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Conference Proceedings

**Nemzetközi tudományos konferencia
a Magyar Tudomány Ünnepe alkalmából**
International Scientific Conference
on the Occasion of the Hungarian Science Festival

Sopron, 2022. november 3.
3 November 2022, Sopron

**TÁRSADALOM – GAZDASÁG – TERMÉSZET:
SZINERGIÁK A FENNTARTHATÓ FEJLŐDÉSSEN**

SOCIETY – ECONOMY – NATURE: SYNERGIES IN SUSTAINABLE DEVELOPMENT

Szerkesztők / Editors:

OBÁDOVICS Csilla, RESPERGER Richárd, SZÉLES Zsuzsanna, TÓTH Balázs István

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Green Manufacturing Practices Towards Sustainable Development in the Ready-Made Garments (RMG) Industry of Bangladesh

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Abstract

In recent years, green manufacturing practices have gained significant attention in academia and industry. The ready-made garments (RMG) industry, the second-top industrial polluter in the world, is incorporating green manufacturing practices to reduce the negative impacts on the environment of the RMG industry and sustainable development for experiencing increased pressures from the stakeholders. The RMG industry in Bangladesh, being the world's second-largest garment exporter, has become the leading sector in the country's economy. However, the RMG industry is generating several environmental challenges like global warming, CO₂ emissions, climate change, etc. Thus, the RMG sector in Bangladesh is adopting green manufacturing practices to save the environment and attain sustainable development. The available literature needs a structured analysis of the issues despite the significance of the green development area. This study aims to represent the framework of green approaches in the RMG sector of Bangladesh and to construct the linkages between green manufacturing tactics and sustainable development of the Apparel industry in the country. This study adopts a systematic literature review to explore green manufacturing strategies such as organic materials, green building, green innovation, green supply chain, social issues, etc., which businesses are integrating for sustainability.

Keywords: green manufacturing practices, ready-made garments industry, sustainable development

JEL Codes: L67, Q56, Q57

1. Introduction

The ready-made garments (RMG) business is recognized as one of the world's top industrial sectors and the most crucial contributor to Bangladesh's economy in employment, export earnings, and women empowerment (Habib et al., 2021). The sector employs about 4.1 million people, 65% of women, and accounts for 84% of Bangladesh's exports (BGMEA, 2020). The textile industries of Bangladesh are responsible for environmental and social issues like water pollution and unhealthy working conditions despite the crucial contributions they provide to the country's economy (Khan & Islam, 2015; Komal et al., 2020; Schiros et al., 2021). Every

textile-manufactured product contaminates the environment in some way, whether during production, consumption, or landfill. The fashion industry causes ecological catastrophes such as greenhouse gas emissions, water pollution, and waste generation for enormous consumption of resources, energy, and freshwater. Because of these problems, the fashion industry is under intense criticism from various groups, including the United Nations, governments, customers, and employees (Schaltegger et al., 2019; Schmitz et al., 2019; United Nations Global Compact, 2022). From this perspective, adopting green manufacturing practices (GMPs) in the textile sector is a valuable strategy for lowering adverse effects on the environment and society while simultaneously boosting the sector's profitability (Sangwan, 2011; Digalwar et al., 2017; Sharma et al., 2021).

Green manufacturing is an eco-friendly product and process design mode that minimizes waste and pollution and saves energy and resource consumption. According to Al-Hakimi et al., (2022), green manufacturing strategies lead to production efficiency, such as less energy and water consumption, lesser raw material costs, such as recycling and reuse rather than purchasing virgin materials, reduced environmental and occupational safety expenses, for example, and reduced regulatory compliance costs and potential liabilities, as well as an improved corporate image, such as a reduction in adverse environmental impact perceived by the public. Many researchers (Alay et al., 2016; Deif, 2011; Dilip Maruthi & Rashmi, 2015; Sarkar et al., 2020). Worldwide have worked on green manufacturing practices. However, the existing literature still needs a systematic explanation of the green manufacturing issues toward sustainable development of the apparel industry in Bangladesh. Hence, to fill this gap, the main objective of this paper is to identify green manufacturing approaches to promote the sustainability of Bangladesh's RMG sector.

2. Literature review

2.1. Sustainable development of the apparel industry

The announcement of the Sustainable Development Goals (SDGs) by the United Nations (UN) in September 2015 has shifted the focus of governments, policymakers, scholars, and practitioners worldwide to sustainable development (D'Angelo et al., 2022). Sustainability focuses on meeting present needs without risking future generations' ability to do the same (Purvis et al., 2019). The phrase "triple bottom line (TBL)" is a well-known term in business that paved the way for the three aspects of sustainable development: societal, ecological, economic or people planet, and profit (Macchion et al., 2018). Sustainable development is currently a top priority for many companies, particularly apparel manufacturing companies, disreputable for carbon emissions and other forms of pollution. More and more businesses are publicly committing to sustainability initiatives, including recycling more, switching to renewable energy, and funding groups working to make society more environmentally friendly (Faysal et al., 2022). Sustainable development aims to address environmental, social, and economic issues. Environmentally, development should not threaten the atmosphere, water, soil, or living things. Environmental sustainability compares the tradeoff between financial benefit and ecological effect as the manufacturing process of textile products requires many resources and can cause critical environmental problems (Islam et al., 2021). By adopting initiatives such as the green button, 3R policy, sustainable energy, water, and chemical management approach, Bangladesh's textiles and apparel factories are striving to promote environmental sustainability (BGMEA, 2020). Economic dimensions of sustainability entail developing long-term competitiveness, controlling, and predicting long-term risks, generating earnings, attracting customers, lowering expenses, and creating jobs (Wong & Ngai, 2021). Apparel sustainability practices can bring competitive benefits such as greater employee recruitment and retention, cost reductions, improved employer brand, stakeholder interactions, and returns on capital. Social sustainability in

the RMG industry is concerned with ensuring social issues, for instance, workplace safety, hygiene and health, well-being, quality of life, access to training and education, and equity (Negrete & López, 2020). Addressing social issues from a supplier perspective can help achieve social sustainability. However, most development scholars, researchers, and professionals use the term "sustainable development" to mean improving and maintaining an economic, environmental, and sociocultural system that works for human progress (Mensah, 2019). Press (2021) pointed out that apparel sustainability is relevant to weak sustainability because it is micro-focused and examines on tiny subsets of economic activity whereas strong sustainability incorporates multiple stakeholders. However, the most difficult aspect of achieving apparel sustainability is managing all three challenges such as excessive consumption of scarce resources, industrial waste, and hazardous working conditions (Negrete & López, 2020). Therefore, integrating economic, social, and environmental dimensions is essential for sustainable development of textile industry.

2.2. Concept of green manufacturing practices

Although the idea of green manufacturing dates to the 1990s (Sezen & Çankaya, 2013), in the recent two decades, it has got substantial attention from scholars, policymakers, and practitioners because of growing consciousness among stakeholders concerning sustainability (Rehman et al., 2016; Bai et al., 2019). Toke & Kalpande (2019) defined *green manufacturing* as a strategy of a manufacturing system that minimizes carbon footprint through the reduction of toxic pollutants and waste, the efficient use of materials and energy, and the application of a life cycle assessment (LCA), closed loop, and end-of-life (EOL) strategy. Clean manufacturing, environmentally conscious manufacturing, ecologically benign manufacturing, environmentally responsible manufacturing, sustainable manufacturing, and sustainable production are common synonyms for green manufacturing (Rehman & Shrivastava, 2013). Regardless of the terminology, the objective is the same: producing and distributing products that reduce the adverse impact on the environment because of their production, usage, and disposal (Hassan & Jaaron, 2021). Based on current research, this study believes green manufacturing is a manufacturing system that minimizes greenhouse gas emissions through the optimal and effective use of resources, energy, and water and increases social and economic resilience.

2.3. Green manufacturing practices towards apparel sustainability in Bangladesh

Several authors have used the term "green manufacturing practices" (Govindan et al., 2015; Hassan & Jaaron, 2021). Green manufacturing processes refer to business procedures that uphold the three pillars of the sustainable development framework. Reducing manufacturing waste and using scarce natural resources are two of the primary goals of "green manufacturing techniques," which also seek to avoid trash sent to landfills. Thus, it safeguards workers and the environment while boosting operational efficiency, profitability, and productivity (Mukonzo, 2017). Green manufacturing processes include pro-environmental design, environmentally sustainable raw materials, environmental packaging, delivery, and disposal beyond the product's useful life (Rehman et al., 2016). However, green initiatives in the manufacturing industry are significant. Due to the need for a well-defined green business strategy, only some producers in emerging countries care much about environmental protection (Yasir et al., 2020). Many apparel firms in Bangladesh are reluctant to apply green manufacturing techniques in their operations, but interest groups, including buyers, compel manufacturers to implement green technology. Bangladesh has been taking a leading position in the green industrialization process. As a representative body, Bangladesh Garment Manufacturers and Exporters Association (BGMEA) founded the RMG sustainability council (RSC) in 2019 to achieve sustainable development. Realizing the gravity of the situation, BGMEA has joined the global fashion industry charter for climate change as a supporting body to cut the sector's greenhouse gas (GHG)

emissions by thirty percent by the year 2030, compared to the business as usual (BAU) level (BGMEA, 2020). In recent years, many apparel firms in Bangladesh have adopted green approaches such as the national 3R policy, organic raw materials usage, renewable energy, water, and chemical management to promote sustainability (Islam et al., 2018). Consequently, Bangladesh has the world's greenest apparel factories, with 91 LEED (Leadership in Energy and Environmental Design)-certified plants. Bangladesh is also home to 24 of the world's platinum-rated garment manufacturers, the highest amount in the world. Twenty-five Bangladeshi manufacturers have earned the US Green Building Council's (USGBC) highest certification, with six of the top ten LEED-certified factories in the world being in Bangladesh. Many RMG companies in Bangladesh are now using green practices such as green materials, green innovation, green energy, green building, waste management, green supply chain, and corporate social responsibility to reduce stress and make their businesses more sustainable (Chowdhury & Yasmin, 2018; BGMEA, 2020; Kaizer, 2020; Sarkar et al., 2020; Sabuj et al., 2021; Shamsuzzaman et al., 2021; Khairul Akter et al., 2022).

3. Research methodology

This study is based on a systematic review of the literature on green manufacturing practices and sustainability in manufacturing sectors. This study incorporates the most recent literature on different dimensions of green manufacturing practices and sustainable development, including theses (MS and Ph.D.), journal articles, review articles, conference proceedings, reports, books, and web materials. Google Scholar, Scopus, and Science Direct were only a few databases and journals that were searched to find the necessary articles. The relevant literature review helped to identify "green manufacturing practices" and demonstrate how they contribute to Bangladesh's sustainable development of the RMG industry. "Green manufacturing practices," "Sustainable development," "Fashion industry" were used as keywords to search for relevant articles to build a conceptual model. Table 1 demonstrates the literature search procedure. The study considers research papers which are published between 2011 and 2022 and in English language only. Though primarily 1147 records were identified through three databases, Google scholar (1073), Science Direct (61) and Scopus (15) and then by reading title and abstract 135 records were screened. Finally, the paper includes 54 studies, and a few papers were picked randomly based on the study's needs. A technique described in Fig. 1 was used to exclude inappropriate papers from the literature. Information gathered from reviewed literature was consolidated and recorded. The green manufacturing and sustainability-related publications were evaluated using a content analysis approach. This paper developed a green manufacturing practices framework for fashion sustainability in Bangladesh based on a content analysis of evaluated literature.

Table 1: The literature search process

<i>Research Protocol</i>	Description of details
<i>Research databases</i>	Google Scholar, ScienceDirect, and Scopus
<i>Publication Type</i>	Research articles, review articles, theses (MS and Ph.D.), conference proceedings, reports, books, and web materials
<i>Language</i>	Only English-language publications were considered
<i>Timeframe</i>	Studies published between 2011 and 2022
<i>Search boxes</i>	Abstracts, titles, and keywords
<i>Phrases used in search engines</i>	"Green manufacturing practices", "Sustainable development", "Fashion industry"

Source: Authors' clarification

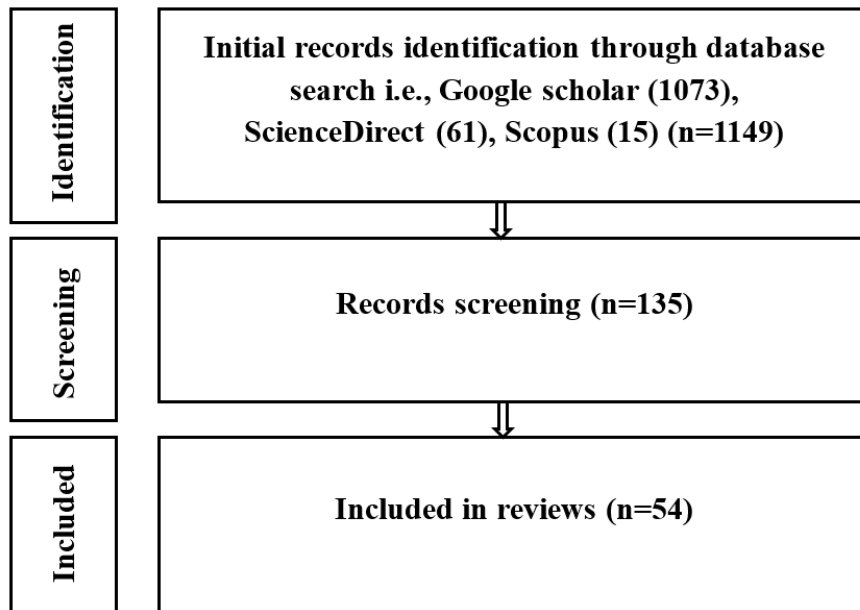


Figure 1: Article selection procedure
Source: Authors' clarification

4. Findings and discussion

4.1. Development of research framework

In this model, the green manufacturing approaches directly affect sustainability in the apparel industry. According to the study, the propounded model provides ease in systematically bringing the outcomes of this research.

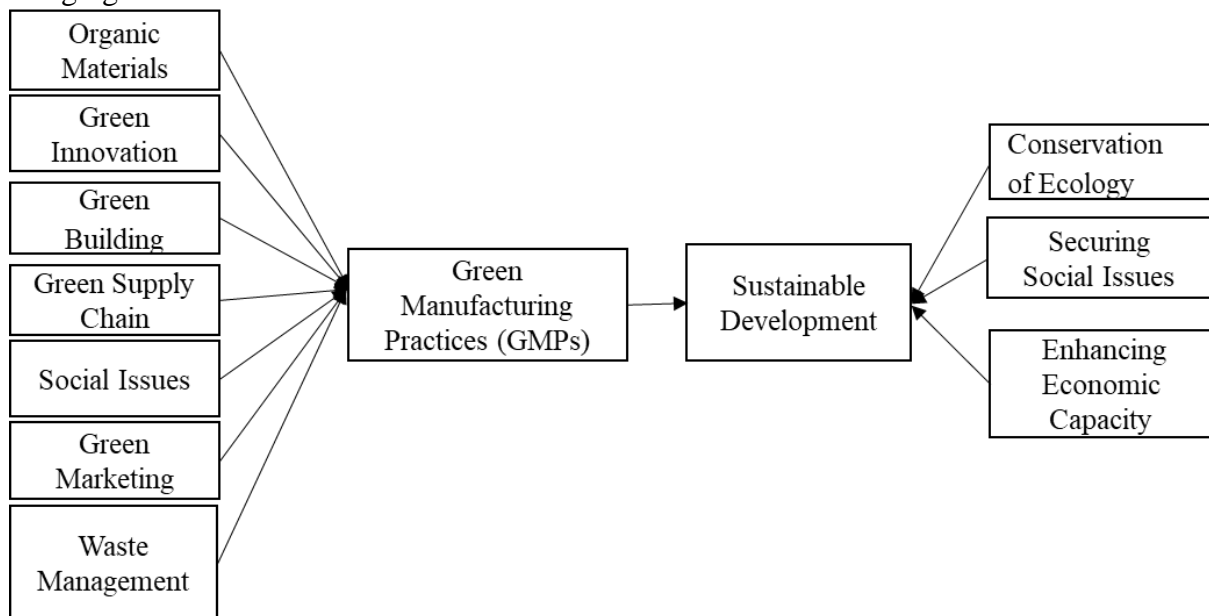


Figure 2: The proposed research framework: Sustainable development through green manufacturing practices

Source: Authors' clarification

The research framework illustrates how green manufacturing approaches promote environmental, social, and economic sustainability of the fashion industry in Bangladesh. As the literature states, all green issues are connected to the theme of sustainable development. Therefore, based on a literature review, this study makes a theory about the role of green manufacturing approaches and suggests that green manufacturing strategies can help make clothing more sustainable. The authors find that existing green manufacturing practices induce the pillars of sustainable development such as conserving ecology through cleaner production, ensuring social security through social compliance and enhancing economic capacity through increasing profitability. More clearly, when the apparel firms use organic materials and other green approaches in the apparel industry minimize wastage and maximize the use of natural resources and finally promote to achieve environmental sustainability. This impact is not confined to ecology but also the financial and social environment. Therefore, integrating green practices in the apparel manufacturing industry, sustainable development can be attained easily.

4.2. Result of relevant variables

Based on this review, Table 2 presents the GMPs emphasized in recent literature from all three dimensions of sustainability.

Table 2: List of identified green manufacturing practices toward textile sustainability in Bangladesh from literature

Green Manufacturing Practices	References
<i>Organic materials</i>	Eryuruk (2012), Khan & Islam (2015), Kaizer (2020), Hasan et al. (2022), Khairul Akter et al. (2022)
<i>Green innovation</i>	Sezen & Cancaya (2013), Kaizer (2020), Islam et al. (2021), Khan et al. (2022)
<i>Green building</i>	Kaizer (2020), Nath et al. (2021)
<i>Green supply chain</i>	Green et al. (2012), Tumpa et al. (2019), Kumar et al. (2020), Islam et al. (2021), Shamsuzzaman et al. (2021)
<i>Social issues</i>	Huq et al. (2014), Munny et al. (2019), BGMEA (2020)
<i>Green marketing</i>	Saari et al. (2018), Ara et al. (2019)
<i>Waste management system</i>	Kaizer (2020), Islam et al. (2021), Pervez et al. (2021), Khairul Akter et al. (2022)

Source: Authors' clarification

Based on the content analysis of reviewed papers, this study has identified seven green manufacturing practices in the RMG industry of Bangladesh for meeting the research question raised in the introduction chapter. Green material is the first approach to promote sustainability in the apparel sector. Organic textile materials are eco-friendly resources (e.g., organic fibers and leather) characterized renewability of the raw materials and ecological footprints of the resources that can produce sustainable apparel products(Khan & Islam, 2015; Hasan et al., 2022; Khairul Akter et al., 2022). Most of Bangladesh's RMG factories exclusively use organic cotton textiles validated by Global Organic Textile Standard-certified (GOTS)(BGMEA, 2020). Green material is not enough for sustainability. Thus, green innovation is necessary to design process and product innovation. Green innovation refers to adopting technological, organizational, and social practices that create less or have no harmful environmental impacts (Sezen & Çankaya, 2013; Khan et al., 2022). Green innovation is the combination of green products and

green process innovation. To achieve long-term success in economic and environmental spheres, "green innovation" is the cornerstone strategy (Ikram, 2022).

Green building means constructing buildings and utilizing eco-friendly and resource-efficient methods throughout the entire building's lifespan (Kaizer, 2020). It includes building design plans, operation, construction, deconstruction, maintenance, development, and reconstruction. 123 RMG factories in Bangladesh have also been certified by LEED (Leadership in Energy and Environmental Design). These factories consume 40% less water compared to conventional factory buildings.

The green supply chain comprises green procurement, green logistics, green dealer awareness, and reverse logistics (Green et al., 2012). They are innovating sustainable, biodegradable products and packaging and designing an energy-efficient transportation network. A green supply chain yields better environmental and economic performance in the individual supply chain partners, which results in the overall improvement of the business organization (Islam et al., 2018; Habib et al., 2021).

The social aspect evaluates how the actions affect society and can be used to "improve the benefits and welfare of workers." Many RMG firms in Bangladesh actively engage in community and environmental improvement projects, such as employee training and education programs, ensuring workplace safety and fair wages (Munny et al., 2019; BGMEA, 2020; Fontana et al., 2021). They also take measures to protect and secure the rights of their employees by introducing certification compliance with workers' rights.

Green marketing is nothing but an ecological marketing activity. It promotes sustainability in the apparel manufacturing industry (Ara et al., 2019). In Bangladesh the RMG industry have started environmentally friendly marketing (BGMEA, 2020).

Garment manufacturing factories utilize various toxic chemicals, groundwater, and power for manufacturing and operation (Kaizer, 2020). Material waste in the textile-apparel production cycle can reduce value and economic opportunities and harm the environment. Effective ETP plants, recycling, and reusing wastewater water conservation, harvesting of water, and hazardous and non-hazardous substance reduction are examples of waste management (Gupta et al., 2022; Khairul Akter et al., 2022). The 75 Bangladeshi factories that are part of the Partnership for Cleaner Textiles (PaCT) have improved water efficiency, decreased energy consumption, and increased chemical control by adopting best production practices (BGMEA, 2020). In 2019, these factories saved 20 billion liters of water (Gupta et al., 2022; Singh & Ambika, 2022).

5. Conclusion, limitations, and future research directions

This article's principal objective was to provide a comprehensive report on green manufacturing techniques in the fashion industry. This paper analyzed green manufacturing processes and RMG industries of Bangladesh. The review of the relevant literature assisted in elucidating the concepts of sustainable development, green development, and green manufacturing, as well as how green manufacturing practices contribute to the global and Bangladeshi apparel industries capacity for long-term sustainability. Based on the literature, this study demonstrates a substantial contribution of green manufacturing approaches to the RMG businesses, which is mainly responsible for negative environmental and social impact and is facing pressures for carbon emissions minimization and other crises. This study proposes a framework for implementing green manufacturing techniques for the RMG industries sustainable development and firm performance by identifying green practices. Even though this study has numerous vital implications, it has limitations. The lack of actual data is the study's most significant shortcoming. These constraints might be regarded as an existing gap of this research. Therefore, in future considering this study gap an empirical study could be undertaken in the fashion industry of Bangladesh.

Moreover, future research could be conducted in other sectors, such as leather, the pharmaceutical industry, and service industries, still need to be explored by adopting green manufacturing techniques.

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