Development Company Limited (IDCOL), and Bangladesh Infrastructure Financing Fund Limited (BIFFL). IDCOL and BIFFL are the implementing financial institutions that extend low-interest loans. Both implementing financial institutions are provided the loan fund through the Finance Division of the Government of Bangladesh. EECPF Project utilizes a two-step loan or financial intermediate lending instrument.

Table 2: Terms of loans under the SSREU project

Item	Description
Loan Purpose	Safety remediation, environmental and social up-gradation of RMG factories
Loan Amount	BDT equivalent of EUR 1 million; may be extended up to BDT equivalent of EUR 3 million in case of (i) major environmental up-gradation or (ii) any other duly justified and documented case
Interest Rate	Maximum 7% per year
Maturity	3-5 years, maybe extended up to 7 years in the case of (i) major environmental up-gradation or (ii) any other duly justified and documented case
Incentive	Performance-based investment grant as a deduction from the loan account: 10% of the total loan related to safety remediation investment, 20% of the total loan related to environmental and/or social investments. The breakdown of investment grants among eligible RMG companies and PFIs would be 90:10

Agreements have been already signed between Bangladesh Bank and eleven financial institutions marking an important step for the project's implementation and paving the way for the next phases of remediation investment proposals and loans to RMG end borrowers.

Some of the barriers and/or hurdles for getting the loan are as follows:

i. **Only the registered export-oriented factories could get the loan**

ii. **The loan is tied with safety remediation i.e. no loan is available for environmental and/or social investments only. To get the loan the factories must provide evidence of full compliance to the CAP with positive review by the Independent Technical Assessors or must design their investment plans as recommended by the Corrective Action Plans (CAPs) prepared by Accord, Alliance, or the National Tripartite Plan of Action (NTPA before going for the E&S activities**

iii. **Factories may avail both facilities if they are eligible for investments, but at first, the safety retrofits have to be done, and then environment & social up-gradation**

iv. **The loan could be availed only from the 11 financial institutions registered for this program**

v. **Most PFIs are still getting familiar with such loans for the RMG sector hence the processing of loans might be too cumbersome for both parties that could end up in frustrations**

vi. **Contacting the potential factories in a coordinated way and make them interested especially in the COVID 19 is still developing**

3. Results and Discussions

3.1 Opportunities, Barriers, and Challenges from Global Perspective

It is quite evident from the study that the most significant barriers and challenges in the adoption of RWHS lie with the current water pricing, licensing agreement, and policy and regulations; which make the RWHS a far-from-lucrative option based on the financials alone, especially for the factories outside the EPZ as the payback periods are too high. “Free” water with no or hardly any regulation to extract groundwater outside the EPZ provides limited business cases for the textile and apparel sector and creates less enthusiasm or urgency to invest in water-efficient technology including RWHS that not only saves water and energy but also reduces production time, WTP/ETP cost, and pollution. In addition to that, lack of communications to the top management to convince for investing in improvement measures, non-holistic assessment with short-term planning focus and limited understanding of the long-term benefits, non-understanding of the business cases, limited market overview, lack of water management, the high upfront cost of investment, not sure about projected benefit or perception of high risk, different priorities, lack of policy or policy enforcement, lack of fund, knowledge or easy access to financing, lack of tax incentives, to name a few further hinders the adoption of RWHS in the textile and apparel industries of Bangladesh.

Financing, though one of the most important motivating factors for the adoption of improvement measures except RWHS could not, at least as of yet, played the desired role in shaping the textile and apparel sector. As the financial institutions are relatively new in processing the low-interest funds for environmental technologies, the loan processing mechanism is often complicated and not streamlined. This, along with other restrictions e.g. not reaching bulk factories or letting them know what financing is available became a contributing factor. On the policy or brand level, not getting any incentives from the policy authorities or getting slightly higher prices from the buyer were also contributing factors that act as barriers to adoption. On the institutional level, inadequate support for capacity development, not making loan processing comparatively easier by taking additional responsibility as well as not working as a knowledge hub to their capacity is also contributing to the slower adoption of the environmental improvement measures.

As a result, a comprehensive approach involving all stakeholders including BGMEA, BKMEA, BTMA and Brands shaping the policy, regulations, and requirements, financial, technical and training support is needed to implement RWHS attractive and feasible.

Having worked with nearly 400 textile and apparel factories in Bangladesh as well as learning from current and different studies, the identified barriers and challenges with possible remedies are summarized under five major categories and presented below:

Barrier In	Major Contributing Factors	Possible Remedies
Awareness and knowledge at the factory level	• Water is considered a “free” or very low-priced resource • High payback period for RWHS • Limited knowledge of low-interest financing and requirements, or not-so-interested to avail it • Environmental and/or social considerations are surpassed by financial returns • Fail to make a holistic assessment of the investment’s payback that needs to consider future resource price hikes, increased productivity, increased compliance, strict regulations, etc. • Low share of water cost got little attention compared to higher cost-saving measures • Existing building constructions/drainage system was not initially planned for incorporating RWHS • Inadequate engagement of decision-makers	• Raise awareness about the value of water, social and environmental consequences of depleting the water sources, and possible regulatory measures restricting water usage • Provide a simple assessment tool to roughly estimate the financials for implementing the RWHS • Provide sources of low-interest financing, and qualified service and training providers • Provide institutional/brand support to easily avail financing and technical support • Ensure all new constructions are designed with provision for RWHS • Help to develop a business case by any of the stakeholders including factory itself, brands, financial institution, trade bodies like BGMEA/BKMEA, promotors of RWH like WaterAid, RAiN Forum, 3rd party institutions/consultants, donors (through funded projects), etc.
Policies and enforcement of regulatory measures	• Absence of regulatory measures for water utilization • Not considering water as a natural resource as others e.g. gas, coal, minerals, etc. • Need for a proper policy like the Bangladesh National Building Code (BNBC 2020) or review of the policy to address current needs • Need for stimulating economic or non-economic incentives or duty-structure • Creating awareness about the value of water on a national level	• Review or formulating and/or strengthening policy, regulatory and legal frameworks as well as enforcing and implementing capabilities including a detailed plan for enforcing regulatory measures for water utilization • A comprehensive plan that includes preferential tax incentives e.g. stimulating economic or non-economic incentives or duty-structure • Accelerate the Zero Liquid Discharge (ZLD) initiative • Incorporation of RWH as a condition for renewing or issuing Environmental Clearance Certificate • Make separate RWHS for new constructions mandatory and ensure the compliance • Incorporating the value of water and benefits of RWH in the curriculum to create awareness in all generations especially in the younger generations

Barrier In	Major Contributing Factors	Possible Remedies
Financing	• Low awareness of the funding window and associated mechanisms among the majority of smaller and medium-sized RMG companies • Complex application process and loan processing • Stringent requirements or conditional loan tagged with other requirements e.g. safety measures • Preference for borrowers with strong financial strength only • Not-so-clear guidelines or instructions about loan processing • Many of the RMG factories are family owned and do not follow standard accounting and auditing rules to qualify for loans	• Elimination of complexity in application and loan processing through developing clear guidelines and training of lenders • Setting rational requirements or conditions for a loan that is achievable and attractive to borrowers • Inclusion of organizations like BGMEA, BKMEA, or BTMA to support getting loans for financially not-so-strong business units
Institution	• Non-existent or not-so-strong knowledge hub for awareness-raising, knowledge enhancing, and information sharing mechanism • Need for support especially for not-so-strong business entities • Need for one-stop service • Need for showcasing and implementing business models	• Strengthening existing organizations such as RAiN Forum that eventually leads to one-stop service for awareness-raising, knowledge enhancing, information sharing, showcasing, financing, training, and implementing business models • Support financially not-so-strong business entities in getting financing by acting as a partial guarantor, when needed
Brands	• Not all buyers give enough importance to RWHS in their factory evaluation process	• Brand's no-cost technical support e.g. assessment and design of RWHS • Encourage RWH through some financial mechanism e.g. early payment, partial advance payment, etc.

To tap the potentials or have large-scale adoption of RWHS, all of these barriers and challenges need to be properly addressed. A framework, which was originally proposed for the adoption of clean technology in the Bangladesh textile SMEs under a different study [1] is also found very relevant for this current study and is described below in some detail.

Proposed Framework

Currently, all stakeholders namely textile and apparel SMEs, financial institutions, technology suppliers, regulatory bodies, industry associations, and brands are more or less operating independently. However, bringing all the stakeholders to operate collectively under a framework could synergically achieve significant benefits for all. Especially, by getting appropriate institutional level support from the BGMEA, BKMEA, or BTMA in terms of financing, knowledge sharing, training, etc. as well as help in getting low-interest funding easily accelerated progress could be made in multiple areas including the implementation of RWHS. It is found that RWHS could easily be incorporated in the comprehensive implementation framework that was proposed in the USAID/EHS+ study to accelerate and streamlined the clean technology adoption process in the Bangladesh textile and apparel sector.

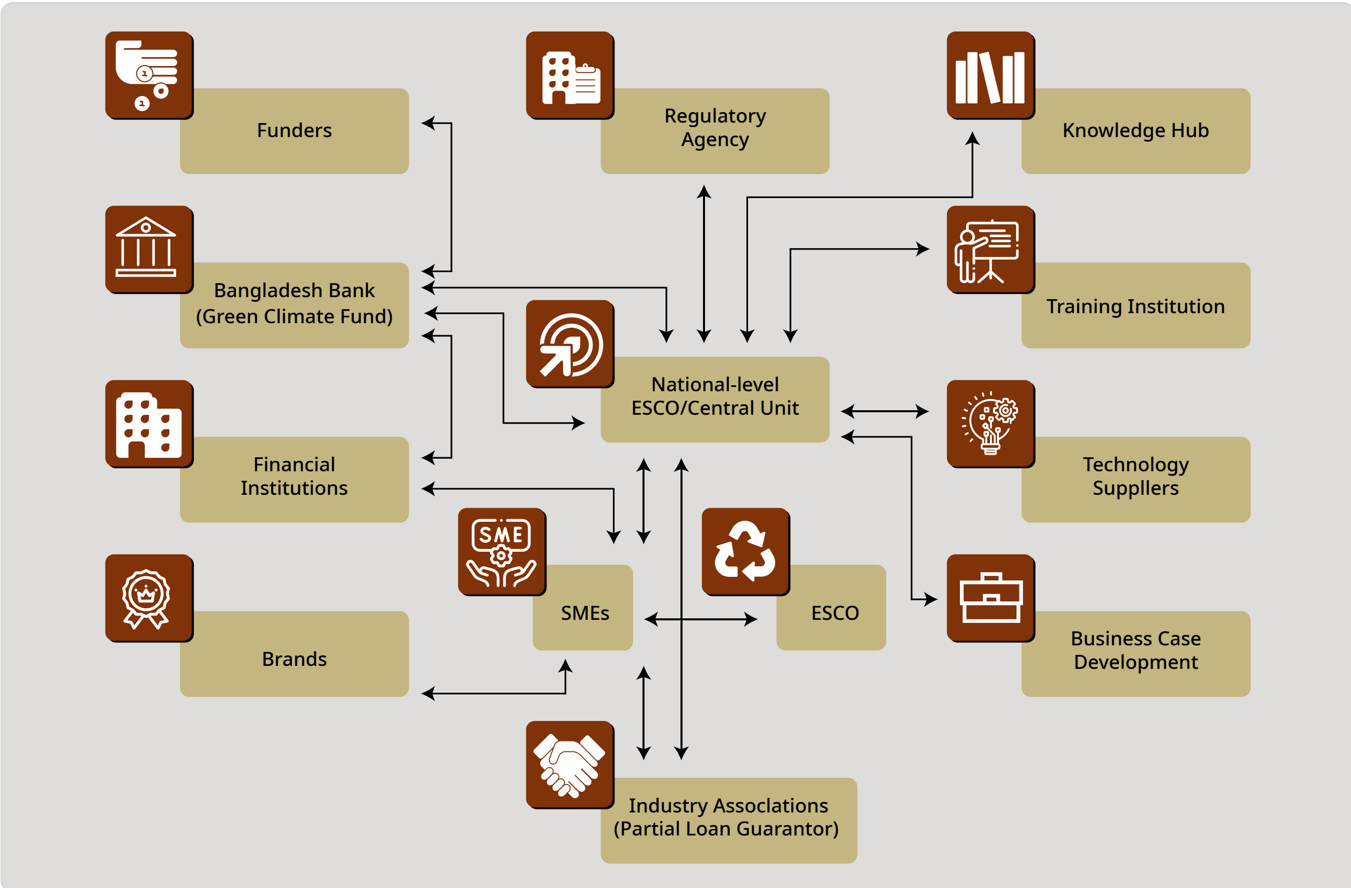


Figure 9: Proposed Model for Accelerating Adoption of RWHS and Clean Technology

The framework requires a Central Unit which could be an existing organization or could be a new entity formed by the GoB, who as a knowledge hub would collect and share all the relevant information, as a non-banking financial institution gets low-interest funding from donors through Bangladesh Bank, gets and aggregates demands from SMEs, procures materials and services in bulk from manufactures through an open tender at the lowest possible cost, makes financing easier for the SMEs by incorporating organizations like BGMEA, BKMEA or BTMA as a partial loan guarantor.

3.2 Opportunities, Barriers, and Challenges from Factory Perspective

The key objective of this study is to generate profound knowledge on rainwater uptake prospects, constraints, and the way forward in the apparel sector. This study will aim to underpin the chronological development of RWH in Bangladesh with a full and

3.2.1 Factory Selection

To assess the experience of implementation and operation of RWHS, information from 7 factories of different sizes, types, and clusters that already have implemented RWHS was collected. Table 2 shows the results:

Table 3: Glimpses of RWHS at Multiple Factories

Sl. No.	Factory Name	Size	Type	Location	RWHS Coverage	Volume Collected in 2020 (m^3)	Total Water Demand in 2020	% of Total Water Demand	Investment for RWHS (BDT)	Ground Water Cost (BDT/m^3)	Payback Period (year)	Motivation
1	A.K.M. Knitwear	Large	Washing	Savar	Partial	3478	1,750,000	0.20%	700,000	9.89	20.4	Buyer
2	Ananta Apparels Ltd.	Medium	Denim, Washing	Narayanganj EPZ	Total	7096	606,408	1.17%	500,000	38.89	1.81	Self
3	Apparel wet processing ltd.	Medium	WDF	Mymensing	Partial	4162	831,253	0.50%	600,000	1.78	81.0	Self
4	Dekko Designs Ltd.	Medium	Garment Washing	Savar	Partial	181	402,430	0.04%	200,000	3.78	292.3	Buyer
5	Dekko Garments Ltd	Medium	RMG	Gazipur	Partial	875	41,880	2.09%	850,000	22.73	42.7	Self
6	Pahartali Textile & Hosiery Mills Ltd.	Large	Spinning	Chattogram	Partial	8000	331,855	2.41%	4,588,047*	3.72	154.2	Buyer
7	Visual Knitwear Ltd.	Small	RMG	Chattogram	Total	2381	12,744	18.68%	250,000	5.27	19.9	Buyer

Even though all the factories except one did not include the cost of reservoir tank11 in the cost of implementing the RWHS, it is clear from the above table that except for EPZ where the water price is several folds higher than that for others, the payback period of RWHS is very high , which automatically discourage factory owners from implementing the system. Also, the amount of collectible rainwater is only a very small fraction of the total water demand in most cases and whose supply is also intermittent.

It could be mentioned that a major portion of the total cost is incurred for the reservoir and the pump, which must be incurred irrespective of the partial or total RWHS, it is not surprising that the payback period becomes significantly lower when the total catchment area is brought under the system to collect much higher amount of rainwater thereby increasing the benefit of the system.

The cost of a total RWHS widely varies based on the size and complexity of the system. From our experience of implementing several RWHS, it is found that the cost ranges from BDT 10-50 lacs with a payback period of not less than 25-30 years.

Out of the 7 factories, 4 factories implemented the RWHS to meet the buyer's requirements. Except for the factory inside the EPZ, the other two implemented it to enhance their image

7 Ref. [16] reported BDT 20-30 lacs for total RWHS based on 4 factories in Narayanganj.

to the buyers. It is quite evident that with the current water pricing and regulations, buyer requirements were the major influential factor for implementing the RWHS.

In addition to the 7 factories with RWHS, information was collected from 16 other factories without RWHS to find the willingness or preparedness, factors influencing the decisions, etc. to assess the opportunities, barriers, challenges in the implementation of the RWHS; as well as finding a “Representative” factory for which a detailed financial and environmental analysis could be done.

It was found that 9 out of the 16 factories (56%) are not implementing RWHS because of the high investment and higher payback period. The rest of the factories (44%) are considering it to either improving their Higg FEM score, meet brands’ current or future requirements or increase their images to the brands. Out of the 9 factories mentioned above, 8 of them would implement RWHS if it becomes a brand’s requirement, and 1 factory will not implement it at all.

It is quite evident from the above information that with the current water pricing and policies, the brand’s influence is the major determining factor for the apparel industry in implementing the RWHS.

It was also found that financing has very little impact on the implementation of the RWHS. Only 1 factory (6%) showed interest in getting financing while others might consider it as a part of a larger loan if the management pursues such loans. This is because the loan amount is too small compared to the tasks they need to perform in getting the loan, and eventually the factory has to pay back the money which has a very low return on investment. All showed some interest if they can get the loan interest-free for an extended period.

In determining the “Representative” factory, information for the physical infrastructures e.g. number, height, roof area, etc., of buildings/shade were collected. It is already known that the biggest challenge in defining a representative factory lies in the fact that each unit is unique when RWH is considered. Even for a factory with the same total roof area, the difference in number, type, height and locations of the sheds/buildings, number and size of the down-pipes, combined or separated sewer and rainwater lines, collection points- central or localized, usage pattern- domestic and/or process, cost of water- nearly “free” to 5-10 times higher in EPZ, to name a few, which make each unit practically incomparable to one another in terms of difficulty in designing RWH system as well as in financial terms. As a result, using the result of one “representative” unit to assess the business opportunity for 6350+ textile and apparel units of different types (spinning, weaving, washing and dyeing, composites, RMG, etc.) including nearly 4500+ RMG units, and considering mostly smaller units per requirements of the study makes thing far more complicated. However, developing an excel-based Estimation Tool that could incorporate nearly all the variations in design parameters mentioned above in estimating the financial and environmental benefits nearly eliminated all of the stated challenges. Table 3 below shows the details of the estimation of the “Representative” factory.

8 Environmental Compliance Opportunities in the Bangladeshi Ready Made Garments Industry: Lessons from the Green High Achievers, Economic Dialogue on Green Growth, Adam Smith International, September 2018.
9 www.idcol.org, www.sreda.gov.bd, www.biffl.org.bd, https://www.jica.go.jp/bangladesh/english/index.html

Table 4: Summary of the Physical Structures at non-RWHS Factories

Factory Type	Factory Size			Total Factory	Average for Shade			Average for Building			Distance to Reservoir (m)
	Small	Medium	Large		Number	Area (m^2)	Height (m)	Number	Area (m^2)	Height (m)	
RMG	9	1	0	10	4.5	10235	83	11.3	20272	214	240
Composite	2	2	1	5	2.3	872	13	4.9	6066	82	128
Spinning	0	0	1	1	0.0	0	0	2.8	12875	34	17
TOTAL	**11**	**3**	**2**	**16**	**6.8**	**11107**	**96**	**19.0**	**39213**	**330**	**385**
AVERAGE					**0.43**	**694**	**6**	**1.19**	**2451**	**20.6**	**24**

Please note that the approximate distribution of the RMG, composite, and spinning & weaving factories in Bangladesh is 4500 (71%), 750 (12%), and 1100 (17%), while the distribution of the sample for the current study was 63%, 31%, and 6%, respectively. Although efforts were made to keep the sample distribution close to the actual distribution of the universe under consideration, practical limitations especially collection and availability of information during the pandemic made it deviated from the target. As a result, correction factors of 1.13, 0.38, and 2.77, respectively i.e. the ratios of the corresponding distributions were used to align the data to represent the actual landscape of the apparel and textile industry in Bangladesh. The adjusted numbers appeared to be more representative of the universe under consideration.

From the analysis, the dimensions of the “representative factory were considered as follows:

Table 5: Dimensions of the Representative Factory

Installation	No.	Area (m^2)	Length (m)	Width (m)	Height (m)	Distance to Reservoir (m)
Shed	1	700	30	23.3	6	25
Building	1	2500	61	41	20	

3.2.2 Rainfall Information

Rainfall data for the six major areas namely, Chattogram, Dhaka, Hobiganj, Mymensing, Narayanganj, and Pabna, where most of the textile and apparel factories are located were collected for the year 1981- 2019 from Bangladesh Meteorological Department (BMD). Figure 9 and Figure 10 show the yearly rainfall and the 1-day maximum rainfall trend:

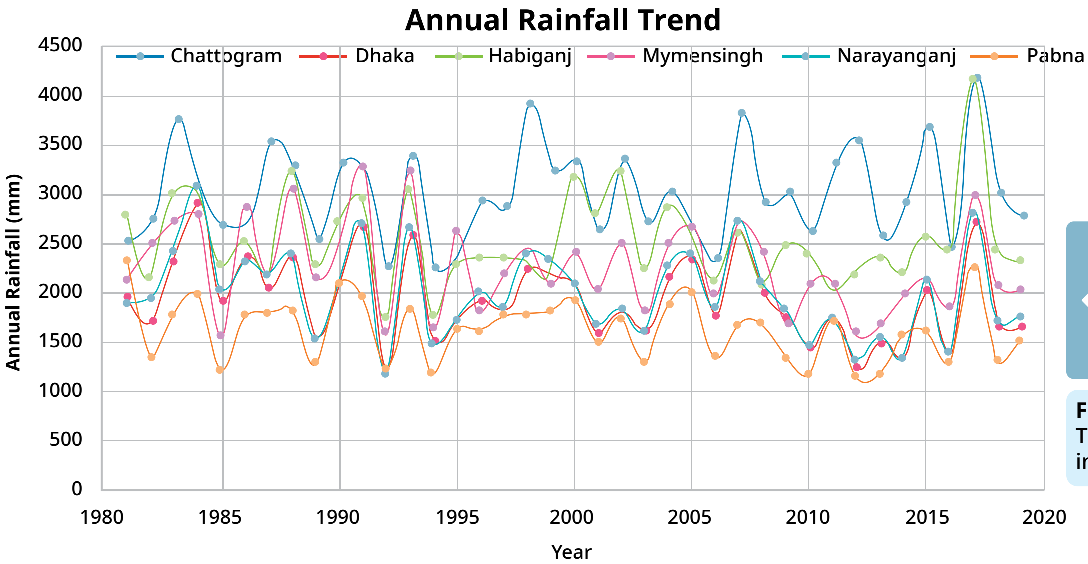


Figure 10: Annual Rainfal Trend for Six Major Areas in Bangladesh (1981 - 2019)

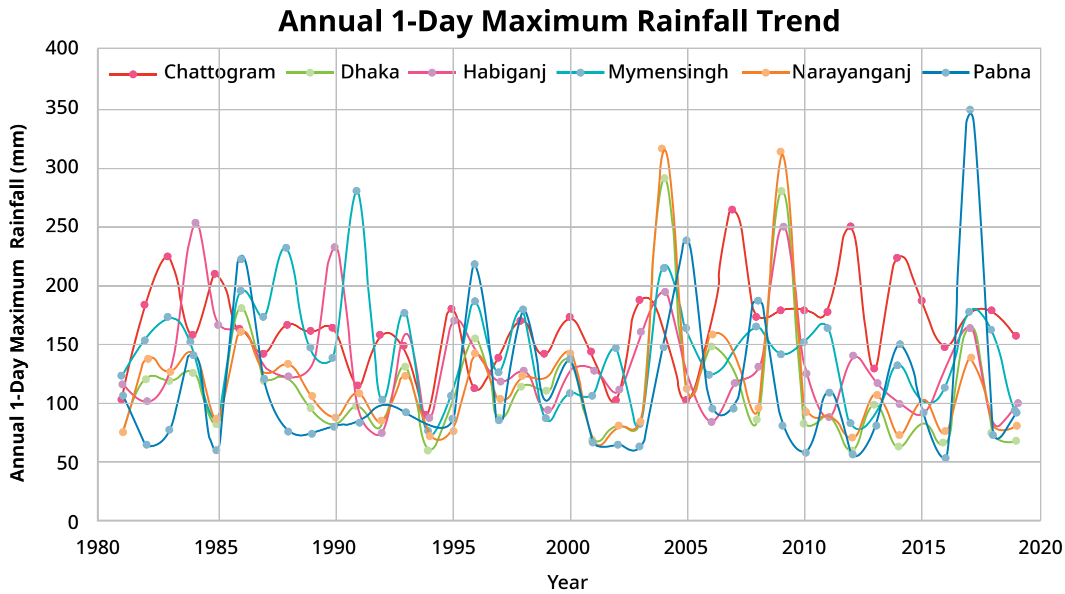


Figure 11: Annual 1-day Maximum Rainfall Trend for Six Major Areas in Bangladesh (1981 – 2019)

The figures above show sinusoidal variations in the rainfall trend, so does the 1-day maximum rainfall trend although not in the same sequence. Details of the rainfall data are presented in Annex. 6.3.

Since there is no clear trend in either yearly rainfall or the 1-day maximum rainfall figure, the average rainfall was considered for the designing purpose of the RWHS. To accommodate the maximum rainfall in a day in the design factor, this yearly rainfall was considered available during the six months of the monsoon season. Table 5 and Table 6 below show the average and the maximum rainfall data for six major areas in Bangladesh during 1981 – 2019.

Table 6: Average Rainfall Data for Six Major Areas of Bangladesh

Trend	Annual Rainfall (mm)					
	Chattogram	Dhaka	Habiganj	Mymensingh	Narayanganj	Pabna
AVG. (1981 – 2019)	3003	1927	2535	2271	2012	1631
Avg. Last 5 yr.	3215	1880	2804	2221	1972	1609
Avg. Last 10 yr.	3098	1658	2527	2057	1733	1487
Maximum	4133	2910	4188	3283	3100	2324
Minimum	2236	1183	1758	1562	1183	1156

Table 7: One-day Maximum Rainfall Data for Six Major Areas of Bangladesh

Trend	Annual Rainfall (mm)					
	Chattogram	Dhaka	Habiganj	Mymensingh	Narayanganj	Pabna
Maximum (1981 – 2019)	261	290	251	279	315	349
Max. Last 5 yr.	184	167	163	276	137	349
Max. Last 10 yr.	247	167	163	276	137	349

3.2.3 RWHS Design

Based on the information from the "representative factory" shown in Table 4, a RWHS has been designed. In designing the reservoir, both total RCC construction and brick wall with RCC floor (referred to as Brick) construction were considered. The volume of the reservoir was determined from the amount of collectible rainwater that could be reserved for one week. As the cost of the constructions especially for the Brick construction varies with the area of the wall and the floor, the lowest possible cost was determined by varying the wall dimensions and keeping the reservoir depth 5m or below for the safety of the constructions.

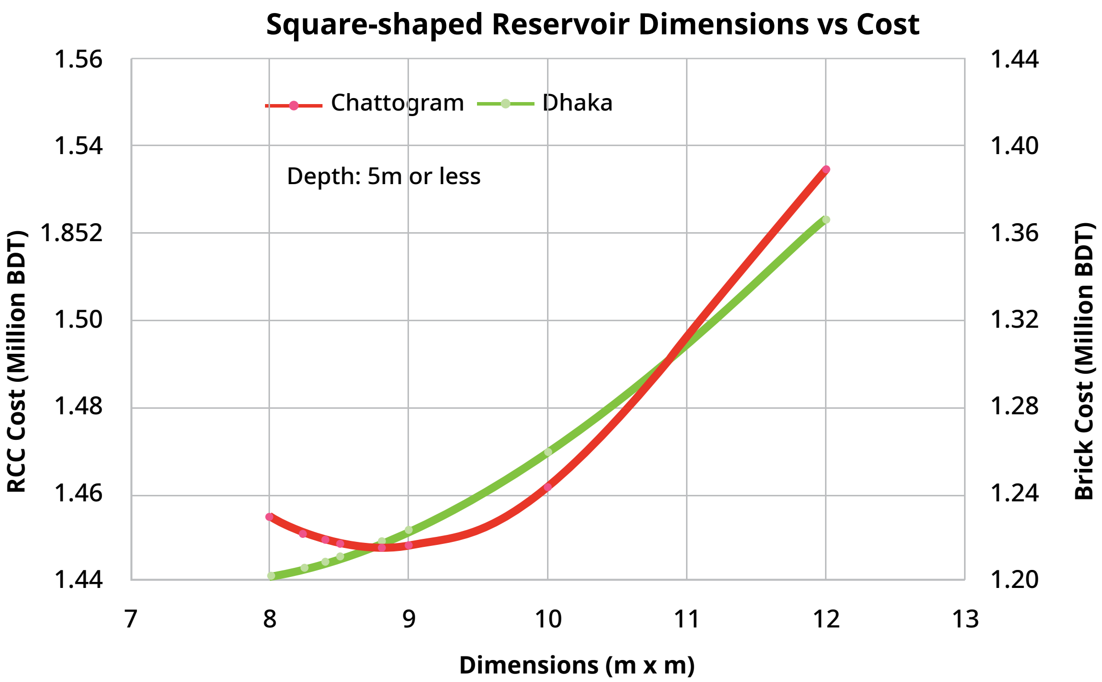


Figure 12: Tank Dimensions vs Cost of Reservoir (Square-shaped)

For simplicity, a square-shaped tank was considered while keeping in mind that the actual dimensions would be determined by the physical constraints of the implementing factory. Figure 12 shows that the minimum cost appears at around 9m x 9m for RCC construction and 8m x 8m for Brick construction while maintaining the depth of the reservoir at 5m or below. For the analysis purpose, an 8.5m x 8.5m tank was considered for both types of constructions. An excel-based Estimation Tool spreadsheet has been developed for calculating the cost of the RWHS where a number of inputs such as catchment area, building/shed dimensions including height, distance to the reservoir, runoff coefficient, reserve time, material and labor cost, etc. have been kept as variables so that factory specific cost of the RWHS could be readily estimated. One must, however, keep in mind that the actual cost of the RWHS depends on so many factors including the complexity of the piping system, materials and labor costs, reservoir location, or the type of use of the rainwater; the cost of the RWHS determined using the excel spreadsheet should, therefore, be taken as a best "Guesstimation" of the actual cost based on the available information. The Estimation Tool is attached in Annex 6.4.

3.2.4 Environmental Impact

Since aquifer recharge is not an option due to the DoE's restrictions as stated earlier, only GHG emission reduction from electricity savings due to reduced extraction of groundwater was considered. However, the benefit of reduced groundwater depletion and associated positive impacts are significant, and can't be ignored.

Bangladesh textile and apparel units get electricity from three major sources namely grid supply, captive generation using Natural Gas (NG) and backup generation using diesel; and sometimes a tiny amount from solar power plants. RMG units meet about 90% of their electricity demand from the grid and the rest from captive the generations while it is exactly opposite for the WDF factories, and other factories use some intermediate mix. Since the GHG emission factors vary widely with the source (Annex 6.4), the effective GHG factor is unique for each factory. As the concertation of the current study is mostly on the small RMG units, the energy mix of RMG units was used to calculate the weighted-average GHG factor. The Estimation Tool developed, however, has the option to change the mix to match that of any factory.

3.2.5 Financial Analysis

The cost of water extraction for the selected factories was found to be between BDT 1.4 – 6.6/m3. Based on the experience of working with about 400 textile and apparel units in Bangladesh, and where most apparel factories do not need WTP hence no cost incurred for water treatment, an average price of BDT 4/m3, which is the representative price for most of the factories outside the EPZ was considered. This price, which is about 10 times less compared to the same in the EPZ shows the clear advance of implementing RWHS inside the EPZ while showing how financially less favorable it is for the rest of the factories, and demonstrate the dire need for a comprehensive approach that includes water pricing, policy, incentives, financial support, to name a few to make RWH a lucrative and sustainable option.

Table 8 below shows the details of the financial analysis.

Table 8: Financial Analysis of the "Representative" Unit

	For RCC Construction	For Brick Construction
Cost of RWHS (BDT)	1,450,000	1,205,000
Savings from RWH (BDT)	32,700	32,700
Payback Period (year)	47	39
IRR (%)*	0.22	0.99
GHG Emission Reduction (tCO_2e)	2	2

*Water price BDT 4/m3 of extracted water. The lifetime of the RWHS = 50 years. BDT 2000/year maintenance cost, which is minimal, was considered.

It is quite evident from the analysis that to make the RWHS viable, water pricing or policy change, or a combination of both are required.

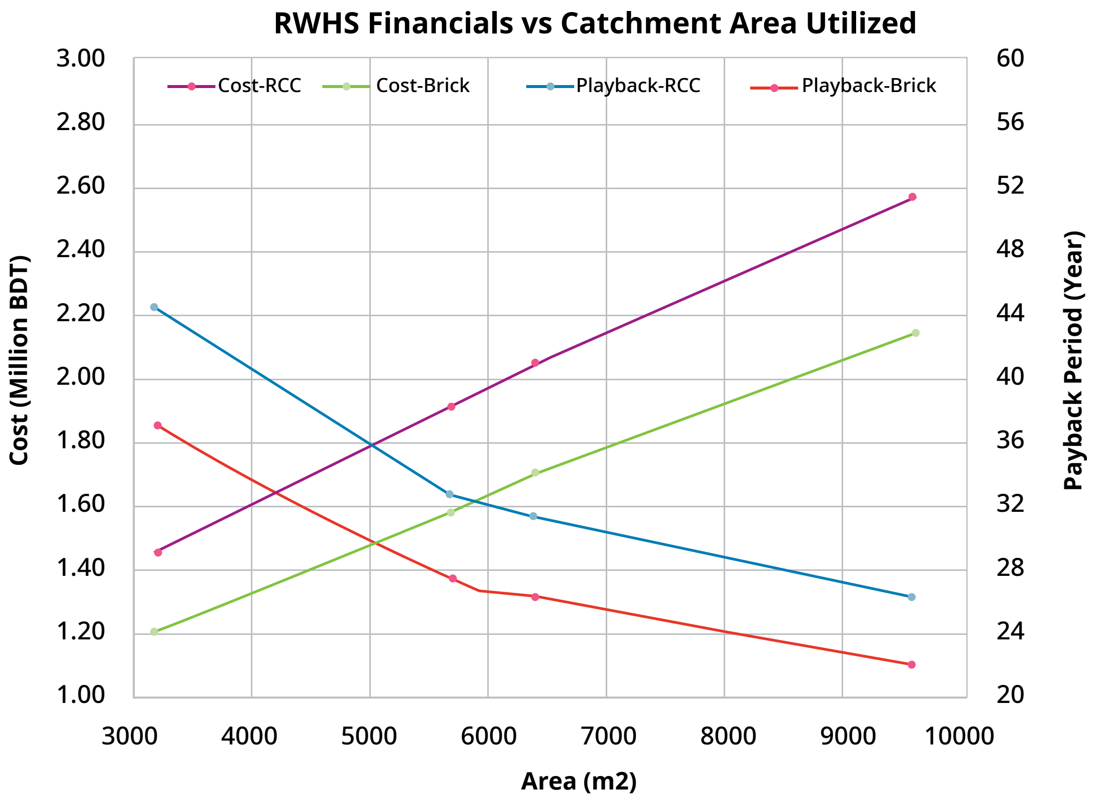


Figure 12: RWHS Financials vs Catchment Area Utilized

As it was found in the analysis of factories with RWHS, it is also evident from Figure 13 that although the cost increases, it is better to bring as much area as possible under the RWHS as the increased cost is compensated by the benefit and payback period gets significantly reduced for the bigger system .

12 It is interested to note that the cost estimation follows the thumb rule known as six-tenth rule i.e. a X time bigger or smaller unit would cost X0.6 times the cost of the base unit ± 30%. Here, the variation is within ± 10%.

4. Recommendations and Way Forward

It is quite evident from the study that with the current water pricing and policies, the financials alone are not sufficient to make the RWHS lucrative as the payback period is way too high especially for the factories outside the EPZ. The study also found that the factories that have implemented RWHS were motivated by other factors such as LEED certification, higher Higg FEM scores, meet buyer's selection criteria, etc., that would increase its image and selectability to the brands. In other words, encouragement or direct or indirect push from brands were almost the sole determining factor in implementing the RWHS. It is, therefore, policy support including licensing, certification, water pricing; encouragement from government agencies and trade bodies like BGMEA/BKMEA/BTMA, ease of financing, etc., are required for widespread dissemination of the RWHS in the apparel sector.

The message should be conveyed to the industry that even though rainwater harvesting may not be an absolute solution for the industries and could meet only a small part of the total water demand especially during the dry season, it would bring significant benefit by changing mindset that ultimately contributes to the sustainability in the broader sense. The cost of developing alternative water sources is substantial and could hinder the growth of this sector of the economy as the country is facing serious challenges in terms of the availability of blue water due to the alarming rate of groundwater depletion. It should also be kept in mind that to achieve environmental sustainability in industrial water use through the efficient use of groundwater, the development of systematic processes and effective monitoring tool is critical.

The following are the step that could be explored to create an environment that would significantly encourage the implementation of the RWHS in the apparel sector of Bangladesh. [16]

Policy Level

1. Change the existing groundwater licensing arrangements
2. Incorporation of RWH as a condition for renewing or issuing Environmental Clearance Certificate
3. The DoE regulatory bodies should be decentralized and strengthened to monitor RWHS of the industries if the installation of RWHS is made mandatory
4. Valuing water: While valuing water is not equal to the pricing of water, it can be a useful tool to determine equitable and incentivized pricing schemes for water.
5. Align existing incentives and provide more targeted incentives toward a cleaner textile and apparel industry

6. Explore other kinds of positive incentives that reward the industry's initiative to be more water smart and innovative
7. Green incentives should be better aligned with industrial incentives beyond environmental requirements, such as tax rebates for the adoption of greener technologies, tax exemption for import of cleaner technologies, and so forth
8. Broader stakeholder engagement in building the capacity of the textile and apparel industry toward sustainability
9. Establish a one-stop-service knowledge hub to promote research and wider dissemination of RWH related information, case studies, etc., to all stakeholders. A convenient platform for regular communications and interactions among the textile and apparel units, service providers, etc., along with a database with regular updates after necessary scrutinization and verifications of information could be developed
10. Support training and capacity building initiatives on rainwater harvesting
11. Make separate RWH lines for new constructions mandatory
12. Making scientific knowledge of sustainable water management mandatory to all relevant professional disciplines
13. Regulatory clauses in BGMEA/BKMEA policy to support, implement and monitor RWHS
14. Multiple sessions with top management from business associations like BGMEA, BKMEA, etc., as well as major brands, textile and apparel units, and technical and training service providers could be brought together to make the case for RWH.

Financing

1. **A fund can be set up to provide loans to factories and make it mandatory for the industry to set up a rainwater harvesting system.**
2. **Green incentives provided by Bangladesh Banks and other commercial banks and financial institutions need to be more targeted to medium and smaller enterprises, which face a higher barrier in adopting cleaner technology**
3. **BGMEA/BKMEA could help such enterprises in getting loans by providing some sort of loan guarantee mechanism**

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6. Annex

6.1 Objective of the Study

Specific objectives are:

- To analyze impacts and challenges of existing RWHS in apparel industries (small, medium, and large)
- To assess the potential of RWHS in industries without RWHS
- To conduct a detailed cost-benefit analysis of RWHS uptake for apparel industries using relevant metrics including Net Present Value (NPV) and Internal Rate of Return (IRR)
- To develop a costed business plan for RWHS uptake, including operations and maintenance
- To conduct carbon auditing of business-as-usual water usage and estimate the level of reduced emissions after adopting RWHS

6.2 Methodology

Step 1: Data Collection

A. Questionnaire Development

Questionnaires have been developed for data collection from the factories with and without RWHS, which is shown in Annex 6.5.

B. Data sources and information collection

Rainfall data: Location-wise historical rainfall data has been collected from the Bangladesh Meteorological Department (BMD) for the period 1981- 2020.

RWHS information: BGMEA was contacted to get relevant information on any such initiatives, and on incentives, instructions, policy measures, etc., that could influence the installation of RWHS.

Factories without RWHS from different clusters: Based on the size, type, and locations, information was collected from 16 factories using the structured questionnaires (Annex 6.5). The target was to select factories in the same proportion that exists in Bangladesh i.e. 75% apparel, 12% composite, and 17% spinning & weaving, with the preference given to small units for RMG factories. Details of the targeted factories and the selection criteria (S. M, L) are given in Annex 6.6.

Factories with RWHS from different clusters: Based on the size, type, and locations, information was collected from 7 factories using the structured questionnaires (Annex 6.5).

C. Identifying other relevant stakeholders

Several relevant stakeholders were identified and consulted to get their views on the prospect, opportunities, and challenges of RWH in the apparel industry in the context of water pricing, policy, SDG goals, awareness-raising, capacity development, etc.

Details of the consultations are given in Section 2.5.

Step 2: Landscape Analysis

A. Literature review:

To identify the initiatives taken, developments done, and/or knowledge gathered in RWHS, a thorough internet search, as well as consultation with known sources, were done. A preliminary search revealed that other than an initiative by WaterAid in four factories in Narayanganj, no such comprehensive initiative has taken place in the Bangladesh textile and apparel sector.

Policy level information e.g. groundwater extraction and pricing policy or planning were sought from DoE, WRG 2030, BGMEA as well as literature like Position Paper on Valuing Water in Bangladesh, 8th FYP, etc.

Policy and brand level Information was collected through KII with all stakeholders identified above.

Step 3: Scoping Study

A. Compilation and analysis of the collected information:

Information collected from all sources was compiled and analyzed.

B. Factory data analysis

Physical infrastructure data collected from the factories were analyzed to create a "hypothetical" factory that was considered and used as a "representative factory". The percentage of each type of factory e.g. apparel, washing, etc., in the Bangladesh textile and apparel sector were duly considered to give the proper weightage in determining the "representative" factory.

C. Cost of RWHS for representative factory

Preliminary design e.g. catchment area; number, length, and size of rainwater collection pipes, etc., to determine the investment for the representative factory was done. A decision support tool i.e. an Excel-based Estimation Tool to incorporate the variations in design parameters e.g. different sizes, locations, etc., in estimating the financial and environmental benefits has been developed.

A costed business plan i.e. thorough cost-benefit analysis including investment; social and environmental benefits, life-cycle savings, NPV, IRR, Payback Period, GHG emission reduction, etc., has also been performed

D. Environmental and social benefits of the RWHS

From the location-wise rainfall data, roof area, and considering the appropriate design factors, the amount of collectible rainwater was determined for the representative factory. The cost of the electricity was determined from the energy mix e.g. grid, natural gas, or diesel used for the electricity generation. The savings from RWH were determined from the electricity cost for groundwater extraction/pumping. Provision has been made to include the WTP cost as well when the water is to be used as the process water.

E. Carbon footprint reduction

From the average energy mix used for electricity generation, the average GHG emission factor was calculated. The carbon footprint reduction was then calculated from the savings in electricity multiplied by the average GHG factor.

F. Identifying opportunities, barriers, and challenges

From the information collected through the structured questionnaire and the KII, the opportunities, barriers, and challenges identified in the implementation, operation, and financing of the RWHS were compiled and analyzed. Impact of how the governmental policy change and/or implementation, brand's policy, access to green financing, or any other factors that could influence the implementation of RWHS were duly considered.

Step 4: Draft Report

Draft report based on the collected information and per study objective containing details of the analysis and findings has been prepared and shared with WaterAid for review.

Step 5: Final Report

A final report has been prepared to incorporate the feedback and recommendations from WaterAid within the scope of work. Key findings, recommendations, and way forward would be shared with the audience/stakeholder as arranged by Water/Aid.

6.3 Yearly Rainfall and 1-day Maximum Rainfall Data for Six Major Areas of Bangladesh

Year	Annual Rainfall (mm)					
	Chattogram	Dhaka	Habiganj	Mymensingh	Narayanganj	Pabna
1981	2515.115	1958.393	2792.205	2130.343	1922.451	2324.386
1982	2736.621	1707.259	2158.486	2499.35	1952.697	1353.049
1983	3763.951	2297.004	3002.066	2720.839	2436.818	1783.255
1984	2983.141	2909.95	3003.878	2787.807	3100.348	1978.77
1985	2674.098	1911.859	2291.331	1562.348	2044.91	1217.711
1986	2693.351	2385.547	2527.206	2875.53	2340.072	1759.757
1987	3517.962	2047.122	2247.906	2173.844	2202.997	1797.279
1988	3283.137	2333.005	3237.919	3051.806	2405.566	1817.644
1989	2547.635	1537.326	2287.872	2156.151	1545.157	1288.64
1990	3298.232	1999.14	2713.108	2448.979	2101.37	2087.759
1991	3264.022	2664.739	2952.868	3283.213	2719.8	1946.422
1992	2254.378	1183.198	1757.743	1603.062	1183.184	1240.226
1993	3372.141	2590.055	3060.989	3217.207	2678.284	1840.561
1994	2235.727	1480.591	1790.437	1654.573	1515.739	1188.531
1995	2425.284	1729.748	2293.956	2612.596	1732.686	1626.549
1996	2926.129	1917.813	2352.154	1820.391	2025.119	1614.29
1997	2860.931	1784.637	2347.596	2206.476	1871.283	1756.454
1998	3901.922	2237.624	2324.22	2448.972	2412.398	1781.485
1999	3226.256	2172.053	2176.584	2086.671	2343.864	1816.042
2000	3325.325	2076.479	3183.884	2388.064	2110.61	1940.542
2001	2618.439	1600.181	2799.322	2027.906	1700.146	1512.277
2002	3334.646	1840.496	3238.459	2510.49	1851.81	1763.732
2003	2707.758	1586.34	2248.987	1797.457	1623.08	1311.015
2004	3015.648	2162.78	2877.514	2496.069	2297.015	1877.913
2005	2589.24	2335.561	2596.022	2654.203	2407.642	2016.454

Year	Annual Rainfall (mm)					
	Chattogram	**Dhaka**	**Habiganj**	**Mymensingh**	**Narayanganj**	**Pabna**
2006	2333.787	1772.541	2129.062	1977.702	1856.056	1358.168
2007	3818.22	2613.998	2635.573	2719.456	2755.194	1692.974
2008	2904.606	1994.661	2100.585	2417.718	2144.37	1685.523
2009	2999.263	1743.509	2484.784	1666.815	1851.878	1353.357
2010	2619.583	1448.049	2411.968	2106.706	1471.839	1182.273
2011	3296.499	1630.274	2046.574	2081.302	1754.774	1732.181
2012	3536.408	1254.691	2208.288	1589.787	1335.391	1155.88
2013	2553.872	1481.65	2378.184	1692.007	1568.231	1173.979
2014	2899.431	1362.374	2203.749	1998.009	1344.793	1587.408
2015	3687.133	2024.386	2604.617	2139.212	2126.1	1614.813
2016	2483.316	1320.428	2455.715	1866.169	1413.669	1306.783
2017	4132.892	2708.808	4188.26	2997.278	2820.406	2281.465
2018	3001.012	1671.639	2446.605	2071.381	1721.282	1325.42
2019	2769.149	1673.732	2326.668	2030.237	1776.051	1514.209
AVG.	3003	1927	2535	2271	2012	1631
Avg. Last 5 yr.	3215	1880	2804	2221	1972	1609
Avg. Last 10 yr.	3098	1658	2527	2057	1733	1487
Maximum	4133	2910	4188	3283	3100	2324
Minimum	2236	1183	1758	1562	1183	1156

Year	1-day Maximum Rainfall (mm)					
	Chattogram	**Dhaka**	**Habiganj**	**Mymensingh**	**Narayanganj**	**Pabna**
1981	100.559	74.254	115.679	119.888	74.543	105.859
1982	181.01	120.131	101.199	149.735	136.455	62.729
1983	222.087	118.203	125.727	171.636	125.209	76.68
1984	154.598	124.797	251.455	150.712	141.558	140.185
1985	207.66	81.814	166.935	63.907	86.183	58.821
1986	162.872	180.906	161.364	193.453	160.263	220.673
1987	140.232	122.12	131.909	171.963	125.399	118.838
1988	165.057	122.843	121.915	229.807	132.222	74.066
1989	157.918	96.543	130.311	145.506	106.306	71.595
1990	161.35	79.574	231.583	135.749	87.336	78.534
1991	112.502	96.427	90.011	279.031	108.196	82.362
1992	155.697	77.498	74.844	102.823	83.083	95.809
1993	145.012	130.265	156.591	176.536	123.683	90.275
1994	93.995	59.297	88.8	74.407	71.752	78.37
1995	178.373	101.749	169.523	104.074	76.573	85.064
1996	108.904	154.554	141.283	183.946	141.668	215.796
1997	136.348	87.766	118.747	123.129	102.352	82.543

Year	1-day Maximum Rainfall (mm)					
	Chattogram	**Dhaka**	**Habiganj**	**Mymensingh**	**Narayanganj**	**Pabna**
1998	166.367	114.479	127.314	177.397	121.353	176.258
1999	140.059	109.553	93.843	85.188	120.36	101.783
2000	170.114	134.944	127.248	107.077	140.94	134.187
2001	142.372	68.411	127.346	103.971	66.556	65.022
2002	99.388	81.068	110.351	145.147	79.076	63.107
2003	184.885	77.581	160.187	80.259	83.617	61.392
2004	165.193	290.051	193.633	213.277	314.744	145.56
2005	100.038	112.084	120.94	161.129	110.206	235.584
2006	155.401	147.656	84.077	122.082	157.746	92.97
2007	261.498	128.348	117.694	141.506	141.354	94.093
2008	170.735	85.828	129.385	162.794	95.471	187.332
2009	175.996	279.517	249.294	139.319	311.115	79.153
2010	176.749	82.758	125.185	149.535	91.568	56.224
2011	174.866	89.389	87.49	162.357	89.303	108.377
2012	247.482	59.264	139.186	81.071	69.705	54.073
2013	127.498	98.112	114.93	87.413	106.467	79.318
2014	220.338	61.209	100.144	129.669	71.353	149.201
2015	184.383	82.84	91.788	99.543	102.813	90.569
2016	145.747	66.687	130.963	110.507	76.245	52.068
2017	171.973	167.469	163.493	176.456	137.219	349.261
2018	175.209	74.151	83.985	159.511	79.522	70.792
2019	154.194	65.826	99.629	83.569	79.402	91.376
Max	261	290	251	279	315	349
Max. Last 5 yr.	184	167	163	176	137	349
Max. Last 10 yr.	247	167	163	176	137	349

6.4 Excel-based Estimation Tool for Calculating Cost of RWHS

Basic Assumptions

1. All budlings/shades of a factory have existing downpipes for rainwater, hence no cost for downpipes was considered i.e. costing is done for existing buildings/shades.

2. Four larger-dia pipes- two slanted ones connecting all the downpipes on two sides, the 3rd one connecting these two, and one vertical

3. 4” ID pipe was found good enough for the 4 pipes mentioned above. A 6” ID pipe was considered for the one taking the water from the bottom of the buildings/shades to reservoir. Since the cost of the pipes and fittings, and associated labor cost is only about 5% of the total cost of the RWHS, some variation in these diameters would have a negligible effect on the cost estimations.

4. GHG Emission factors:

Fuel/Source	GHG Emission Factor*	Unit
Grid Electricity	0.000762	tCO2e per kWh
Natural Gas	0.001926	tCO2e per m3
Diesel	0.002715	tCO2e per liter

Source: Higg FEM 2019

With the typical 30% generator efficiency, 1 m^3 of NG or 1 liter of diesel produces approximately 3.33 kWh of electricity. That translates to the following GHG Emission factor for electricity:

Source of Electricity	GHG Emission Factor	Unit
Grid Electricity	0.000762	tCO2e per kWh
Natural Gas	0.0005784	tCO2e per kWh
Diesel	0.0008153	tCO2e per kWh

6.5 Questionnaire for RWHS prospects in Textile and Apparel Industries in Bangladesh

Factories with RWHS

Name of the factory:	
Name of the group:	
Location:	
Factory type:	
Production capacity:	
Number of shifts (please specify shift length):	
Number of workers per shift:	
Number of management personnel:	
Total water consumption: (provide monthly record, if possible)	
i. Process water	
ii. Domestic water	
iii. Others (please specify)	
Do you know your water extraction cost?	
If no:	
❏ Number of submersible pumps:	
❏ Pump details (depth, capacity & running hour)	
Do you have WTP? If yes, quantify the amount of water treated per month.	
Facility roof area details:	
i. Number of sheds & buildings	
ii. Total roof area of sheds & buildings	
iii. Height of the sheds & buildings	
iv. Please provide a copy of the factory layout	
When did you first start rainwater harvesting in the facility?	
Are you harvesting partially or from all possible areas (if partially, specify area)	
Was the project self-initiated or recommended by any buyer/external authority?	
How did the management/higher authority react to this initiative at the beginning?	
Was there any challenge faced from the top management? If yes, how did you overcome that?	

What was the investment for the RWHS?	
Did you receive any loans/financial aid/benefits from any source for implementing RWHS?	
What is the amount of rainwater collected per year in your facility?	
What is the size of the RWHS reservoir in the facility?	
For which purpose do you use the harvested rainwater (Process/domestic/others(specify)?	
Is there any monthly/yearly maintenance cost to operate the RWHS? If yes, specify the cost.	
How long do you expect the RWHS to last before any major reconditioning/repair?	
What are the current challenges of running an RWHS in your facility?	
What have been the benefits of the RWHS? What was the response of the workers/buyers/other auditors to it initially?	
Has the facility received any recognition for implementing RWHS?	
What are the necessary steps to make RWHS more lucrative to the facilities where RWHS still doesn't exist? What are the ways to overcome the primary challenges of RWHS?	
How motivated/determined is the factory to sustain rainwater harvesting in the facility in the future?	
Has the facility faced any shortage of water over the past 12 months?	
Where is the underground water level in your area (meter or ft)?	

Factories with RWHS

Name of the factory:	
Name of the group:	
Location:	
Factory type:	
Production capacity:	
Number of shifts (please specify shift length):	
Number of workers per shift:	
Number of management personnel:	
Total water consumption: (provide monthly record, if possible)	
i. Process water	
ii. Domestic water	
iii. Others (please specify)	
Do you know your water extraction cost?	
If no:	
❏ Number of submersible pumps:	
❏ Pump details (depth, capacity & running hour)	
Do you have WTP? If yes, quantify the amount of water treated per month.	
Facility roof area details:	
v. Number of sheds & buildings	
vi. Total roof area of sheds & buildings	
vii. Height of the sheds & buildings	
viii. Please provide a copy of the factory layout, and mark a possible place for a storage tank if RWHS is implemented	
❏ If yes	
i. Want to implement RWHS in your facility fully or partially?	
ii. If partially, how much of the roof area do you want to utilize for RWHS?	
iii. Do you have any space to build a RW reservoir?	
iv. Does the facility already have a separate piping and drainage system in place for rainwater?	

v. When do you want to implement the project?	
vi What will be the use of the harvested rainwater (Process/domestic/others(specify))?	
vii Do you require any financial aid to implement the RWHS?	
viii. Do you expect any change in water use behavior among the workers if the RWHS is implemented?	
❑ If no	
i. What are the reasons for not implementing?	
ii. Would you do it if there is an obligation from the brands/buyers?	
iii. Do you have any previous experience in RWHS?	
What are the necessary initiatives by the brands & policymakers to make RWHS lucrative to the factories?	
Has the facility faced any shortage of water over the past 12 months?	
Where is the underground water level in your area (meter or ft)?	

6.6 Factory Size and Selected Factories

Factory Type	Factory Size		
	Small (S)	Medium (M)	Large (L)
RMG		2000-5000 workers	> 5000 workers
Spinning		10-40 ton/day	> 40 ton/day
Composite (more than one type e.g. RMG + washing)		10-40 ton/day	> 40 ton/day
Only Washing		10000-30000 pieces/day	> 30000 pieces/day
Only Printing		10000-30000 yards or pieces/day	> 30000 yards or pieces/day
WDF (Washing, Dyeing, Finishing)		20 - 40 ton/day	> 40 ton/day

6.7 Factory Size and Selected Factories

Factory with RWHS

Sl. No.	Unit Name	Capacity	Factory Type	Location
1.	A.K.M. Knitwear	Large	Washing	Savar
2.	Ananta Apparels Ltd	Medium	Washing	EPZ, Narayanganj
3.	Apparel Wet Processing Ltd.	Medium	WDF	Mymensing
4.	Dekko Design Ltd.	Medium	Washing, RMG	Ashulia, Savar
5.	Dekko Garments Ltd	Medium	RMG	Mawna, Gazipur
6.	Pahartali Textile & Hosiery Mills	Large	Spinning	Chittagong
7.	Visual Knitwear Ltd.	Small	RMG	Chittagong

Factory without RWHS

Sl. No.	Unit Name	Capacity	Factory Type	Location
1.	Al-Muslim Apparels Ltd.	Small	RMG	Ashulia, Savar
2.	Billah Resources Limited	Small	RMG	Tongi, Gazipur
3.	Body fashion Pvt Ltd.	Small	Composite	Joydevpur, Gazipur
4.	Body Link Sweater Ltd.	Small	Sweater Washing, RMG	Joydevpur, Gazipur
5.	Dekko Ready Wear Ltd.	Small	RMG	Mirpur, Dhaka
6.	Fashion Step Limited	Small	RMG	Tongi, Gazipur
7.	MG Niche Flair Ltd.	Small	RMG	Narayanganj
8.	Organic Jeans Ltd.	Small	RMG	Chittagong
9.	Helicon Ltd.	Small	RMG	Ganakbari, Savar
10.	Pimkie Apparels Ltd.	Small	RMG	Tongi, Gazipur
11.	Northern Fashion Ltd.	Small	Composite	Sadar, Gazipur
12.	Auko-Tex Limited & Yasin Knittex Industries Limited	Medium	Composite	Sadar, Gazipur
13.	Nafa Apparels Ltd.	Medium	RMG	Kaliakoir, Gazipur
14.	K. C. Lingerie	Medium	Dyeing, Printing, RMG	Narayanganj
15.	International Classic Composite Ltd.	Large	Dyeing, Washing, RMG	Joydevpur, Gazipur
16.	Pahartali Textile & Hosiery Mills Ltd.	Large	Spinning	Pahartali, Chittagong