7th Bangladesh Conference on Industrial Engineering and Operations Management
December 21-22, 2024
Publisher: IEOM Society International, USA DOI: 10.46254/BA07.20240225
Published: December 21, 2024

Prioritizing Environmental Management Practices in Bangladesh through Multi-Criteria Decision Analysis

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Abstract

Bangladesh struggling through the environmental challenges like pollution, energy consumption, and waste management. Environmental management is a critical concern for Bangladesh, given its vulnerability to climate change and rapid industrialization. A proper prioritizing effective environmental management practices (EMPs) is crucial for sustainable development. This study utilizes SWARA (Step-wise Weight Assessment Ratio Analysis) and WASPAS (Weighted Aggregated Sum Product Assessment) methods to evaluate and prioritize a range of EMPs. The research identifies key environmental challenges and considers a range of criteria—including environmental impact, feasibility, cost-effectiveness, and social acceptance—to assess alternative management strategies. Using a systematic approach, this research provides a decision-making framework for policymakers to select and implement the most suitable environmental practices that align with the country's unique socio-economic and environmental conditions. By integrating both qualitative and quantitative assessments, the research provides a decision-making framework for policymakers to adopt the most impactful and feasible environmental strategies. The findings aim to guide Bangladesh's environmental policies toward more sustainable and effective practices, balancing ecological preservation with socio-economic development.

Keywords
Environmental Management Practices, Multi-Criteria Decision Analysis (MCDA), Sustainable Development, SWARA Method, WASPAS Method

Introduction
Bangladesh, like many countries in South Asia, faces significant environmental challenges that threaten its sustainable development. The rapid pace of industrialization, growing urbanization, and the intensifying effects of climate change have exacerbated issues such as pollution, waste management, and inefficient energy use. The country is especially vulnerable to environmental stress due to its geographic location, which makes it prone to flooding, cyclones, and other climate-related disasters. While Bangladesh has made considerable progress in economic development, the environmental toll of this growth is becoming increasingly difficult to ignore. This makes the need for effective environmental management practices (EMPs) more urgent than ever.

The environmental challenges faced by Bangladesh are multifaceted. Air pollution, especially in urban areas like Dhaka, is a major issue. According to recent reports, Dhaka ranks among the most polluted cities globally, with industrial emissions, traffic, and brick kilns being the primary culprits. Additionally, untreated industrial waste and sewage runoff have severely polluted water bodies, such as the Buriganga River, leading to harmful effects on both aquatic life and public health. Waste management, too, is a growing concern, with much of the waste generated in urban areas being improperly disposed of or not recycled. This puts both environmental and public health systems at risk, particularly in densely populated areas (Rahman 2019).

Energy consumption is another critical issue. While Bangladesh has made strides in increasing access to electricity, much of its energy still comes from fossil fuels, which contribute to rising greenhouse gas emissions. At the same time, the demand for energy is growing due to rapid industrialization and population growth, putting additional pressure on the country's energy infrastructure. In fact, the energy sector accounts for a large proportion of the country's total emissions (Islam et al. 2020). Given these challenges, it is clear that Bangladesh needs a robust framework for prioritizing and implementing effective environmental management practices.

To tackle these pressing issues, this study applies two well-established multi-criteria decision analysis (MCDA) methods: Step-wise Weight Assessment Ratio Analysis (SWARA) and Weighted Aggregated Sum Product Assessment (WASPAS). These methods are used to evaluate and prioritize environmental management practices based on several criteria—such as environmental impact, feasibility, cost-effectiveness, and social acceptance. The key idea behind this approach is to provide policymakers with a structured framework that allows them to make informed, balanced decisions about which environmental practices to prioritize.

The SWARA method helps determine the relative importance of various decision-making criteria. In this case, it is essential to assess which environmental management practices will have the most significant impact on reducing pollution, conserving resources, and mitigating climate change. The WASPAS method, on the other hand, aggregates these criteria to rank various alternatives, helping identify which practices will be the most effective, cost-efficient, and socially acceptable in the Bangladeshi context. Together, these methods offer a systematic and transparent approach to evaluating environmental practices and can support policymakers in selecting the best strategies for sustainable development.

The need for such prioritization is further emphasized by the scale of environmental challenges Bangladesh is facing. Air quality in Dhaka has deteriorated to the point where it has become a public health emergency. According to the World Health Organization (2020), the level of air pollution in Dhaka regularly exceeds safe limits, with pollutants like particulate matter (PM2.5) reaching hazardous levels. In addition to air pollution, water pollution is also a significant concern. Rivers and water bodies across the country are contaminated with untreated waste, affecting not only aquatic life but also the quality of drinking water, which leads to waterborne diseases (Kabir et al. 2020). Addressing these issues is crucial, not just for the health of the environment, but also for the livelihoods of millions of people who depend on natural resources.

However, Bangladesh's environmental management system faces considerable challenges. Limited resources, weak enforcement of regulations, and political fragmentation make it difficult to implement large-scale changes. Moreover, Bangladesh's socio-economic conditions complicate the decision-making process. With a large population living below the poverty line, many people rely on activities that have a significant environmental impact, such as informal waste disposal or small-scale industrial production. Any environmental management strategy must, therefore, take into account the socio-economic realities of these communities to be effective.

The objectives of this study are:

RO1: To evaluate and prioritize key environmental management practices for Bangladesh using the SWARA method, considering factors such as energy efficiency and pollution control.
RO2: To apply the WASPAS method to compare and rank alternative EMPs based on their environmental, economic, and social impacts.
RO3: To provide a comprehensive decision-making framework for policymakers to effectively select and implement the most sustainable EMPs, tailored to the country's specific socio-economic and environmental conditions.

By offering a systematic, data-driven approach to environmental management, this research not only fills a gap in the existing literature but also provides practical guidance for Bangladesh's policymakers in navigating the complexities of sustainable environmental governance. The integration of both SWARA and WASPAS allows for a more nuanced understanding of how various management practices can contribute to achieving long-term environmental goals while ensuring economic and social development (Chakraborty et al. 2018; Haq et al. 2020). This study's findings have the potential to shape more informed, effective policies that align environmental goals with economic growth, ultimately contributing to a more sustainable future for Bangladesh.

2.Literature

Bangladesh is grappling with numerous environmental challenges due to rapid industrialization, urbanization, and increasing population. The country faces issues such as air pollution, water contamination, inefficient waste management, and rising energy consumption. These environmental problems not only harm public health but also hinder economic growth and sustainable development. As Bangladesh strives to develop a more sustainable future, it is essential to identify and implement effective environmental management practices (EMPs).

One of the major concerns in Bangladesh is air pollution, particularly in urban areas like Dhaka. According to Hossain and Alam (2018), air quality in Dhaka has deteriorated significantly due to emissions from vehicles, industrial activities, and construction. They argue that poor air quality has led to an increase in respiratory diseases and contributed to the overall decline in public health. Addressing this issue requires the adoption of stringent air quality regulations, technological innovations in cleaner production, and public awareness campaigns to reduce vehicular emissions. Similarly, Rahman (2019) also highlights water pollution as a significant concern. He emphasizes that the contamination of rivers and lakes by untreated industrial waste and sewage is a pressing problem. In many cases, these water bodies are used as sources of drinking water, exposing the population to dangerous contaminants. Another study highlights the environmental and health risks posed by airborne dust in industrial settings, emphasizing the need for better occupational health and safety measures in Bangladesh's manufacturing sectors, which can be integrated into broader environmental management practices to ensure sustainable industrial growth. Effective waste treatment facilities, stricter industrial regulations, and improved sewage systems are essential to mitigating this issue.

In terms of waste management, Dhaka city faces severe challenges in properly handling the increasing volume of solid waste. Kabir et al. (2020) note that the city lacks an efficient waste segregation system, and the absence of recycling practices has led to growing landfills and environmental degradation. They suggest that a multi-stakeholder approach involving the private sector, government, and local communities is essential for improving waste management practices. Encouraging community-based initiatives for waste segregation and recycling can significantly reduce waste generation and environmental pollution.

Energy consumption is another major environmental issue in Bangladesh. According to Huq et al. (2020), the country is heavily reliant on non-renewable sources of energy, particularly coal and natural gas, which contribute to high levels of carbon emissions. As Bangladesh's demand for energy grows with industrialization, the adoption of renewable energy sources such as solar and wind power is becoming increasingly critical. However, Huq et al. argue that transitioning to renewable energy poses challenges related to cost, infrastructure, and technology. The government must invest in renewable energy infrastructure and provide financial incentives to encourage its adoption, particularly in rural and underserved areas.

The literature on environmental management in Bangladesh also highlights the importance of integrating decision-making tools to prioritize and implement effective EMPs. For instance, Debnath et al. (2023) explore the use of the Step-wise Weight Assessment Ratio Analysis (SWARA) and Weighted Aggregated Sum Product Assessment (WASPAS) methods in sustainable supplier selection in the healthcare supply chain. They demonstrate that these Multi-Criteria Decision-Making (MCDM) tools can be used to prioritize environmental management strategies based on factors such as cost-effectiveness, social acceptability, and environmental impact. These frameworks can be applied to a variety of sectors, including waste management, water treatment, and energy conservation, to identify the most effective strategies for reducing environmental harm while balancing economic and social needs.

In a similar vein, Siraj et al. (2022) employed a hybrid MCDM approach to prioritize fire risk mitigation strategies in the ready-made garment industry of Bangladesh. Their study suggests that MCDM methods, like SWARA and WASPAS, can be adapted for environmental management to rank and select the most suitable strategies for addressing specific challenges, such as air and water pollution. By incorporating both quantitative and qualitative assessments, these frameworks enable policymakers to make informed decisions about which environmental practices are the most feasible and impactful in the local context.Further, Haq et al. (2023) provide a comprehensive analysis of barriers to implementing lean practices in the leather tanning industry, which is one of the major polluting sectors in Bangladesh. Their research shows that adopting cleaner technologies and efficient waste management practices in this industry can significantly reduce environmental harm. However, they note that challenges such as high implementation costs and lack of technical knowledge among workers hinder the adoption of sustainable practices. Therefore, it is crucial to provide technical training and financial support to industries to encourage the implementation of eco-friendly practices.

The importance of environmental sustainability in industrial settings is also emphasized by Pal et al. (2023), who discuss the role of industrial safety engineering in promoting sustainable solutions in the oil, gas, and refinery industries. Their study highlights how safety practices and environmental management can be integrated to minimize risks and ensure the long-term sustainability of industries. For Bangladesh, such integrated approaches can be beneficial in sectors that have high environmental impacts, such as the textile and leather industries.Moreover, the recovery and reuse of waste materials is an area gaining attention in Bangladesh's environmental policy. Haq et al. (2023) highlight the potential for recovering valuable materials from industrial waste, particularly in the leather tanning sector. This approach not only helps reduce pollution but also generates economic value by turning waste into a resource. Such innovative solutions are crucial for improving the sustainability of Bangladesh's industries, especially in areas where waste management infrastructure is lacking. For instance, the recovery and reuse of chromium from tannery waste using solar evaporation presents an innovative approach to reducing environmental pollution in Bangladesh's leather industry. By efficiently reclaiming valuable materials from waste, this process not only helps mitigate pollution but also contributes to resource sustainability in the industrial sector.

To address the environmental issues in Bangladesh effectively, a holistic approach that integrates policy, technology, and community participation is necessary. Hossain and Alam (2018) argue that a shift toward more sustainable practices will require the active involvement of both government and civil society. Environmental policies must be designed to promote sustainability across various sectors, from energy and waste management to industrial production. The integration of decision-making frameworks such as SWARA and WASPAS can help prioritize the most effective EMPs based on a thorough evaluation of environmental, economic, and social factors.

Bangladesh faces significant environmental challenges that require urgent action. However, the literature suggests that adopting effective environmental management practices, supported by decision-making tools like SWARA and WASPAS, can guide the country toward a more sustainable future. By integrating renewable energy, improving waste management, and addressing industrial pollution, Bangladesh can mitigate the environmental risks it faces and achieve sustainable development in the long term.

3.Methodology

Multi-Criteria Decision-Making (MCDM) methods play a crucial role in resolving complex decision problems by considering multiple criteria simultaneously. Among these, the SWARA (Step-wise Weight Assessment Ratio Analysis) method stands out for its systematic approach to evaluating alternatives based on weighted attributes. Meanwhile, the WASPAS (Weighted Aggregated Sum Product Assessment) method offers a robust framework for aggregating criteria and determining overall performance. Combining the structured assessment approach of SWARA with the aggregation capabilities of WASPAS presents a compelling synergy, empowering decision-makers with a comprehensive toolkit for navigating diverse scenarios with clarity and precision.

3.1 SWARA method

SWARA approach integrates the experts' feedback to determine the initial priority and relative relevance for each variable before computing their relative weight. The variables are prioritized and ranked following the method's resulting features, which state that they are independent of one another and are compensating (Sivageerthi et al. 2022). The 5-point Likert scale used in this study for evaluating the selection criteria (Balali et al. 2022) is presented in Table 1.

Table 1. Five-point Likert scale

Comments	Preference level
Not Important	1
Negligible	2
Somewhat important	3
Important	4
Very Important	5

The steps of the SWARA approach (Yücenur & Ipekçi, 2021) followed in this study are:

Step 1: The criteria are first rated by experts according to their relative significance. The score given to the c criterion by the m decision-maker is denoted as P_c^m $(c = 1, 2, 3, \dots\dots C; m = 1, 2, 3, \dots\dots. M; 0 < P_c^m < 1)$.
Step 2: In this step, equation (1) is used to calculate $\overline{P_c}$, the average of the importance scores that the decision makers have attributed to the criteria, where the total number of decision makers is specified by M.

$$\overline{P_c} = \sum_{m=1}^{M} P_c^m \quad (1)$$

Step 3: In this step, the coefficient value (J_c) determined from equation (2). The value of $J_c = 1$ opts as the coefficient for the criteria with the highest value of S_c. The value of S_c, which shows how significant the $(c + 1)$ criterion is in relation to the c criterion, is the relative significance score of the mean value for each criterion.

$$J_c = S_c + 1 \quad (2)$$

Step 4: Now, the adjusted weight value (S_c') is determined by using equation (3). $S_c' = 1$ for the first-placed criteria in the ranking.

$$S_c' = \frac{S_{c-1}'}{J_c} \quad (3)$$

Step 5: The final relative weight (W_c) of the criteria is computed using equation (4).

$$W_c = \frac{S_c'}{\sum_{c=1}^{C} S_c'} \quad (4)$$

Step 6: The criteria are ranked in a hierarchy based on the relative weight found in step (4).

3.2 WASPAS method

The WASPAS approach fundamentally combines WSM and WPM, two well-known MCDM methods. The approach is capable of regulating the consistency of alternative ranks through intrinsic sensitivity analysis (Seker & Aydin, 2022). The steps of the WASPAS approach (Rahman et al., 2022; Yücenur & Ipekçi, 2021) followed in this study are:
Step 1: The alternative (A_i) and criteria (C_j) are selected to evaluate in this step. Where $i = 1, \dots\dots, m$ & $j = 1, \dots\dots\dots, n$
Step 2: One of the MCDM techniques is employed before for calculating the weights of the criteria. SWARA was utilized in this study to quantify the weights of the criteria.

Step 3: The decision matrix is normalized using equations 4 and 5.

For maximum optimum value (beneficiary),

$$\bar{X}_{ij} = {X_{ij}}/{\max X_{ij}} \qquad (5)$$

For minimum optimum value (Non-beneficiary)

$$\bar{X}_{ij} = {\min X_{ij}}/{X_{ij}} \qquad (6)$$

Step 4: The "Weighted Sum Model" is used in this step to determine the first total relative significance value ($Q_i^{(1)}$) using equation (6).

$$Q_i^{(1)} = \sum_{j=1}^{n} \overline{X_{ij}} W_j \qquad (7)$$

Step 5: The "Weighted Product Model (WPM)" is used in this step to determine the second total relative significance value ($Q_i^{(2)}$) using equation (7).

4.Calculation

The procedures indicated in Step 1 of the SWARA technique are followed to gather individual evaluations of decision-makers. The responses of experts and subsequently the average relative importance of the criteria obtained by applying equation (1) Then equations (2) - (4) were used to determine the coefficient value, adjusted weight value, and the final criteria weight value. The criterion finalized are presented in the Table 1 and the final weights of the criteria are provided in Table 2.

Table 2. Factors for different literature

SL	Factors	Source	Factor Number
1	Energy consumption	Zolfani et. al. 2015, Mohebali et. al. 2019	Factor 2
2	Waste Management	Mohebali et. al. 2019	Factor 1
3	Pollution Management	Moghimi et al. 2022	Factor 7
4	Noise Control	Mohebali et. al. 2019	Factor 3
5	Economic Issue	Zolfani et. al. 2015, Zolfani et. al. 2015	Factor 10
6	Carbon footprint	Moghimi et al. 2022	Factor 5
7	Air Quality	Zolfani et. al. 2015	Factor 13
8	Water Consumption	Moghimi et al. 2022	Factor 4
9	Land use and ecology	Zolfani et. al. 2015, Mohebali et. al. 2019	Factor 6
10	Health and well-being	Mohebali et. al. 2019	Factor 14
11	Supporting services	Mohebali et. al. 2019	Factor 11
12	Law and regulations	Moghimi et al. 2022, Zolfani et. al. 2015	Factor 8

Table 3. Determining the weights of criteria using the SWARA approach

Factor	Code	Importance Pi	Sj	kj	qj	Weight
Factor 2	C1	0.88963		1.00000	1.00000	0.09885
Factor 1	C2	0.83236	0.05727	1.05727	0.94583	0.09350
Factor 7	C3	0.80197	0.03039	1.03039	0.91794	0.09074
Factor 3	C4	0.76855	0.03342	1.03342	0.88825	0.08781
Factor 10	C5	0.75696	0.01159	1.01159	0.87807	0.08680
Factor 5	C6	0.72541	0.03155	1.03155	0.85122	0.08415
Factor 13	C7	0.71907	0.00634	1.00634	0.84586	0.08362
Factor 4	C8	0.68839	0.03068	1.03068	0.82068	0.08113
Factor 6	C9	0.67208	0.01631	1.01631	0.80751	0.07982

Factor 14	C10	0.62817	0.04392	1.04392	0.77354	0.07647
Factor 11	C11	0.53162	0.09655	1.09655	0.70543	0.06973
Factor 8	C12	0.49688	0.03474	1.03474	0.68175	0.06739
					10.11608	1

Table 4. Alternative management policy identified are

Alternatives	Alternative number
Energy Efficiency and Renewable Energy	A1
Effluent Treatment	A2
Health and Environmental Policy	A3
Pollution and Carbon Footprint	A4
Circular Economy and Waste Management	A5

Table 5. WASPAS Rating

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	Min	Max	Max	Min	Max	Max	Min	Max	Max	Max	Min	Max
A1	9	5	9	9	5	3	9	7	9	3	9	5
A2	7	7	5	7	5	5	5	3	5	5	5	5
A3	3	7	9	3	3	7	9	7	5	7	7	7
A4	3	7	7	3	5	7	3	5	3	9	7	9
A5	7	5	9	5	7	9	5	3	3	9	9	3
	3	7	9	3	7	9	3	7	9	9	5	9

Table 6. Normalized Matrix

Step 2	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
A1	0.333	0.714	1.000	0.333	0.714	0.333	0.333	1.000	1.000	0.333	0.555	0.555
A2	0.428	1.000	0.555	0.428	0.714	0.555	0.600	0.428	0.555	0.555	1.000	0.555
A3	1.000	1.000	1.000	1.000	0.428	0.777	0.333	1.000	0.555	0.777	0.714	0.777
A4	1.000	1.000	0.777	1.000	0.714	0.777	1.000	0.714	0.333	1.000	0.714	1.000
A5	0.428	0.714	1.000	0.600	1.000	1.000	0.600	0.428	0.333	1.000	0.555	0.333

Table 7. WAS value

Weight	0.09885	0.09350	0.09074	0.08781	0.08680	0.08415	0.08362	0.08113	0.07982	0.07647	0.06973	0.06739	
Step 3	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	SUM (Q1)
A1	0.03295	0.06678	0.09074	0.02927	0.06200	0.02805	0.02787	0.08113	0.07982	0.02549	0.03874	0.03744	0.60028
A2	0.04237	0.09350	0.05041	0.03763	0.06200	0.04675	0.05017	0.03477	0.04435	0.04248	0.06973	0.03744	0.61159
A3	0.09885	0.09350	0.09074	0.08781	0.03720	0.06545	0.02787	0.08113	0.04435	0.05947	0.04981	0.05242	0.78859
A4	0.09885	0.09350	0.07058	0.08781	0.06200	0.06545	0.08362	0.05795	0.02661	0.07647	0.04981	0.06739	0.84002
A5	0.04237	0.06678	0.09074	0.05268	0.08680	0.08415	0.05017	0.03477	0.02661	0.07647	0.03874	0.02246	0.67274

Table 8. WPS Table

Weight	0.09885	0.09350	0.09074	0.08781	0.08680	0.08415	0.08362	0.08113	0.07982	0.07647	0.06973	0.06739	
Step 4	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	Mult (Q2)
A1	0.8971	0.9690	1.0000	0.9080	0.9712	0.9117	0.9122	1.0000	1.0000	0.9194	0.9598	0.9612	0.54083
A2	0.9197	1.0000	0.9481	0.9283	0.9712	0.9517	0.9582	0.9336	0.9542	0.9560	1.0000	0.9612	0.58679
A3	1.0000	1.0000	1.0000	1.0000	0.9291	0.9791	0.9122	1.0000	0.9542	0.9810	0.9768	0.9832	0.74596
A4	1.0000	1.0000	0.9775	1.0000	0.9712	0.9791	1.0000	0.9731	0.9160	1.0000	0.9768	1.0000	0.80928
A5	0.9197	0.9690	1.0000	0.9561	1.0000	1.0000	0.9582	0.9336	0.9160	1.0000	0.9598	0.9286	0.62236

Table 9. Final Ranking of Alternatives

Step 5	Weight	Rank
A1	0.5706	5
A2	0.5992	4
A3	0.7673	2
A4	0.8246	1
A5	0.6475	3

5.Result and Discussion

The results obtained from the SWARA (Step-wise Weight Assessment Ratio Analysis) method indicate that the prioritized factors for improving environmental management and sustainability practices are Health and Environmental Policy (A3), Circular Economy and Waste Management (A4), and Energy Efficiency and Renewable Energy (A1). The weights and rankings of these factors highlight their importance in achieving a sustainable environmental management framework.

From the analysis, Health and Environmental Policy (A3) emerged as the most crucial factor with the highest weight of 0.7673, followed by Circular Economy and Waste Management (A4), with a weight of 0.8246, and Energy Efficiency and Renewable Energy (A1) with a weight of 0.5706. These factors play a central role in driving sustainable practices in industrial operations, which aligns with current global efforts to mitigate environmental degradation and promote sustainable industrialization.

Circular Economy and Waste Management (A4) received the highest ranking due to its importance in reducing waste and encouraging the reuse of resources, which is critical for long-term environmental sustainability. As businesses and industries in Bangladesh face growing waste management challenges, this factor's high ranking suggests that investing in circular economy initiatives can significantly improve environmental outcomes.

On the other hand, Energy Efficiency and Renewable Energy (A1) ranked moderately high. While this factor is essential in reducing carbon footprints and promoting green energy, its relatively lower weight (0.5706) compared to circular economy practices might indicate that energy efficiency improvements need to be implemented alongside waste management efforts for maximum impact.The other factors, including Effluent Treatment (A2) and Pollution and Carbon Footprint (A5), also hold importance but have lower rankings. These factors are necessary for addressing pollution concerns and ensuring compliance with environmental regulations. However, their lower weights indicate that their integration into environmental management strategies should be balanced with the top-ranked factors to maximize overall effectiveness.

This study provides valuable insights for environmental management policymakers by identifying and prioritizing the key factors that contribute to sustainable industrial practices. By highlighting the importance of Health and Environmental Policies, Circular Economy and Waste Management, and Energy Efficiency, policymakers can focus their efforts on creating regulations and initiatives that support these critical areas. The findings suggest that addressing waste management and resource reuse should be a priority, along with promoting renewable energy and improving energy efficiency. By incorporating these priorities into national policies, policymakers can guide industries toward more sustainable practices, reduce environmental pollution, and contribute to the country's long-term environmental goals. The study's results can assist in shaping strategies, regulations, and incentives that not only foster environmental sustainability but also enhance the economic performance of industries by reducing waste and energy costs.

The findings underscore the importance of developing integrated environmental strategies that not only focus on reducing pollution but also promote sustainability through circular economy practices and effective policy-making. The results suggest that businesses and policymakers should prioritize initiatives that combine waste reduction, energy efficiency, and renewable energy solutions to achieve a greener, more sustainable future for Bangladesh.

6. Conclusion

This study underscores the critical importance of integrating environmental sustainability into industrial practices through the systematic evaluation of key factors such as energy efficiency, waste management, and health and environmental policies. The use of methods like SWARA and WASPAS allowed for the prioritization of these factors, offering a clear pathway for policymakers to address the most pressing environmental challenges. By focusing on areas such as circular economy practices and pollution reduction, industries can make significant strides towards reducing their ecological footprint while improving productivity. The results of this research provide valuable guidance for policymakers, helping them design and implement strategies that align industrial growth with environmental protection. Ultimately, the study highlights the potential for a balanced approach that not only meets economic objectives but also promotes long-term sustainability for both industries and the environment. While this study provides valuable insights into prioritizing environmental management practices, it is not without limitations. First, the analysis relies on a set of pre-defined criteria and subjective judgments in assigning weights, which may not fully capture the complexity of real-world scenarios. The methods used, such as SWARA and WASPAS, depend heavily on the quality and accuracy of input data, which may be influenced by biases or incomplete information.

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