

Green Industrialization as a Solution to the Energy Crisis in Bangladesh: A Study about Green RMG Factories in Bangladesh

Md. Ahsan Habib, Mahfuja Akter, Rejoana Islam, & Kazi Md. Yusuf

Abstract

This research paper aims to investigate the potential of green industrialization as a solution to the energy crisis in Bangladesh, with a specific focus on the ready-made garment (RMG) sector. The purpose is to assess the economic viability of implementing green practices in RMG factories and their impact on energy consumption, environmental sustainability, and overall economic development. The study employs a comprehensive approach, utilizing a mix of qualitative and quantitative methods. It includes an analysis of green manufacturing processes, energy-saving measures, and the use of renewable energy sources in 30 RMG enterprises. The research also explores challenges faced by the industry in adopting green practices, such as higher initial costs, reliance on foreign consulting firms, and customer behavior. Green manufacturing processes in RMG companies result in decreased energy use, increased use of renewable energy, reduced water consumption, and decreased noise pollution. About 63% of businesses employ some form of renewable energy, with popular measures including the use of solar panels, turbo ventilation, and daylighting systems. However, the study also identifies challenges such as higher installation costs, reliance on foreign expertise, and customer reluctance to pay more for green products. The findings may not fully represent the entire industry, and variations in practices across different regions and sizes of enterprises may exist. The need for government subsidies, awareness campaigns to promote green practices among factory owners, and incentives for importing eco-friendly machinery. The study focuses on a sector critical to Bangladesh's economy and its potential to contribute to sustainable development goals and address the energy crisis.



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About Author (s)

Md. Ahsan Habib (corresponding author), Lecturer, Department of Economics, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

Mahfuja Akter, Assistant Professor, Department of Economics, Bangabandhu Sheikh Mujibur Rahman Science and Technology University (BSMRSTU), Gopalganj-8100, Bangladesh.

Rejoana Islam, Associate Professor, Department of Economics, University of Barisal, Bangladesh.

Kazi Md. Yusuf, Lecturer, Department of Marketing, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

1. Introduction

1.1 Background of the study

The green manufacturing emphasizes resource- and highly energy-efficient, low-carbon, low-waste, ecologically friendly, safe, and manufacturing products that are effectively managed during their span of existence patterns of production and consumption. Green production methods attempt to mitigate the adverse impacts on the environment, preserve natural resources and energy, and are sustainable in the long term (UNIDO, 2011). A key factor in determining the economic sustainability and long-term success of activities focused on the Sustainable Development Goals (SDGs) is the greening of industries. By promoting energy security, workplace health and safety, job creation, and cost savings through increased productivity of the Bangladeshi Ready-Made Garment (RMG) sectors, the greening of industries also plays an essential role in the reduction of poverty and the preservation of the environment. About 36.92% of the GDP is currently contributed by industry to the national economy, which is an increase over time (Bangladesh Economic Review, 2023). Green industrialization for sustainable development has been prioritized under the Industrial Policy of 2016. Governmental incentives have been implemented to promote green industrialization. The textile industry, which includes a variety of small to big privately and publicly owned businesses, has long played a significant part in the national economy of Bangladesh. At present, Bangladesh's textile sector employs 45 percent of the nation's workforce in the industrial sector and contributes 13.10 percent of the country's overall income. Nearly 4.2 million individuals work in the sector, largely women. According to the most recent data available, textiles and clothing account for an enormous 81.7 percent of the nation's export earnings (Bangladesh Economic Review, 2023). There are now 171 RMG factories that are green. Bangladesh now has the highest proportion of green RMG industries and is the country with the greenest manufacturing overall. Notably, Bangladesh is home to nine of the top ten greenest apparel factories worldwide. There are many advantages to using eco-friendly materials in construction projects, including the ability to get more business from global brands and dealers. Compared to a normal RMG production, a green factory consumes 41% less energy, 40% less water, and 35% less carbon. Green buildings also result in a 25% reduction in energy use and a 50% reduction in water use (International Finance Corporation, 2019). And the recent decision by Bangladesh to shut down ten coal-fired power plants has been hailed as a triumph in the fight to recognize climate change as a crucial aspect of sustainability and becoming green. Bangladesh had been working closely with its neighbors India, Nepal, and Bhutan on regional power distribution. US corporations may look into potential for investment in the energy sector. The global energy crisis has implications for Bangladesh and many other nations. To achieve its energy needs, the nation mainly relies on non-renewable energy sources like natural gas, coal, and oil. In these circumstances, the green industry is seen as a pragmatic and promising approach to alleviate Bangladesh's energy crisis while fostering social, economic, and environmental development. The resolving of the energy problem and fulfilling the nation's sustainable development goals can both be considerably aided by the promotion and growth of green industries. Green industry methods present prospects for resource efficiency improvement, job creation, and poverty reduction in addition to aiding in the solution of the energy crisis. Studies on Bangladesh's green industrialization techniques are relatively uncommon. This study will contribute to elucidating the current state of such practices in many sectors of the economy, particularly in Bangladeshi RMG manufacturing. Researchers, extension service providers, students, and especially planners are expected to find the study's findings to be very helpful in developing and planning extension methods for incorporating green industrialization activities. The primary objective of this study is to identify the state of green industrialization within the ready-made clothing sector in Bangladesh. To achieve this overarching goal, the study delineated specific objectives. Firstly,

it aims to evaluate the effectiveness of green manufacturing practices as a strategic response to the energy problem confronting the nation. This assessment encompassed an in-depth analysis of sustainable manufacturing techniques and the integration of renewable energy sources within the ready-made clothing industry. Secondly, the study tries to investigate the broader implications of green industrialization, focusing on its impact on both the socioeconomic structure and the environment.

1.2 Statement of the problem

Green factory architectures are responsive to the environment in their planning, design, construction, and process, reducing or eliminating adverse impacts while recovering the value of life throughout the course of the structure's lifecycle. These structures provide a healthier working environment because to improved air circulation, increased sunshine exposure, less pollution, and chemical paints and finishes made without harm. The environment's increased quality not only stimulates workers and increases retention and productivity while also reducing the prevalence of many breathing disorders like asthma and respiratory allergies. The current study's objective is to assess the effects of RMG's green industrialization as a potential remedy for Bangladesh's energy issue. This study will try to find the prospects and challenges of green industrialization as a reply to energy crisis in Bangladesh. The study tries to identify the innovation, promotion of renewable energy to achieve Sustainable development.

1.3 Scope of the study

There are already more than 5400 ready-made clothing factories in Bangladesh, both environmentally friendly and non-green, complaint-free and complaint-filled (BGMEA, 2019). Green manufacturing has expanded its efforts to include initiatives such as facilitating employee transportation for RMG employees and enhancing the working environment, occupational health, and welfare (Islam et al. 2021). The frequent interruptions in power, restricted access to electricity in remote areas, and barriers to industrial and economic development are all outcomes of the energy crisis. To effectively address this situation, it is crucial to explore alternative energy options, such as green industrialization (World Bank, 2020). Bangladesh has pledged to accomplish the Sustainable Development Goals (SDGs) of the United Nations (UNDP, 2018). This study aims to close the information gap by providing a thorough examination of the role, positive aspects, difficulties, and prospective routes for green industrialization in Bangladesh. The challenges of socioeconomic growth and the environment demand more focus and thorough investigation (Islam et al. 2021). Research on how Bangladesh's green industry is developing in connection with the performance of various enterprises is essential (World Bank, 2020). Despite time and resource limitations, this study's topic of interest is the green industry, expected to be valuable for researchers, extension service providers, students, and policymakers in developing and implementing strategies for green industrialization operations (Islam et al. 2021). The Dhaka, Narayanganj, Gazipur, and Rangpur Districts of Bangladesh will be a major beneficiary of the study's findings, but the results might also be applicable in other parts of Bangladesh where geographical, physical, socioeconomic, and cultural factors are similar to those in the research area (World Bank, 2020; BGMEA, 2019). The research aims to broaden the researcher's scope of knowledge and make a substantial contribution to the green industrialization of the RMG industry and the improvement of the nation's environmental conditions altogether.

2. Literature review:

2.1 The energy crisis in Bangladesh

As a result of Bangladesh's severe energy crisis, load shedding has grown and there is a shortage of gas and other essential fuels for industry and commerce. More severe and frequent load shedding has been occurring recently, lasting several hours each time. This has had a

negative impact on people's lives, businesses, industry, and the economy. Production and business operations have been badly affected by this, especially in energy-intensive industries like textile, leather, RMG, ceramic, metal, and steel. The situation has gotten so bad that many sectors are now pleading with the government to guarantee gas and power delivery even at a greater cost (Islam et al. 2021). The business and manufacturing sectors in Bangladesh have been dealing with serious difficulties. Many tasks that are energy-intensive in manufacturing operations strongly rely on the power supply. The industrial sector in Bangladesh has been severely impacted by the energy shortage. Load shedding has an impact on manufacturing processes and output, as well as raises operating costs and lowers competitiveness in local and international markets. Significant societal and economic expenses, both direct and indirect, are associated with load shedding. The immediate economic consequences result from production disruption, increased production costs, product deterioration, and increased system adjustment costs (Chen et al., 2017).

2.2 Green initiatives in global RMG industry

According to Chen et al. (2017), a green industry could significantly boost the socioeconomic progress of a nation and create the ideal environment for long-term industrial growth. According to this study, 45% of the industry has utilized green technology, followed by the service sector at 65%, the agricultural sector at 55%, and the manufacturing sector at 24%. As the annual growth rate of exported green goods grew, this study also demonstrated a relationship between China's national economic development and the growth of the green industry. This study also showed that China's GDP would improve by 0.04% for every 1% increase in exports of green products. Hoque and Clarke (2013) demonstrated that taking advantage of Bangladesh's potential pollution prevention activities can reduce environmental degradation and hence cut costs. Jia et al. (2017) remarked about how industry's resource-constrained processes should be used to achieve sustainable development. In order to achieve this, the consumption of natural resources such as water, minerals, fossil fuels, and environmental resources should be decreased. Using environmentally friendly products and minimizing resource consumption will assist to ensure sustainability over the long term. Ito, K. (2016) investigates on the connections between CO₂ emissions, the use of renewable and non-renewable energy, and the economic progress of 31 developed nations. They discovered that while the usage of renewable energy greatly lowered those countries' carbon emissions, the energy consumption strategy had a detrimental influence on economic growth. According to Hashim et al. (2014), adopting sustainable procedures can lessen negative environmental effects while also ensuring energy savings. According to the US Environmental Protection Agency (2017), commercial building uses 40% of raw materials, uses between 24% and 50% of energy, produces 30% of waste, emits 38% of carbon dioxide (CO₂), and consumes 72% of the nation's power. According to BKMEA (2016), the competitiveness requires special attention if long-term sustainability is to be achieved, as the level of rivalry among industries and sectors is rising noticeably on a national and international scale. There is a growing understanding that the existing resource-intensive corporate practices, which also contribute to pollution, cannot last for very long. This will have negative social and environmental effects, as well as business concerns. Morgera and Savaresi (2013) reported that enhancing efficiency in energy and resources and prevent the loss of biodiversity and ecosystem services. According to UNIDO (2010), the solution to the issues mentioned lies in enabling output to grow while minimizing growth in inputs of materials and energy. For instance, developing countries should adopt the "three Rs" strategies; lessen the utilization of raw materials during manufacturing processes; switch to green sources of energy and materials; and redesign products to contain fewer materials and utilize less energy, water, etc. while use. Lehmhus et al. (2013) investigated the iron and steel industry's energy efficiency and changes in green productivity. According to

empirical findings, the average energy efficiency from 2001 to 2008 was 61.1%. The main driver of this period's productivity development was technological advancement. Eco-friendly manufacturing techniques that are lowering waste and even pollution (Seadon, 2006). A proactive organizational environmental attitude and a more strategic approach to purchasing and supply management both help to build the skills necessary for green production (Rusinko, 2007). It is attainable to accomplish a good quality of life and living standards through waste minimization without causing long-term environmental impact, since globalization raises knowledge and competence standards. Organizations that implement lean principles may reduce or perhaps get rid of wastes altogether. Additionally, lean as a green strategy aids businesses in reducing waste and pollutant emissions by reducing product shipment volumes (Hong et al., 2012). The theoretical basis for this paper was established with aid from the body of current literature on the subject. Previous studies have emphasized the adoption by organizations of green manufacturing techniques such waste management, green manufacturing processes, pollution prevention, and sustainable materials. In order to understand the overall situation regarding green manufacturing practices in the RMG industry of Bangladesh as a solution to the energy crisis, this paper examines waste management system, energy reduction system, water consumption reduction system, pollution from noise elimination system, usage of green energy system and sustainable raw materials purchase, recycled/ reused materials usage as well as harmless chemicals utilization practice of different RMG companies.

3. Methodology

This study was conducted using pragmatic analysis; this is a highly important subject in the modern corporate environment, and many academics and practitioners are still working on it. In such cases, a conceptual framework was developed in accordance with published reports of green manufacturing methods by reputable overseas enterprises, researchers, and practitioners, as well as existing literature. Since the study was done from a pragmatist perspective, any appropriate approach or strategy that can be employed to address the research objectives was taken. The main goal is to gather data, mostly qualitative, through knowledge exchange and discussion. There are currently 187 LEED-certified green factories in Bangladesh, all but four of which are in the apparel industry. These LEED-certified textile manufacturers have 63 platinum-rated buildings, 110 gold-rated buildings, and 10 silver-rated buildings. This study will be conducted on 30 ready-made clothes (RMG) in the Gazipur, Narayanganj, Dhaka and Rangpur districts. Due to time and financial restrictions, the research is a hybrid of an online survey based on secondary data and a field visit to five industries that are used as case studies. Convenience sampling and the snowball technique, two sample methods, will be combined. This suggests that the samples will be chosen based on the managers' comfort and accessibility. Additionally, examples with a wealth of information will be sought out for an interview using a string of references. Using renewable energy sources, reducing energy use, and water use will all be covered in this paper. A variety of information sources, including research reports, journals, local and foreign public procurement policies, procurement policies of international organizations, and company-published green procurement regulations will be searched for using the Google general search and Google Scholar search tools in order to compile preliminary knowledge about the study topic. These constituted the report's secondary sources of data. Through a survey that will involve both in-person and phone interviews, raw data will be gathered. The majority of these basic data are qualitative in traits. The survey has conducted using a questionnaire that is semi-structured to get the survey's preliminary data. There will be four sections in the questionnaire. The first component will include information about the company's foundation, efforts made to assure green manufacturing, and awareness of it. Waste management challenges related to green

manufacturing were covered in the second and third sections, respectively. These processes included energy conservation, the use of renewable energy sources, water conservation, and others. The respondent will have the option to add any further information they would like to contribute while the data is being collected. The survey will make every effort to gather true, pertinent, and accurate information. Descriptive statistics were used to examine the data and present it as percentages and Microsoft Excel is used to create pie charts and bar charts.

4. Energy consumption in Bangladeshi RMG factories

Bangladesh's largest power consumer is the industrial sector. More than 45% of the electricity used in the nation's industrial sector is consumed by electric motors. By employing variable speed drives (VSD) resulted in savings of approximately 137,003 kWh, 319,673 kWh, 502,343 kWh, and 1,312,484, 3,062,463, and 4,812,442 BDT per month for speed reductions of 20%, 40%, and 60%, respectively. For motor loadings of 50%, 75%, and 100%, respectively, high efficiency motors (HEM) may save about 28,311 kWh, 41,713 kWh, and 57,080 kWh of energy as well as BDT 271,242, BDT 399,574, and BDT 546,852 of bill. The payback times of various energy-saving techniques showed that HEMS appear to be cost-effective. For large motors, HEMS and VSD are both more affordable. Additionally, it has been discovered that various energy-saving techniques used in clothing can significantly cut emissions.

5. Case study: green RMG factories in Bangladesh

AR Jeans producer: The location of this factory is Ashulia, Savar. Every drop of water that enters the production facility is precisely controlled in this sector. Due to a rainwater management plant, rainfall cannot exit the area. Rainwater is collected in a harvesting tank and recycled for use in flushing toilets and other plantation requirements. On the basis of information from sensors regarding the CO₂ level, fans are activated to regulate the flow of fresh air. Here is a 45 KW solar power plant. Project buildings have variable flow drive-controlled compressors, servo-driven sewing machines, and LED lighting to save an additional 43% on energy. 77% of the building's interior space was lit by natural light. This project's construction utilized more than 20% recycled materials.

Bay Creations Limited: For the past 14 years, Bay Creations Limited has built a solid reputation as a manufacturer and exporter of knitwear. Bay Creations Limited is a sale and managing house for ready-to-wear clothing and is located in Kornogop, Borpa, Narayanganj. Bay Creation Limited obtains a 36% improvement in energy and environment. 90% of the working space is now better able to see. The Bay Creation Limited's green building project was a brand-new building venture. For the building's construction, it used 10% recycled content and 20% locally extracted, recovered, or made resources. According to The Green Building Information Gateway (n.d.), the green factory lowered its wastewater generation by 50%, baseline interior water usage by 40%, and water used to irrigate landscaping by 100%. Workers at this company are very happy with their work, in the perspective of the management level. The fact that chillers are available to keep the temperature in their working area down has, most crucially, earned them respect from the workers.

Remi Holdings Ltd. This environmentally friendly workplace employs solar panels, LED lighting, and servo motors for each sewing machine to reduce power use rainwater can be stored in a facility. The water is frequently used after being cleansed. There is always 26 degrees Celsius temperature. 13% of the electricity supply insured by solar panel system. Comparison with other ready-made garment factories, it will use 50% less water and power.

Nasa Hitech Style Ltd. This factory is situated in Gazipur, Bangladesh's capital city of Dhaka., This industry has cut energy consumption by 26%. Less water consumption fixtures used recycle waste water production by 50% and indoor water use by 40%. This company's green industrialization process has boosted costs by 20% through manufacturing and the construction of new buildings, up from 18%. The plant management claims that since the start

of the green initiative, machine efficiency in terms of electricity usage has significantly increased. Additionally, they have Low E glass installed, which has enhanced the amount of daylight available and decreased the cooling burden. 75% of the workplaces at this environmentally friendly factory have access to daylight.

Echotex Limited. It is situated in Gazipur, Bangladesh. This facility has modern manufacturing machinery that enables it to create more with less energy. This business has a productive storm water management system in place that routes hardscape precipitation to a neighboring green area. The practice of working without emitting any carbon emissions has been introduced by using self-powered transportation to get to the factory. This industry has cut its water consumption by 30% by regulating water flow.

Karupannya Ltd. This green manufacturing unit is situated in Rangpur. Average temperature of this project site is 24 degrees Celsius due to its green environment. This structure is both climate-responsive and energy-efficient and can reduce energy use by up to 40%. The sustainable design features that are being used are energy efficiency, water efficiency, optimal use of daylight, plantation, and eco-system preservation. The cool air is progressively eliminated via the spaces to the ceiling above from the surface of the mass to its center. Contrarily, water oxidizes naturally to become ionized and ready for use when it comes into contact with the air, negating the need for a chemical water treatment facility. ETP treats used water so that it can be recycled. These sources of water are also used to collect rainwater during the monsoon. However, the monsoon season's humid weather encourages vegetation to grow to its greatest potential, thus air moving inward is always dryer and far more comfortable to breathe.

6. Result and Discussion

6.1 Companies Consciousness on Green Manufacturing

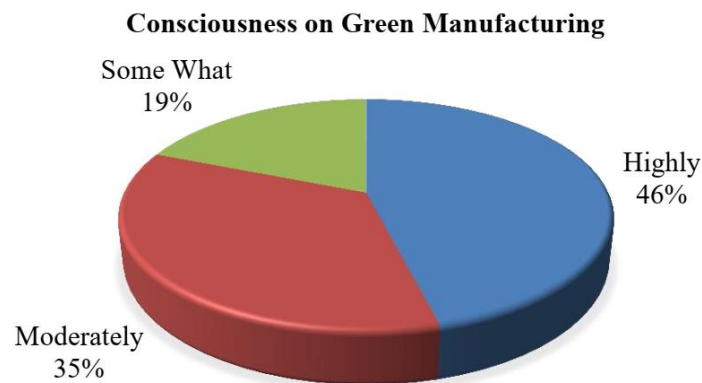


Figure:1 Consciousness on Green Manufacturing

From the survey there the industries are conscious about green manufacturing numbered 46% (Highly interested), 35% of the factories are moderately interested.

6.2 Waste Management

The RMG industry in Bangladesh typically uses an ETP to treat liquid waste, reuse toilet water for washing, sprinkle on gardens and plantations, reuse spinning waste, reuse fabric, make organic fertilizer, and sell returned clothing to local markets or third parties. Figure 2 shows the waste management survey findings for the RMG-selected manufacturers.

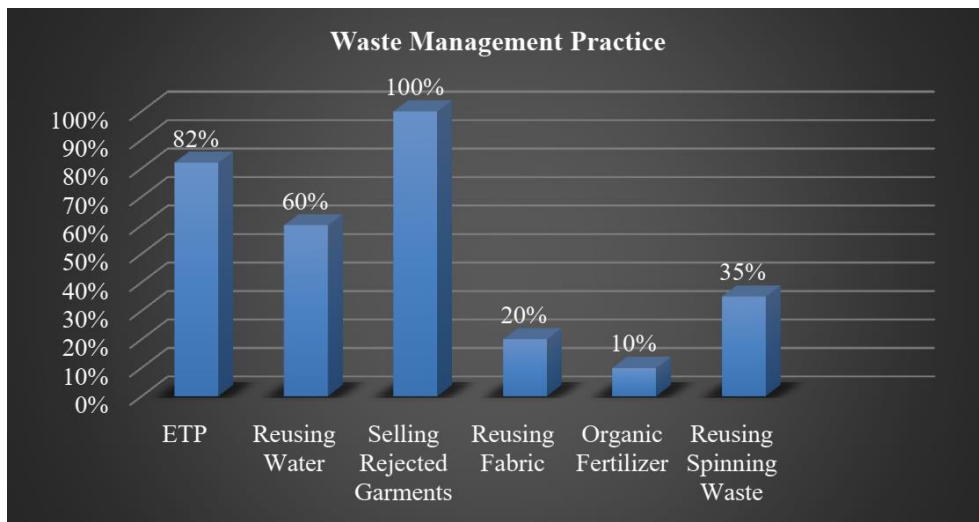


Figure-2: Waste Management

82% of enterprises used effluent treatment plants to handle liquid waste from various production processes, particularly the dyeing stage. Additionally, all 30 of the enterprises have sold their returned goods to local or third-party markets.

6.3 Practices for lessening Energy Consumption:

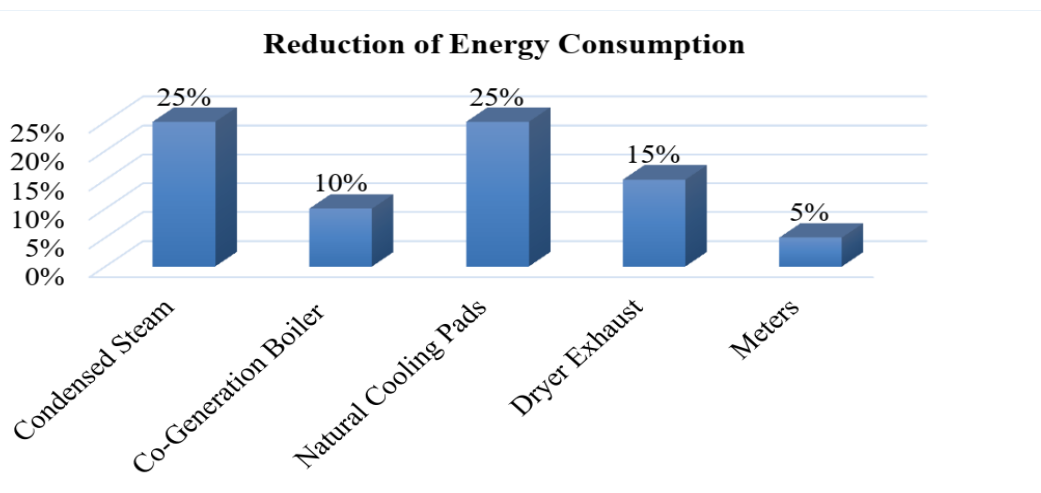


Figure 3: Reduction of Energy Consumption Practices

8 out of the 30 enterprises claimed that 25% of their condensed steam was recycled. This heated water is supplied to the boiler where it is used to create steam once more, conserving natural gas. Only 10% (3 out of 30) of the boilers employed co-generation, saving fuel gas. 25% (8 out of 30) of the companies use natural cooling pads instead of air conditioning or hundreds of ceiling fans, which saves electricity. In order to reduce the amount of gas consumed in dyeing units, dryer exhaust was installed by 15% (5 out of 30) of the enterprises. In order to reduce energy consumption, just 5% (2 out of 30) of companies install meters (water flow meters, energy meters, and steam flow meters).

6.4 Renewable Energy

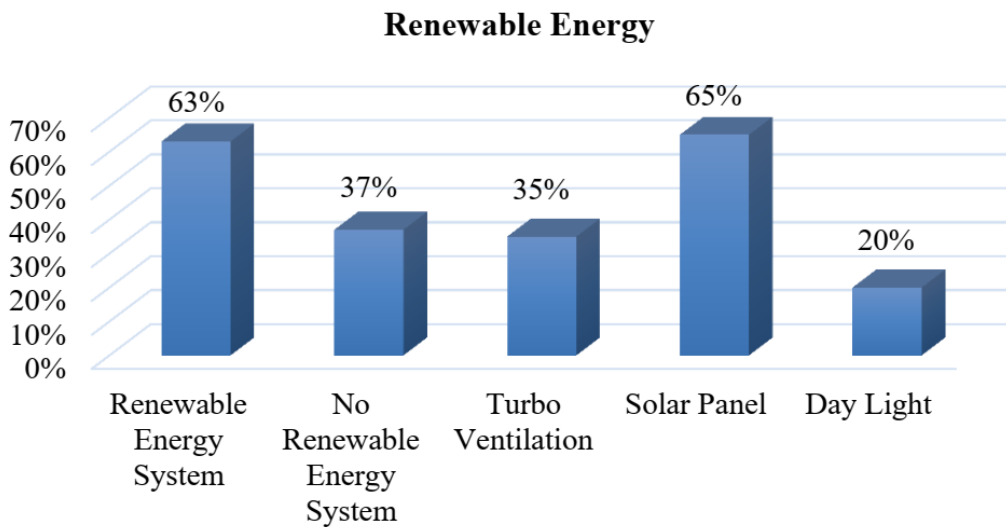


Figure 4: Renewable Energy

From the survey results showed (Figure 4) that 63% of the businesses (or 19 out of 30) only partially installed renewable energy systems in their workplaces and industries, while 37% (or 11 out of 30) still had not taken any steps to do so. A total of 30 RMG enterprises employed renewable energy sources to partially satisfy their energy needs, with 35% (11 out of 30) using turbo ventilation, 65% (20 out of 30) using solar panels, and 20% (6 out of 30) using daylight.

6.5 Reduction of Water Consumption

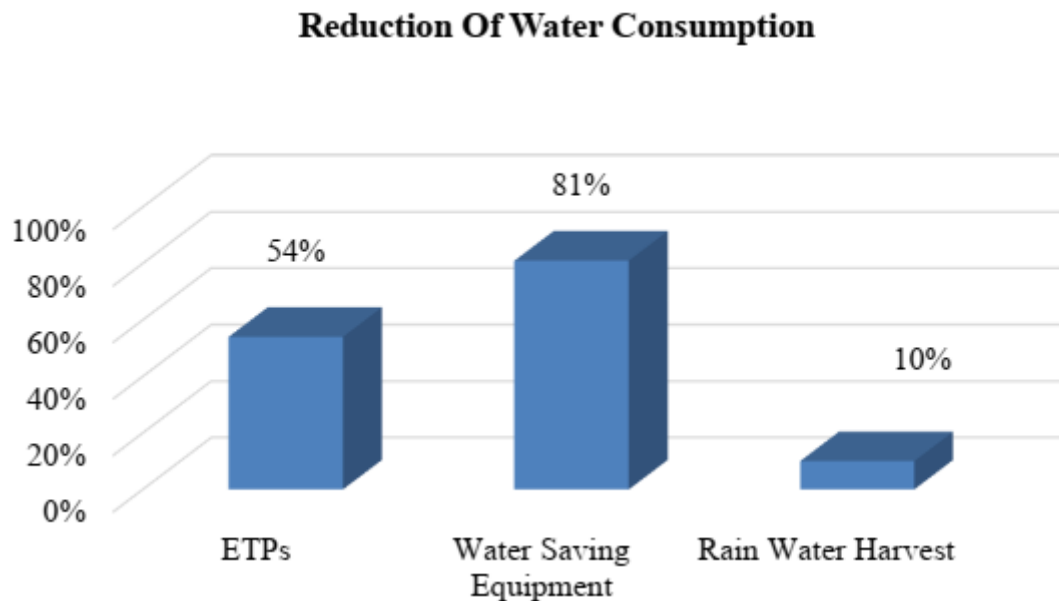


Figure 4: Reduction of Water Consumption

16 out of the 30 enterprises, or 54%, claimed that they had reduced their water use by reusing their treated process water. 24 out of 30 businesses, or 81%, adopted water-saving technology such servo motors and air drying machines to reduce water consumption in the RMG sector. In the study, 10% (3 out of 30) of the businesses used their roof space or unoccupied area as a rainwater harvesting system to reuse the water for washing, fabric dyeing, and other uses, thereby reducing the need for ground water.

7. Major Findings:

Results of studies on green manufacturing processes demonstrate decreased energy use, use of renewable energy, decreased water consumption, and decreased noise pollution. The use of LED lighting, Servo motors, recycling condensed steam, using cogeneration boilers and natural cooling pads, installing dryer exhaust, and installing meters (water flow meters, energy meters, and steam flow meters) are popular energy saving measures across 30 enterprises. 63% of businesses employ some form of renewable energy in their workplaces. The RMG companies frequently uses solar panels, turbo ventilation, and daylighting systems as sources of renewable energy. Reused ETP processed water, the use of water-saving tools, and rainwater collection are prominent water conservation techniques in the RMG sector. In order to reduce noise pollution, all but 30 enterprises utilize active measurements, while very few use passive measurements.

8. Development of the green industry: Challenges

Establishing green factories in Bangladesh encounters several formidable challenges. Firstly, the initial cost of installing a green factory is substantially higher—ranging from 20 to 30 percent—compared to conventional factories. This increased cost is attributed to the incorporation of green manufacturing processes, energy- and water-saving technologies, solar panels, inverter technology, and rainwater collection systems, all of which demand additional capital. Secondly, the reliance on foreign consulting firms due to a shortage of local technological professionals in a variety of industries escalates construction costs, presenting a significant barrier to budget-friendly green initiatives. Furthermore, entrepreneurs face hurdles in negotiating prices, as customers may resist paying more for products from green manufacturing. The absence of a formal proclamation of a green industrial policy in Bangladesh, coupled with high corporation tax rates, Value Added Tax, and the lack of fiscal incentives for importing technological equipment, adds complexity to the green industrialization landscape. Consumer behavior is an additional challenge, with a lack of awareness among the general public about eco-friendly apparel, limiting the market primarily to the western fashion industry. Lastly, high interest rates on lending facilities, a scarcity of available land, inadequate transportation infrastructure, and insufficient support from utilities collectively pose significant obstacles to the establishment of green companies. Addressing these multifaceted challenges is critical for fostering sustainable and economically viable green industrialization in Bangladesh.

9. Policy Recommendations:

Recognizing the critical role of financial and policy support in fostering green business development, the Bangladeshi government has actively engaged in initiatives to propel the green industrialization agenda forward. Advocating for legal measures, the government can play a pivotal role in enacting and enforcing green policies. To incentivize entrepreneurs interested in a green transformation, subsidies should be offered, and the government can consider waiving duties on the importation of raw materials and equipment for those committed to adopting environmentally friendly practices. Equally crucial is the need to raise awareness among factory owners about the tangible benefits of embracing green industries, encouraging their transition. Owners of ready-made garment enterprises are urged to enhance their negotiation capacities, considering the adoption of green manufacturing processes, and adjust prices accordingly. Financial institutions can contribute to this shift by facilitating access to green financing loans, while mass and social media platforms can play a significant role in inspiring business owners through the dissemination of success stories from existing green factories. This integrated approach involving financial incentives, policy frameworks, and awareness campaigns is essential for propelling green industrialization in Bangladesh.

Conclusion:

RMG factories in Bangladesh that are demonstrating how they have adopted energy-efficient technologies, renewable energy sources, water conservation techniques, and waste management systems. Through these approaches, energy use, water use, and environmental pollution have all been reduced. There are some obstacles to green industrialization, including greater start-up costs, a lack of technological know-how, and customer behavior. The study emphasizes how government policies and funding help businesses embrace green practices by pushing them to do so. Incentives for importing eco-friendly machinery, subsidies for green transformations, and awareness campaigns to inform factory owners of the advantages of green industries are all ways to encourage green industrialization. In conclusion, green industrialization has enormous potential to help Bangladesh achieve its sustainable development goals and resolve its energy crisis.

Research limitations and future direction of research: The study's focus on green Ready-Made Garments (RMG) manufacturers in Bangladesh introduces certain limitations. Firstly, the narrow focus on this specific industry may limit the generalizability of findings to other sectors, potentially excluding crucial insights into the broader landscape of the energy crisis and green industrialization across diverse economic areas. To address this limitation, future research could broaden its scope to encompass a more comprehensive range of industries, providing a holistic view of Bangladesh's efforts in green industrialization. Moreover, potential limitations in data sources, small sample sizes, or reliance on data from a specific timeframe could compromise the study's validity and the reliability of its conclusions. A comprehensive examination of the energy crisis and green industrialization would benefit from diverse and extensive datasets, covering various periods, ensuring a more robust foundation for drawing meaningful inferences. Future studies could prioritize obtaining larger, more varied datasets to enhance the robustness and reliability of research findings. Furthermore, the research may not thoroughly explore the challenges hindering the implementation of green industrialization in Bangladesh, such as financial constraints, technological preparedness, legal barriers, and potential opposition from stakeholders. A more comprehensive investigation into these barriers could yield valuable insights for policymakers and practitioners aiming to promote sustainable practices in the industrial sector. Future directions for research should delve into these complexities, offering nuanced perspectives on the obstacles faced and potential strategies to overcome them. In doing so, future studies can contribute to a more holistic understanding of the dynamics surrounding green industrialization in Bangladesh.

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