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RESEARCHARTICLE

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Scope of Circular Economy Approach for the RMG Sector in Bangladesh to Address Climate Change

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Abstract

The economy of Bangladesh heavily depends on the Ready-Made Garments (RMG) industry, which generates over USD 45 billion annually and employs more than 4 million people, 60% of whom are women (BGMEA, 2023). However, the industry's rapid growth has led to environmental challenges, including textile waste, energy dependence, and water pollution, exacerbating climate change effects. As one of the world's most climate-vulnerable nations, Bangladesh faces rising temperatures, floods, and sea-level increases, making sustainability in the RMG sector a national priority. Embracing the principles of a circular economy (CE) waste reduction, recycling, resource efficiency, and sustainable production offers a transformative path forward. Drawing on secondary data from academic and industry sources, this study analyzes the potential for CE adoption in Bangladesh's RMG sector. Findings indicate that CE practices such as eco-design, industrial symbiosis, and renewable energy can reduce emissions, enhance competitiveness, and create green jobs. Transitioning to CE would not only mitigate climate risks but also ensure the long-term resilience and sustainability of Bangladesh's most vital industry.

KEYWORDS
Circular Economy, Ready-Made Garments, Climate Change, Bangladesh, Sustainability

1 | INTRODUCTION

The Ready-Made Garments (RMG) industry has been the catalyst of economic reform of Bangladesh in the last four decades, leading to industrialization, job creation, and the reduction of poverty in the country. It provides approximately 11 per cent of the national GDP and more than 80 per cent of export revenues now, putting Bangladesh second in the world in terms of apparel exports, following China (World Bank, 2022). The industry has a workforce exceeding 4 million people, and women make up around 60 percent of the people working in the industry, as such making the industry crucial in the empowerment and socio-economic development of women (BGMEA, 2023).

The susceptibility of Bangladesh to climate change increases the severity of the need to address these sustainability issues. The country is one of the most climate-impacted countries in the world, experiencing the rising sea level, temperature changes, intrusion of saline components, and frequency of floods and cyclones (IPCC, 2022). Not only are agricultural livelihoods threatened by these risks, but also industrial endeavors such as the RMG sector that heavily depend on a stable supply of energy and water (Kibria, 2022). Lacking a systemic intervention, the linear production model of take-make-dispose in the sector will further enhance environmental degeneration and compromise its long-term competitiveness in the global marketplace, which has become more conscious of sustainability issues.

The idea of the circular economy (CE) offers a possible paradigm shift to deal with those interrelated problems. CE operates on the principles of resource efficiency, waste minimization, and regenerative design and focuses on maintaining products and materials in circulation and lessening dependence on virgin resources (Ellen MacArthur Foundation, 2017). The figures of global practices, such as textile recycling facilities in Sweden and the eco-design work of such

global corporations as H and M or Levi denim can be utilized to view how CE practices can reduce the amount of waste, save water, and decrease the level of greenhouse emissions (GHG) and assist companies to get more sustainable (Palm et al., 2019; Niinimaki et al., 2020). In Bangladesh, the steps toward success have already been made. In the number of LEED-certified green garment manufacturing facilities, the country takes first place, with more than 180 (USGBC, 2023). Meanwhile, there are pilot projects on recycling and the adoption of renewable energy that prove the feasibility of CE-based interventions (Rahman, 2021). Nevertheless, such initiatives are still disconnected and mostly focused on the bigger export-oriented companies. The wider industry, especially smaller factories, which are the workhorse of supply chains, is faced with a lack of financing, technological disparities, and enforcement of regulations, among other things, which hinders mass movement towards circularity (Ahmed et al., 2021).

This paper analyses the opportunities for propping up CE principles in the RMG sector of Bangladesh as a solution to climate resilience, environmental sustainability, and economic competitiveness. It examines how eco-design, industrial symbiosis, renewable energy, and recycling hubs, all of which are interventions, could be scaled up by synthesizing evidence on the basis of international case studies, national policy frameworks, and sector-specific data. This is the main point; the integration of CE practices in the RMG sector is no longer a choice; it becomes a necessity in the reduction of climate risks, income protection, and the future framework of the most significant industry in Bangladesh.

1.1. Literature Review

The circular economy (CE) has become an innovative paradigm that questions the traditional linear system of production and consumption of the take-make-dispose model. According to the Ellen MacArthur Foundation (2017), a system that focuses on the creation of waste and pollution, maintenance of products and materials in service, and creation of natural systems, CE lays stress on resource efficiency and regenerative design. It is an expansion of concepts of industrial ecology and cradle-to-cradle design, which have environmental and economic advantages through minimization of environmental effects and stimulation of innovation, competitiveness, and green employment. According to scholars Kirchherr et al. (2017) CE demands systemic transformation of governance, finance, and consumer behavior, and is, therefore, a multidimensional model that goes beyond waste recycling to include a more globalized economic and social transformation.

The textile and apparel supply chain has been one of the main areas of experimentation by CE since it is a resource-intensive industry with a high environmental footprint (Franco, 2017). Research estimates that the textile manufacturing industry contributes to approximately 20 percent of all wastewater and 10 percent of all carbon emissions globally, making it one of the most polluting industries in the world (Niinimaki et al., 2020). In reaction, other nations like Sweden and the Netherlands have built massive textile recycling centers, whereas global brands like H&M, Levi, and Patagonia have created eco-design projects, take-back programs, and industrial symbiosis models which combine textile mills with energy plants and chemical facilities (Palm et al., 2019). The Circular Economy Action Plan of the European Union has evolved sustainable textile policies at the policy level by extending producer responsibility (EPR) and committed eco-labeling policies (Bürgin, 2021). These experiences have shown that CE practices such as fiber-to-fiber recycling, modular clothing design, and others can decrease waste, water conservation, greenhouse gas (GHG) emissions, and improve business resilience and consumer confidence. However, obstacles like a lack of recycling facilities, the expense of high technology, and the ripple effect of fast fashion use still make it difficult to move on a large scale (Zanjirani Farahani et al., 2022).

The special constraints and unutilized opportunities also characterize the use of CE in the emerging economies. Even though poor funding, lack of institutional capacity, and technology gaps have the propensity of slowing down implementation of CE, the quantity of waste and the existence of informal recycling networks can be a point of entry to the implementation of the circular approach (Ezeudu et al., 2021). China and the national CE policies show that industrial symbiosis parks can be organized to put textile factories in integration with other industries to put the resources to the maximum and reduce emissions (Geng et al., 2019). Upcycling of textile waste into new products is relatively significantly engaged today in small-scale enterprises in India, thus enabling people to have employment opportunities and ecological utility. The examples highlight that CE in developing environments can capitalize on the low-cost innovation, labor-intensive recycling, and policy to transition to more sustainable and comprehensive production systems. Despite the initiatives of systemic reforms in the country, scholars caution that unless the RMG exports are adjusted to increase their sustainability, the industry may become less competitive in long-term sustainability-focused markets such as the European Union, which is implementing strict environmental regulations as a new norm (Ahmed et al., 2021).

Climate change exacerbates these difficulties because the country is one of the most vulnerable countries in terms of climate change across the world. An increase in the sea level, a high number of cyclones, floods, and intrusion of salinity not only affect the agricultural populations, but also industries as well (IPCC, 2022). In the case of the RMG industry, the climate risks are in the form of water shortfall, heat waves, and industrial infrastructure and supply chain damage. Heat waves minimize the productivity of workers and raise the cost of energy to cool down the

workers, whereas floods and storms disrupt the logistics and jeopardize export commitments (Kibria, 2022). Here, CE offers an adaptation avenue through the lessening of reliance on resources, increasing energy sources, and increasing the ability to resist climate shocks. Although there are structural issues, the RMG sector of Bangladesh is showing indications of CE integration. The number of LEED-certified green factories is the highest in the world, and over 180 of the garment plants in the country have been certified (energy and water efficiency) (USGBC, 2023).

Other innovative factories have developed a recycling system at their location, implemented renewable energy measures, and experimented with eco-design concepts of clothing manufacturing (Rahman, 2021). Pilot projects in fiber-to-fiber recycling and supply chain transparency based on digital technologies like blockchain and IoT-based tracking have also been supported by international buyers. Nevertheless, adoption has been uneven and sporadic, with smaller-scale factories (which comprise the larger portion of the industry) unable to obtain financing, technology, and regulatory incentives to make the transition to CE. Researchers believe that to eliminate these structural barriers to scale up the adoption of CE in Bangladesh, the combination of investment mechanisms, regulation, and capacity building will be necessary (Ahmed et al., 2021).

In combination, the literature demonstrates that although the global textile industry offers practical approaches to CE implementation, the RMG industry in Bangladesh is affected by specific challenges that are associated with the climate vulnerability of the country, systemic flaws in infrastructure, and structural reliance on the production that requires resources. However, the international pressure on buyers, global standards in sustainability, and the pioneering position of the country in the world of green factories open the opportunity to scale the CE practices. By integrating eco-design, recycling, industrial symbiosis, renewable energy, and digital transparency into its production model, the RMG sector in Bangladesh will be able to mitigate the effects on the environment, be prepared to deal with climate risks, and ensure its competitiveness in the global apparel market in the long run (Hossain & Hossain, 2025).

2 MATERIAL AND METHOD

The study adopts a qualitative, desk-based research design to assess the scope of circular economy (CE) adoption in Bangladesh's Ready-Made Garment (RMG) sector. The methodology was structured around three key stages: (i) data collection, (ii) data organization and synthesis, and (iii) thematic analysis.

2.1. Research Design

This paper is based on a qualitative desk-based research design to evaluate the extent of circular economy (CE) implementation in the Bangladesh Ready-Made Garment (RMG) industry. The research approach was based on three main steps, namely (i) data collection, (ii) data organization and synthesis, and (iii) thematic analysis.

2.2. Data Collection

Data were drawn exclusively from secondary sources. These included:

- **Academic literature**: Peer-reviewed journal articles and books addressing circular economy practices, textile waste management, and climate resilience.
- **Industry reports**: Publications from the Bangladesh Garment Manufacturers and Exporters Association (BGMEA), International Labor Organization (ILO), and the United States Green Building Council (USGBC).
- **International institutional reports**: World Bank, IPCC, and Ellen MacArthur Foundation documents relevant to sustainability, resource efficiency, and global CE best practices.
- **Policy and media sources**: Bangladesh government policy papers, sustainability guidelines, and sectoral news platforms (e.g., *Textile Today*).

A time frame of 2015–2023 was prioritized to ensure that data reflect the most recent developments in CE discourse and RMG sustainability practices, though earlier foundational studies were also included.

2.3. Data Organization and Screening

To guarantee reliability, only those sources that were published by reputable journals, international organizations, and recognized industry associations were used. Conference papers and unpublished theses were not included in grey literature unless they are essentially referred to in the discipline. Every source got a thematic code based on their relevance in the topic: (a) the difficulties in the RMG sector, (b) the principles of the circular economy, (c) the effects of climate change, and (d) examples of cases in Bangladesh or similar economies.

2.4. Data Analysis

A thematic analysis technique was employed. The data were reviewed systematically to identify recurring themes and patterns across different sources. The analysis was structured into three broad thematic domains:

- Environmental challenges of the RMG sector (waste, water use, energy dependence).
- Potential CE interventions (eco-design, recycling hubs, industrial symbiosis, renewable energy, and supply chain transparency).
- Implications for climate change mitigation and sectoral resilience.

Triangulations were made among various datasets (e.g., academic studies versus industry reports) to make findings more valid and minimize possible bias. Quantitative estimates (where applicable) of waste volumes of textiles, water use, or GHG reduction potential were (where possible) extracted and synthesized into comparative tables and figures.

2.5. Limitations

This research will be based entirely on secondary data and will not involve primary data collection (e.g., factory-level surveys, interviews, or case studies). Therefore, results are limited by the presence and trustworthiness of the published materials. Additionally, the recorded CE programs in Bangladesh target large export-oriented factories that are not necessarily reflective of the experiences of small and medium enterprises (SMEs). Nevertheless, the secondary data methodology offers a strong overview of the sectoral environment and presents the information on the scalable interventions of CE.

3 DISCUSSION AND FINDINGS

3.1. Current Challenges in the RMG Sector

Bangladesh's RMG industry is characterized by excessive textile waste, high water consumption, fossil fuel dependency, and weak recycling infrastructure. Approximately 400,000 tons of textile waste could be recycled annually if adequate facilities were in place (Haque et al., 2020).

3.2. Scope for Circular Economy Practices

The Bangladesh ready-made garment (RMG) sector can be one of the biggest textile exporters in the world; as a result, it can make great use of the opportunities offered by the implementation of the ideas of the circular economy (CE). It can lead to a reduction of the impact on the environment, efficient use of resources, and increased sustainability. Some of the CE strategies have a good potential in this direction:

3.2.1. Eco-design

The application of eco-design in the production of garments can significantly decrease the environmental impact of the industry. This involves the use of regenerated fibers, recycled polyester, and organic cotton, which are sustainable raw materials that use less water and less energy compared to traditional materials. Another aspect of eco-design is on the durability, modularity, and recyclability of garments so that the products can be reused, remanufactured, or recycled at the end of the life cycle. As an example, it can be helpful to design clothing made of easily separable materials that can be recycled mechanically, and the textile in a landfill may be minimized.

3.2.2. Recycling Hubs:

The expansion of the post-production and post-consumer recycling of textiles in recycling hubs is a crucial CE approach. At present, much textile waste in Bangladesh is disposed of in landfills or burned, and this leads to environmental damage.

3.2.3. Industrial Symbiosis:

Establishing industrial symbiosis networks—linking textile mills, garment factories, and other industrial facilities can create closed-loop systems whereby by-products from one process serve as inputs for another. As an example, the offcuts of fabrics, dye sludge or water at one production stage might be used in another stage of production so that waste will be reduced, and fewer resources will be consumed. According to a study by Palm et al. (2019), industrial symbiosis is effective in reducing environmental, operational, and cost burden, in addition to minimal environmental pressure, and as a result, is a realistic solution to sustainable industrial development in Bangladesh.

3.2.4. Renewable Energy and Energy efficiency:

The RMG industry is very energy-consuming, and most of the facilities and equipment use fossil fuels. Greenhouse gas emissions and reliance on fossil fuels can be minimized by the adoption of renewable energy solutions, including solar panels on factory rooftops, as well as the use of energy-efficient machinery. According to Rahman (2021), the incorporation of renewable energy and the replacement of equipment with energy-efficient standards can result in substantial decreases in the costs of operation and carbon emissions, which can be used in decarbonization efforts of the sector.

3.2.5. Supply Chain Transparency and Digital Solutions

Transparency in the supply chain is a crucial concept in the execution of the circular practices. Digital technologies like blockchain, IoT-based tracking, and smart labelling may enhance the traceability of materials, guarantee adherence to environmental norms, and provide lifecycle management of garments. Ellen MacArthur Foundation (2017) says that supply chain transparency enables brands and manufacturers to see the flow of resources, check sustainable sourcing, and optimize product recovery, making it simpler to execute CE strategies on a large scale. The following table demonstrates the possible effect of the circular economy practices in Bangladesh on the environment:

Implementation of circular economy principles in the textile industry shows that such a move would have a great potential to reduce the effects on the environment in various measures. Recycled polyester and organic cotton, as well as modular design

(comprising eco-design), would significantly decrease textile waste, water use, and greenhouse gas (GHG) emissions. Recycling centers, targeting post-production and post-consumption textile recycling, can also serve to prevent landfills, as well as decrease the general energy usage. Industrial symbiosis, enabling the exchange of resources between the factories and encouraging the reuse of waste as input, adds to the decrease in textile waste, water consumption, and energy consumption.

The combination of renewable energy and energy-efficient equipment, including energy-saving systems and solar panels, directly reduces GHG emissions and energy use. Lastly, the addition of transparency to a supply chain with the help of blockchain, IoT tracking, and digital lifecycle management is an addition that will make materials traceable and, consequently, help ensure that waste production and GHG emissions are minimized because resources are managed in a more efficient way. All these CE practices point to the possibility of the sector converting the linear production models into more environmentally sustainable systems. According to Table 2, the Bangladesh RMG industry generates 577,000 tons of textile waste each year, of which 400,000 tons can be recycled, and dyeing uses up to 2,000 liters of water/1,000 kg of textile. Interventions in the name of the circular economy are capable of reducing GHGs by 15 percent and generating 200,000 green jobs by 2030, which goes to show that the extension has a high potential of making a quantifiable impact on the environment and society.

3.3. Benefits of CE in the RMG Sector

Circular economy (CE) practices that have been implemented in the ready-made garments (RMG) industry in Bangladesh offer a ground-breaking solution that can be used to alleviate environmental effects and promote resource efficiency. Textile waste and water use can be significantly minimized and greenhouse gas (GHG) emissions can be decreased through eco-design solutions like recycled polyester, organic cotton, and modular garments as well as the use of recycled polyester and organic cotton. Bangladeshi factories have also been experimenting with sustainable fabrics and creating clothes that can be easily reused or recycled, which shows that the sector can incorporate sustainability at the product level.

Recycling also enhances the circularity of the industry. Scraps of post-production (as well as post-consumer) textiles can be gathered and reused in the production of new fabrics, which would decrease the amount of landfill disposal and conserve energy. Certain early RMGs in Dhaka and Chittagong have built recycling plants on-site and by partnering with recycling centers abroad, waste is converted to raw materials efficiently, generating a source of environmental as well as economic value.

The other powerful intervention is industrial symbiosis. Clusters of factories located in Bangladesh can share their waste products, water, and energy resources, whereby the by-products of one factory can be used as inputs by another. As an example, dyeing units could provide non-critical processes in nearby units on treated wastewater, or small manufacturers or craft-based industries could use textile offcuts. This will reduce wastage, usage of water, and will also maximize the use of energy, which is an indication of the positive elements of shared resources. Table 1 indicates the potential environmental impact of circular economy practices.

Finally, the renewable energy and supply chain visibility can make the sector more sustainable. Solar panels, machines that do not require an extensive amount of energy, and digital lifecycle management systems like blockchain and IoT tracking can contribute to the efficient use of energy and allow tracking the flows of materials precisely. The factories will be able to control the waste streams more, reduce the GHG emissions, and increase compliance with the international sustainability standards through the enhancement of traceability. All these CE interventions lead to a path where by the Bangladesh RMG sector

Table 1: Potential Environmental Impact of Circular Economy Practices

CE Practice	Key Interventions	Potential Impact on Environmental Metrics
Eco-design	Recycled polyester, organic cotton, modular design	↓ Textile waste, ↓ Water use, ↓ GHG emissions
Recycling Hubs	Post-production & post-consumer textile recycling	↓ Textile waste, ↓ Energy consumption
Industrial Symbiosis	Resource exchange between factories, waste-to-input reuse	↓ Textile waste, ↓ Water use, ↓ Energy consumption
Renewable Energy & Energy Efficiency	Solar panels, energy-efficient machinery	↓ GHG emissions, ↓ Energy consumption
Supply Chain Transparency	Blockchain, IoT tracking, digital lifecycle management	↑ Material traceability ↓supports Waste & ↓ GHG emissions

Table 2: Indicator-wise transformative changes in the RMG sector due to circular economy intervention

Indicator	Bangladesh RMG Sector (Estimates)	Sources
Textile Waste Generated (tons/year)	577,000	Textile Today (2021)
Estimated Recyclable Waste (tons/year)	400,000	Haque et al. (2020)
Water Use in Dyeing (liters per 1,000 kg fabric)	1,500 – 2,000	Haque et al. (2020)
GHG Emissions Reduction Potential (%)	15%	World Bank (2020)
Green Job Creation Potential (by 2030)	200,000	ILO (2022)

can achieve the objectives of its environmental stewardship and economic sustainability, and at the same time meet the challenges of global competitiveness. The diagram will indicate high chances of the application of the circular economy within the industry of RMG:

Fig 1 visualization demonstrates that there is a lot of potential to adopt the circular economy, and there will be considerable environmental and resource efficiency gains. According to the existing linear model, the industry produces about 400,000 tons of textile waste every year; with the implementation of the circular approaches, i.e., recycling, fabric reuse, and better waste management, the annual output of the industry could be reduced by half to 200,000 tons; this is a 50 percent decrease in the waste. Water used estimated up to 2,000 liters per 1,000 kg of fabric may be cut down to 1,200 liters by 40 percent, such as a closed loop water system, wastewater reuse, and more efficient dyeing processes. The emission of greenhouse gases (GHG) 1,800,000 tons CO2e/per year today may drop to 1,530,000 tons CO2e due to the integration of the circular initiatives, a 15% reduction, which will be facilitated by the energy-saving technologies, as well as the replacement of fossil-based inputs with renewable or recyclable materials. Current energy consumption is 1,500,000 MWh/year, which could be reduced by 25 per cent to 1,125,000 MWh by implementing energy recovery systems, process optimization, and the adoption of renewable energy.

Such results highlight the idea that circular economy approaches provide a complex solution to reducing the negative environmental impact, preserving essential resources, and transitioning the RMG sector to a more sustainable production route without losing its economic sustainability.

3.4. Conclusion

The ready-made Garments (RMG) business has been the center stage of the Bangladesh economy, but because of its linear production system, it has caused more environmental degradation and vulnerability to climate change. As it is stressed in this paper, the transition to a circular economy (CE) may be a viable and crucial remedy that will enable equalizing industrial growth and ecological sustainability. By incorporating the eco-design approach and recycling centers, industrial symbiosis, integration of renewable energy, and providing supply chain transparency, the sector can significantly reduce its textile waste, water savings, greenhouse gas emissions, and create new green jobs. Such interventions alleviate the effects of climate change as well as enhance the competitiveness of the industry in a sustainable global market.

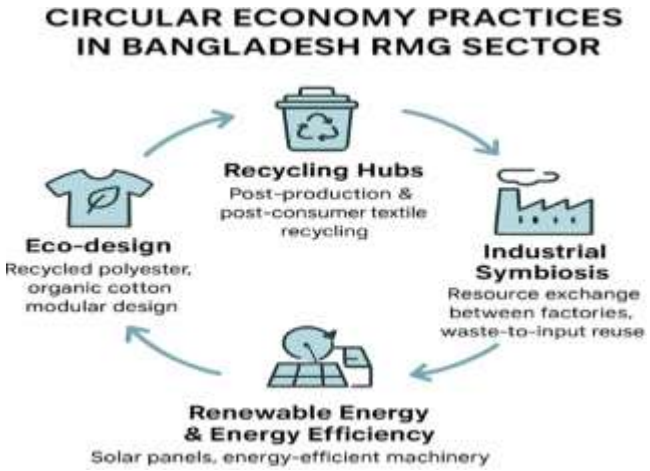

Fig 1: Scope for Circular Economy Practices in Bangladesh

It has been proven that CE implementation may make emissions drop as low as 15 percent, recycle close to 400,000 tons of fabric waste each year, and create more than 200,000 green jobs by 2030, guaranteeing the environmental and socio-economic positive results. Achieving this potential, however, needs a concerted policy backing, technology,

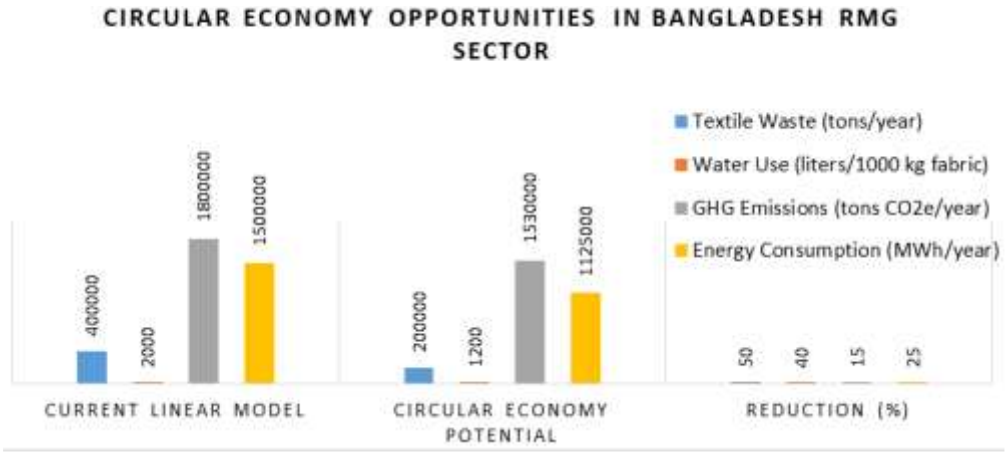

Fig. 2: Circular Economy Opportunities in Bangladesh

Note: The figure illustrates the scale of waste generation and recycling potential, water use in textile dyeing, possible GHG reductions through CE adoption, and projected green job creation by 2030.

infrastructural backing, and capacity-building programs throughout the supply chain, especially to small and medium-sized enterprises. Fig 2 shows that the opportunities and scale of waste generation and recycling potential will be by 2030. Finally, the move towards circularity is not just a call of environmental nature, but it is also an economic call of necessity to Bangladesh. It will not only establish the sustainability of the RMG sector in the long term but also protect millions of lives and make Bangladesh a leader in sustainable apparel production.

3.5. Conflict of Interest

The authors declare no financial, professional, or personal conflicts that could have influenced this study. The research was conducted independently, without support from industry, government, or non-governmental organizations. All conclusions are based solely on a critical review of literature, policy documents, and secondary data sources.

3.6. Data Availability Statement

The study used only secondary data from publicly accessible sources, including peer-reviewed journals, international organization reports (e.g., World Bank, ILO, IPCC), industry publications (e.g., BGMEA, Textile Today), and policy documents. No primary data were collected, and no new datasets were generated. All sources are cited in the reference list, and readers may access the materials directly through the provided references.

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