

Research Article

# Transforming Plastic Waste into Livelihoods: Insights from 'Beyond the Loom' Project on Waste Management and Women's Empowerment

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## Abstract

Plastics, primarily composed of synthetic organic polymers, are integral to many products, with global production soaring from 15 million tons in 1964 to 400 million tons in 2022. Despite recycling potential, only 10% of plastic waste is recycled, while the majority ends up in landfills or pollutes the environment. In Bangladesh, rapid urbanization and inadequate waste management have exacerbated plastic pollution, particularly in cities like Dhaka, Chittagong, and Cox's Bazar. With annual per capita plastic consumption rising from 3.0 kg in 2005 to 9.0 kg in 2020, only 31% of the country's 977,000 tons of plastic waste is recycled. To address this, the "Beyond the Loom" project, funded by the Paul Polak Innovation Fund and implemented by iDE Bangladesh, aimed to tackle plastic pollution and the economic marginalization of women in Cox's Bazar. The project utilized traditional handloom weaving to upcycle low-value plastic waste into marketable products. This approach diverted over 200 kilograms of plastic waste from the environment and created new livelihood opportunities for 40 local women artisans, while addressing environmental issues. This initiative aligns with Bangladesh's broader strategy of sustainable waste management, emphasizing collaboration among stakeholders to promote environmentally sound practices. This paper highlights the key findings from the "Beyond the Loom" project, focusing on innovative plastic waste management, community engagement, and women's empowerment. It also examines the challenges faced, solutions implemented, and lessons learned that could be applied to similar initiatives in other regions.

## Keywords

Low-value Plastic Waste Upcycling, Women Economic Empowerment, Sustainable Development, Livelihood Through Articrafts, Clean Environment, Community Engagement in Rural Bangladesh

## 1. Introduction

Plastics, composed of synthetic organic polymers, are essential in numerous applications, from water bottles to clothing. Global production has skyrocketed from 15 million tons in 1964 to around 400 million tons in 2022, with forecasts predicting a doubling within the next 20 years and a quadru-

pling by 2050 [1, 2]. Despite the potential for recycling, poor management means only 10% of plastic waste is actually recycled, while the remaining 90% ends up in landfills, incinerated, or polluting the environment [3, 4]. According to OECD, 6.1 million tons of plastic flow into water bodies and

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1.7 million tons end up in the oceans every year.

Bangladesh ranks among the most plastic-polluted countries, primarily due to inadequate plastic waste management, such as limited collection and sorting facilities and insufficient incentives for recycling. Bangladesh's annual per capita plastic consumption in urban areas increased from 3.0 kg in 2005 to 9.0 kg in 2020, yet the country recycles only 31% of the approximately 977,000 tons of plastic waste it generates each year [5]. The challenges are further exacerbated by inadequate infrastructure, rapid urbanization, and population growth, which heighten environmental and public health risks, especially in densely populated areas such as Dhaka—the capital city, Chittagong—the commercial hub, Cox's Bazar—a coastal tourist destination that also faces significant climate change risks and a large influx of refugees and tourists, and Sylhet—a tourist hotspot renowned for its natural beauty. In response to these challenges, the "Beyond the Loom" project was launched as an innovative initiative aimed at transforming plastic waste into viable livelihood opportunities for local communities in Cox's Bazar. This initiative aligns with the broader national strategy of promoting environmentally sound waste management technologies through collaboration among key stakeholders to address plastic pollution in a way that is both socioeconomically and environmentally sustainable [6].

Funded by the Paul Polak Innovation Fund and implemented by iDE's Bangladesh Country Program, the project sought to address two pressing issues: the rampant plastic pollution in Ukhiya Upazila and the economic marginalization of women in this region. It did so by leveraging traditional handicraft techniques and handloom weaving to upcycle low-value plastic wrappers into a range of marketable products, including decorative accessories and daily utility items.

Increasingly, research and case studies in South Asia highlight the intersection of plastic waste management and women's empowerment. Women are significant contributors in informal recycling sectors but often remain vulnerable due to socio-economic barriers. A recent World Bank report advocates for gender-inclusive waste management strategies to maximize opportunities for these women [7]. Such approaches can yield dual benefits: reducing environmental pollution while enhancing women's livelihoods. Real-world examples in Bangladesh show that women-led recycling initiatives can flourish – one account documents a female entrepreneur who established a successful plastic recycling business that employs other women and processes nearly 2.5 tons of plastic waste per day [8]. These insights from the broader South Asian context reinforce the significance of the "Beyond the Loom" project's dual focus on waste reduction and women's economic empowerment.

This paper presents the key lessons learned from the "Be-

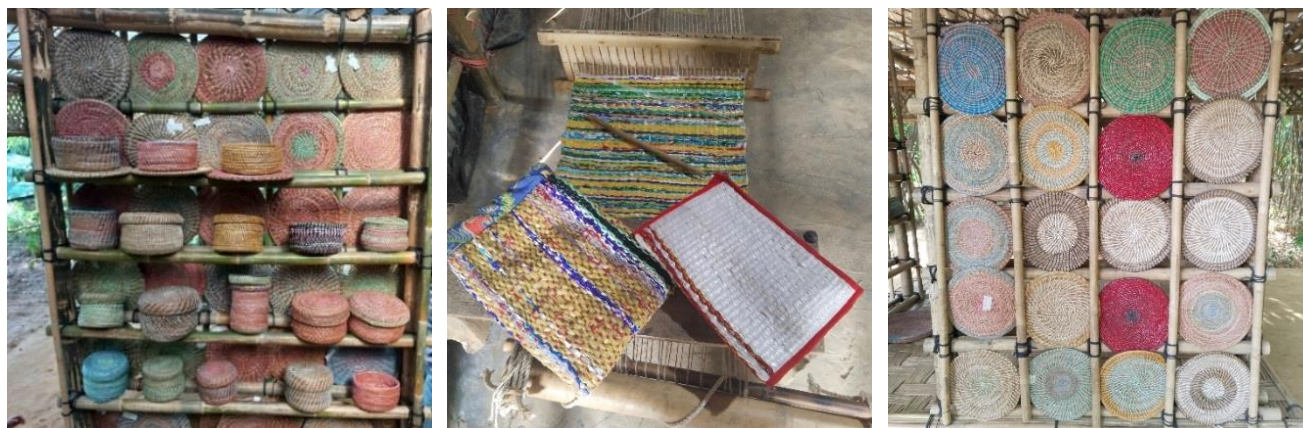
yond the Loom" project, focusing on its innovative approaches to low-value plastic waste management, community engagement, and women's economic empowerment. It also discusses the challenges encountered, the solutions devised, and the implications for similar initiatives in other regions facing comparable challenges.

## 2. Project Overview

The "Beyond the Loom" project was implemented as a 15-month pilot initiative which was designed to test a model to tackle the dual challenges of plastic waste management and economic empowerment in Cox's Bazar. Although at the very early stage, it was planned for a different region in the northeast part of the country, the project team conducted a scouting visit to assess the market there and found that the region lacked the necessary resources and community interest. Consequently, the decision was made to shift the project location to Ukhiya Upazila in Cox's Bazar, with approval from the fund management authority.

Upon relocating, the project team on boarded Foundation for Architecture and Community Equity (FACE) as a technical consultant for the collective implementation of the project and conducted rigorous assessments to evaluate the readiness and willingness of local communities to participate. This process led to the selection of four communities: Uttor Pukiriya, Hatirghona, Telipara, and KashiARBil Hindupara. However, due to insufficient enthusiasm and commitment from the Uttor Pukiriya and Telipara communities, the project eventually focused its efforts on Hatirghona and KashiARBil Hindupara.

The project's implementation phase involved mobilizing 40 women artisans from these communities, organizing them into savings groups, learning their inherent skills, and providing extensive training in upcycling techniques. Collaboration with local waste collectors and the formal waste collection service provider, Garbageman, facilitated the sourcing of raw plastic materials, which were then transformed into 'Plarn' (plastic yarn) by the artisans. Through workshops, skill development training, and local exhibitions, the project not only enhanced the artisans' skills but also created a range of handcrafted products with market potential. The range of products developed by the artisans included items such as woven mats, handbags, and home décor made from "Plarn". Figure 1 showcases several of these upcycled products, highlighting the creative reuse of plastic waste in their design. The weaving activities were primarily conducted in communal settings; Figure 2 depicts some of the women artisans working together in their community, illustrating the project's supportive and women-friendly work environment.



**Figure 1.** Different types of upcycled products made from low-value plastic waste including decorative mats, handbags, and, multipurpose boxes, by the women artisans.

As a pilot initiative, "Beyond the Loom" successfully demonstrated the viability of upcycling plastic waste into valuable products, while also empowering local women and contributing to environmental cleanliness. The experience and knowledge gained from this project provide a strong foundation for future efforts to replicate and scale similar initiatives in other regions.

*within the community.*

### 3. Methodology of Implementation

The "Beyond the Loom" project followed a structured, step-by-step approach to integrate plastic waste upcycling and women's economic empowerment in Cox's Bazar. The methodology emphasized community involvement, skill development, and sustainable practices. The implementation process is outlined below:

#### 1) Searching Communities:

The project began by identifying and selecting communities in Ukhiya Upazila, Cox's Bazar, based on their readiness and willingness to participate. Initial scouting was conducted to assess local interest and potential for plastic waste management.

#### 2) Community Mobilization:

Once target communities were identified, efforts were made to mobilize local women artisans. Meetings and workshops were held to introduce the project's goals and engage potential participants in the upcycling initiative.

#### 3) Savings Group Formation:

The women artisans were then organized into savings groups. These groups aimed to create a sense of ownership and collective responsibility while ensuring financial security for the participants.

#### 4) Co-develop Products with Low-value Plastic Waste:

Collaborating with the women artisans, the project team co-developed product designs that could be made from up-cycled plastic materials. The artisans were introduced to the concept of using discarded plastic wrappers to create marketable products.

#### 5) Making Samples of the Products:

The women artisans, with guidance from local designers and architects, produced samples of their products. These samples included a variety of fashion accessories and utility items made from 'Plarn' (plastic yarn).

#### 6) Backward and Forward Market Linkage:



**Figure 2.** Women artisans learning and working together in groups



The project established connections with both formal and informal waste pickers, along with community members, to ensure a steady supply of raw materials. Additionally, market linkages were created to introduce upcycled products to local retailers and potential customers.

*7) Skill Enhancement Training and Workshop:*

Comprehensive skill development workshops were conducted to enhance the artisans' technical abilities. These workshops also focused on improving product quality and market readiness.

*8) Exchange Visits and Horizontal Sharing:*

The project facilitated exchange visits for artisans to share their experiences and learn from other successful upcycling

initiatives. This fostered a sense of community and horizontal learning, strengthening the overall capacity of the groups.

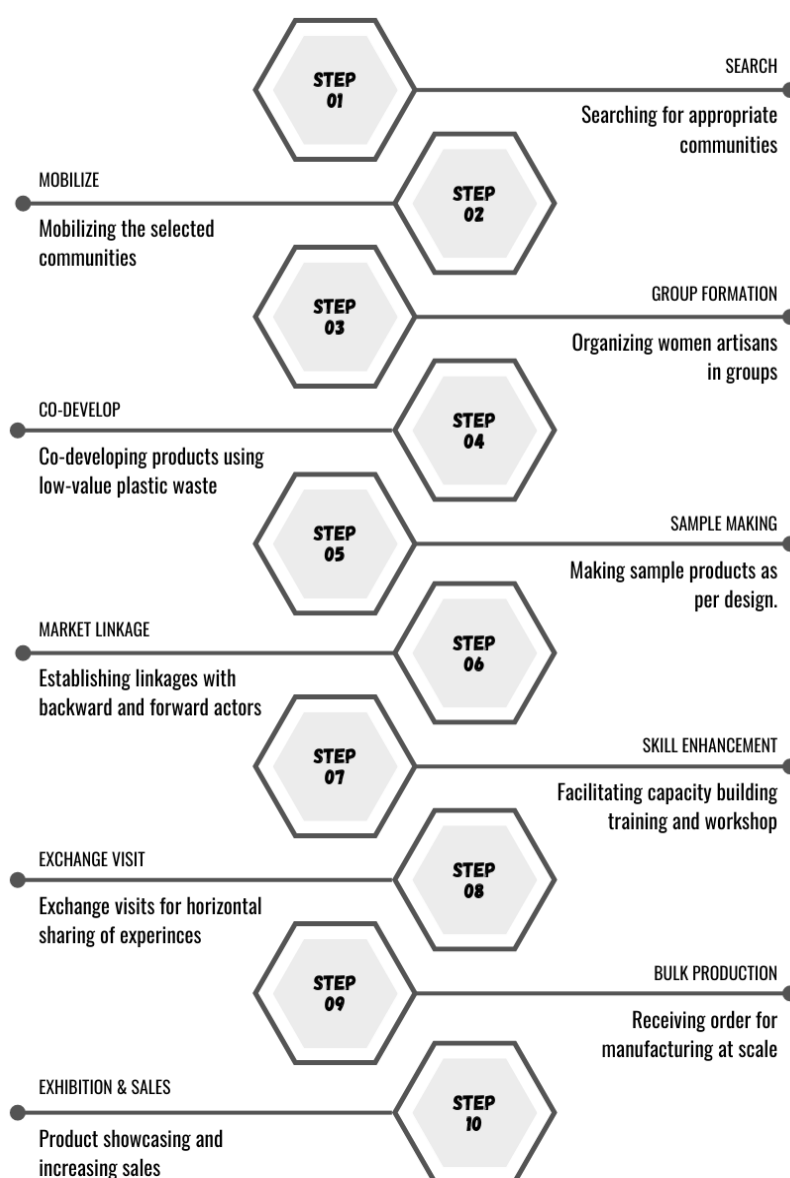
*9) Order for Bulk Production:*

As the project gained traction, orders for bulk production were secured, ensuring a sustainable source of income for the women artisans. This final stage aimed to scale the project and ensure long-term sustainability.

*10) Exhibition and Selling:*

The finished products were showcased in local exhibitions, creating opportunities for artisans to sell their products and build connections with buyers. The exhibitions were critical in raising awareness about upcycled products and expanding market access.

## IMPLEMENTATION METHODOLOGY



*Figure 3. Implementation Methodology.*

## 4. Key Findings and Innovations

The "Beyond the Loom" project stands out for its innovative approach to tackling the pressing issues of plastic waste management and economic marginalization in Cox's Bazar. Through the course of the project, several key findings and innovations emerged, providing valuable insights for future initiatives.

### 1) *Upcycling as a Viable Waste Management Strategy*

One of the most significant findings of the project was the viability of upcycling low-value plastic waste into marketable products. By converting discarded plastic wrappers into 'Plarn' (plastic yarn), the project not only reduced environmental pollution but also created a new source of raw material for the local handicraft industry. This approach proved particularly effective in a region like Ukhiya, where waste management infrastructure is limited, and plastic pollution is rampant. The potential for re-use and remanufacturing of plastic materials highlights how upcycling can help mitigate logistical challenges in traditional reuse practices by turning waste into valuable commodities [9]. The project demonstrated that with the right skills and tools, even materials considered waste can be transformed into valuable products, contributing to both environmental sustainability and economic resilience.

### 2) *Blending Materials for Enhanced Product Quality*

The project also discovered that blending recycled plastic with other materials, such as Areca palm leaves, significantly enhanced the quality and value of the final products. This combination not only improved the aesthetic appeal of the products but also made them more durable and marketable. However, this innovation required careful consideration of material properties and extensive experimentation, highlighting the need for ongoing research and development in the upcycling process. The findings suggest that such material blending can open up new possibilities for product innovation in the handicraft sector.

### 3) *Community Engagement and Empowerment*

A critical success factor of the project was its strong focus on community engagement. By involving local women artisans from the outset, the project ensured that the beneficiaries were not just passive recipients but active participants in the process. The formation of savings groups and the provision of skill development training empowered these women, giving them the tools and confidence to create and market their products. The project also demonstrated the importance of assessing community readiness and willingness to participate, as evidenced by the decision to discontinue collaboration with less enthusiastic groups. This focus on empowerment through skill-building and active participation proved essential for the project's success.

### 4) *Challenges in Scaling and Sustainability*

While the project achieved considerable success, it also encountered challenges that highlighted the complexities of

scaling and sustainability. One of the key challenges was the limited timeframe, which restricted the project's ability to fully explore the potential of using unconventional materials like recycled plastic and Areca palm leaves. Additionally, this short duration meant that long-term impacts on the artisans' income levels and livelihoods could not be fully realized or measured within the project period. Furthermore, the financial constraints associated with acquiring technology and expertise posed significant barriers to scaling the initiative. However, strategic alignment with other similar initiatives offers a model for resource optimization in future projects.

### 5) *Positive Environmental and Social Impact*

The environmental impact of the project was evident in the noticeable reduction of plastic waste in the targeted communities. During the project, roughly over 200 kilograms of low-value plastic waste were collected and upcycled into products, directly preventing this waste from polluting the environment. The use of waste materials in product creation not only cleaned up the local environment but also changed community attitudes towards waste, turning it into a resource rather than a nuisance. Socially, the project had a profound impact on the women involved. For many participants, this was their first opportunity to earn an income; by the project's end, each artisan was able to earn at least some money every month from the sale of upcycled products, providing a minimal yet significant contribution to their household. The women dedicated around 2–3 hours of work per day to the weaving activities (flexibly scheduled around their household responsibilities), and the project ensured safe and supportive working conditions by facilitating group production in communal spaces and providing the necessary tools and training. These women also developed valuable artisanal skills and a greater sense of pride in their work, demonstrating the empowering effect of the initiative. The project also set a precedent for how small-scale, community-driven initiatives can contribute to broader environmental and social goals.

## 5. Challenges and Solutions

While the "Beyond the Loom" project achieved notable success in upcycling plastic waste and empowering local women, it also faced several challenges that provided valuable lessons for future initiatives. These challenges, along with the solutions developed by the project team, offer important insights into the complexities of implementing innovative, community-based projects in resource-constrained environments.

### 1) *Material Complexity and Research Needs*

One of the most significant challenges encountered was the complexity of working with unconventional materials, particularly recycled plastic and Areca palm leaves. These materials, while abundant, posed difficulties in terms of processing and ensuring the durability and quality of the final products. The project team found that the variability in the quality and

availability of these materials required extensive research and development (R&D) to achieve consistent results. However, the project's fifteen-month timeline was insufficient to fully explore these complexities.

*Solution:* To address this challenge, the project team invested in collaborative R&D efforts with local artisans, designers, and technical experts. They experimented with different blending techniques and product designs, gradually improving the quality and marketability of the products. Moving forward, it is clear that longer project timelines and dedicated R&D funding are essential for overcoming the challenges associated with working with unconventional materials.

### 2) *Financial Constraints and Resource Optimization*

Waste management is also affected by the aspects or enabling factors that facilitate the performance of the system. They are classified as technical, environmental, financial, socio-cultural, institutional, and legal by Guerrero, Maas, and Hogland [10]. The financial demands of the project, particularly in acquiring technology and technical expertise, posed another significant challenge. The costs associated with setting up efficient upcycling processes and ensuring product quality were higher than initially anticipated. This financial pressure was compounded by the limited budget available for a pilot initiative.

*Solution:* To mitigate these financial constraints, the project team strategically aligned with another concurrent initiative managed by the technical consultant, FACE. This alignment allowed the sharing of human resources, and their expertise thereby reducing costs and increasing efficiency. The experience underscored the importance of strategic partnerships and resource optimization in managing budgetary challenges in similar projects.

### 3) *Community Engagement and Sustained Participation*

Engaging and sustaining the participation of local communities, particularly women artisans, proved to be both a critical success factor and a challenge. While the project successfully mobilized 40 women artisans, sustaining their motivation and participation required continuous support and encouragement. Integrating informal waste collection systems into the project's planning is crucial, as it builds on existing practices and improves the efficiency and working conditions of the women involved [11].

*Solution:* The project team addressed this challenge by focusing their efforts on the most enthusiastic and committed communities, Hatirghona and Kashiarbil Hindupara. They provided continuous training, mentorship, and opportunities for artisans to showcase their work, which helped maintain motivation and sustained participation. The project's experience highlights the need for flexible project design that allows for the reallocation of resources to more engaged communities, ensuring that efforts are concentrated where they can have the most significant impact.

### 4) *Market Access and Product Diversification*

Another challenge was ensuring that the products created

by the women artisans found a market. Given the variability in the quality of recycled materials, achieving consistency in product design and quality was challenging, which in turn affected marketability. Additionally, the project had to navigate the complexities of connecting rural artisans with broader markets, both locally and potentially internationally.

*Solution:* To enhance market access, the project facilitated local exhibitions and engaged with local retailers and potential buyers to showcase the products. The project also explored online platforms as a means to reach a wider audience. Moreover, the blending of recycled plastic with natural materials like Areca palm leaves not only improved product quality but also helped in diversifying the product line, making it more appealing to different market segments. The project demonstrated that a combination of local and digital marketing strategies is essential for connecting artisans with viable markets.

### 5) *Environmental and Social Sustainability*

Ensuring the long-term sustainability of both the environmental and social impacts of the project was an ongoing challenge. While the project made significant strides in reducing plastic waste and empowering women, there was a need for ongoing support to ensure that these impacts were sustained beyond the project's initial phase.

*Solution:* The project team emphasized the importance of building local capacity and fostering a sense of ownership among the women artisans. By involving them in every step of the process—from material collection to product design and marketing—the project helped to instill a sense of responsibility and pride in their work. Additionally, the creation of savings groups provided a financial safety net for the artisans, supporting both their economic resilience and the sustainability of the project's impacts.

## 6. Lessons Learned

The "Beyond the Loom" project has provided invaluable lessons that can inform future initiatives aiming to address similar challenges in waste management and community empowerment. These lessons underscore the importance of flexibility, community engagement, and strategic planning in ensuring the success and sustainability of innovative projects.

### 1) *Importance of Flexibility and Adaptation*

One of the key lessons from the project was the necessity of being flexible and adaptable in response to on-the-ground realities. The decision to shift the project location from Sylhet to Cox's Bazar, and later to focus efforts on the most engaged communities, demonstrated the importance of adapting to local conditions and community readiness. This flexibility allowed the project to maintain momentum and achieve its objectives despite initial setbacks.

### 2) *Value of Community-Centric Approaches*

Engaging the community, particularly the women artisans, from the outset was crucial to the project's success. By involving them in every aspect of the project—from material

collection to product design—the project ensured that the beneficiaries were not just recipients but active participants. This approach not only empowered the women but also fostered a sense of ownership and pride in their work, which is vital for the long-term sustainability of the project.

### 3) *Necessity of Long-Term Investment*

The project highlighted the need for long-term investment in research and development, particularly when working with unconventional materials. The complexities of processing materials like recycled plastic and Areca palm leaves require careful consideration and ongoing experimentation to ensure product quality and market viability. Future projects should allocate sufficient time and resources to R&D to fully explore the potential of such materials.

### 4) *Strategic Partnerships for Success*

The project's alignment with another initiative by the technical consultant, FACE, demonstrated the value of strategic partnerships in resource optimization. Collaborating with organizations that bring complementary expertise can significantly enhance a project's capacity to innovate and scale. Future initiatives should prioritize forming partnerships with research institutions, universities, or industry experts to leverage their knowledge and resources.

### 5) *Continuous Improvement and Learning*

The success of "Beyond the Loom" also underscored the importance of fostering a culture of continuous improvement within the project team. By encouraging feedback, innovation, and adaptation based on ongoing experiences, the project was able to refine its approaches and improve outcomes. This emphasis on continuous learning is crucial for adapting to evolving challenges and ensuring the project's long-term impact.

### 6) *Importance of Adequate Project Duration*

A final lesson from the pilot is the need for a longer implementation period to ensure lasting impact. Fifteen months was a relatively short timeframe that limited the ability to consolidate the project's benefits or observe long-term changes in participants' livelihoods and community behavior. Future initiatives should consider longer project durations or follow-up phases, allowing successful interventions to mature and their effects to become more sustainable over time.

## 7. Implications for Future Projects

The experience gained from the "Beyond the Loom" project offers several important implications for future initiatives aimed at addressing environmental and social challenges in similar contexts. By building on the lessons learned, future projects can enhance their effectiveness, scalability, and sustainability.

### 1) *Extended Research and Product Development*

Future projects should allocate additional time and resources to research and development, particularly when dealing with unconventional materials. Understanding the intricacies of these materials is essential for refining the

production process and ensuring that the final products meet market demands. Conducting thorough market research to identify consumer preferences for eco-friendly products can help tailor product development efforts, making the products more commercially viable and ensuring long-term success.

### 2) *Strengthening Collaboration and Partnerships*

Forming strategic partnerships with research institutions, universities, or industry experts is critical for future success. These partnerships can expedite the learning process, provide valuable insights into optimizing production techniques, and offer access to cutting-edge technology and expertise. Collaboration with such partners can significantly enhance a project's ability to innovate and overcome technical challenges.

### 3) *Investment in Technology and Infrastructure*

Investing in advanced technology and equipment is necessary to streamline the manufacturing process and maximize material utilization efficiency. Automation and innovative machinery can help reduce production costs, improve productivity, and scale up operations. Future projects should consider integrating technology investments into their planning from the outset to ensure efficiency and scalability.

### 4) *Comprehensive Financial Planning and Management*

A well-structured financial plan that accounts for initial investments, ongoing operational costs, and potential revenue streams is essential for project sustainability. Exploring diverse funding opportunities, including grants, partnerships with investors, and other financing options, can provide the necessary capital to support long-term operations. Effective financial management will also help future projects navigate the challenges of scaling up.

### 5) *Fostering a Culture of Continuous Improvement*

Implementing a culture of continuous improvement within the project team is crucial for adapting to new challenges and improving outcomes. Encouraging team members to provide feedback, experiment with new ideas, and adapt strategies based on lessons learned will enhance the project's capacity to innovate and succeed over time. This approach will also help ensure that future projects remain dynamic and responsive to changing conditions.

## 8. Conclusion

The "Beyond the Loom" project has demonstrated the transformative potential of innovative approaches to waste management and community empowerment in resource-constrained settings like Cox's Bazar. By upcycling low-value plastic waste into marketable products, the project not only addressed the pressing issue of plastic pollution but also created new economic opportunities for local women artisans. Furthermore, to ensure the sustainability of the initiative, the project formed groups of women artisans, who are in the process of formalizing their roles through cooperative registration, an approach that aligns with successful waste management models in other developing countries observed



by Medina [12]. The project's success underscores the importance of flexibility, community engagement, strategic partnerships, and long-term investment in research and development.

As the project moved to its closure, the lessons learned provided a strong foundation for future scale-up efforts. By extending research and product development, strengthening collaboration with industry experts, investing in advanced technology, and fostering a culture of continuous improvement, future initiatives can build on the successes of "Beyond the Loom" to achieve even greater impact.

The implications of this project reach far beyond the boundaries of Ukhiya, offering a model for other regions facing similar environmental and economic challenges. By replicating and adapting the strategies employed in "Beyond the Loom," it is possible to empower more communities, reduce environmental pollution, and contribute to sustainable development on a larger scale. On an institutional level, forging partnerships with local government agencies can help integrate initiatives like "Beyond the Loom" into formal waste management programs. Such collaboration would embed the project's approach into policy, ensuring that similar initiatives are supported, resourced, and replicated as part of long-term development strategies. Ultimately, the project serves as a testament to the power of creativity, innovation, and collaboration in driving positive social and environmental change.

## Abbreviations

iDE	International Development Enterprises (International Non-profit Organization)
OECD	Organization for Economic Co-operation and Development
R&D	Research and Development
FACE	Foundation for Architecture and Community Equity
Plarn	Plastic Yarn (Yarn Made from Recycled Plastic)
Upazila	Sub-district (Administrative Unit in Bangladesh)

## Author Contribution

**Md. Abdullah Al Ahad:** Conceptualization, Formal Analysis, Funding acquisition, Project administration, Supervision, Writing – original draft, Writing – review & editing

**Mahamud Kali:** Data curation, Formal Analysis, Project administration, Validation, Writing – review & editing

## Conflicts of Interest

The authors declare no conflicts of interest.

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