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Sustainability practices and their impact on profitability in textile MSMEs in Panipat District of Haryana

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Abstract
The major factor driving competitiveness and resilience in the manufacturing sector across the globe is to ensure sustainability. The SMEs, although constitute a major economic pillar of most of the countries, are not free from considerable pressure to undertake environmental responsibilities along with meeting their economic performance. The present work explores textile MSMEs in the handloom city Panipat, Haryana, yearning to understand the role of investments in green technology, awareness levels about circular economy, and usage of renewable energy to enhance profit margins and reduce production costs. The results of this study indicate that the investors resorting to green tech have managed to achieve high profit margins, reaching almost double those having no or low investments in green technology. Higher circular economy consciousness levels have been observed among recycling units, when comparing the studied industrial set ups. As expected, enterprises who adopted renewable energy could significantly decrease production costs. The insights obtained from our work clearly indicate that adopting sustainable practices brings out significant economic advantages in the industrial clusters. The study is concluded by providing some recommendations to the major stakeholders, i.e. industry associations as well as policymakers. We have given suitable evidence to indicate that integrating green technology, considering capacity building and providing more supportive finance mechanisms may provide boost to MSME ecosystem.

Keywords: Textile MSMEs, green technology investment, circular economy awareness, renewable energy usage

1. Introduction
The multifaceted and vibrant economic fabric of our country is significantly influenced by the contributions from MSME sector. It is beyond doubt that this sector contributes enormously by generating local employment opportunities, catalyzing industrial output, and boosting exports. In a city like Panipat, which is known to be a textile hub, the role of MSMEs becomes more crucial in supporting both traditional craft and modern manufacturing practices. However, it is to be highlighted that addressing environmental safety concerns, escalating resource costs, skill shortage and policy transitions have exposed these enterprises to sustainability pressures. The global economy is entering new domains like adopting circular models and low-carbon operations. Therefore, MSMEs must adapt to these changing scenarios, a transformation which is crucial not only for ecological considerations, but also for long-term profitability and resilience. This study particularly examines how sustainability practices viz. green technology investment mark their influence on business performance within the local textile MSME ecosystem. It also touches upon the degree of awareness about circular economic principles and the cost benefits of renewable energy adoption, based on field data acquired from 120 MSME entrepreneurs.

2. Literature Review
Rosa *et al.* (2019) [6] systematically reviewed the circular business models and categorized key archetypes guiding resource efficiency and operational redesign. They highlighted the importance of closed-loop systems, and extension of product life in the context of SME. In a similar work, Choi *et al.* (2019) [7] proposed a structured methodology for optimizing the resource efficiency in SMEs. They stressed upon waste reduction and optimal use of energy sources.

The framework suggested in this work provides a connection between business performance metrics and improvements in sustainability. Resurgence of Indian MSMEs has been discussed by Salati (2022) [13], taking view of sustainability and policy reforms. It is indicated that the sector is vulnerable, especially when confronted with climate pressures and regulatory changes. However, local innovation has been identified as a revivor of sustainability. Khababa & Jalingo (2023) [10] presented their analysis on role of green finance and investment in affecting the sustainability outcomes in SMEs. They also drew attention to the role of corporate governance and CSR in performance enhancement by acting as mediating factors. Akhtar (2024) [2], using a different perspective, studied the role of MSMEs in supporting Sustainable Development Goals in India. The role of inclusive growth and environmental stewardship has been discussed in detail. One interesting aspect covered here is to highlight the gap in awareness about sustainability practices among rural and semi-urban clusters. Practical challenges and strategic opportunities for MSMEs in pursuing green growth have been brought to light in a publication by Bhuyan (2024) [5]. Here, pivotal significance of capacity building initiatives to overcome financial constraints and knowledge barriers is emphasized. Joshi *et al*. (2024) [9] assessed the role of ICT investments towards enhancing profitability in Indian manufacturing MSMEs. They have advocated the adoption of green technologies and digital tools for sustainability compliance.

Arroyabe *et al*. (2024) [3] studied the overlapping boundaries of digital transformation and circular economy. They suggested that the SMEs which integrate both the dimensions turn out to be more productive. A multi-perspective review on SME has been presented by Ahmadov *et al*. (2023) [1]. They evaluated how much these SMEs are ready for circular economy. The core suggestion to successfully implement the circular economy is to adopt collaborative ecosystems and spread awareness. Shailendra (2024) [8] presented how the MSMEs can anchor India's SDG performance, despite remaining insufficiently supported in transitioning toward cleaner technologies and sustainable production norms. Rajayya *et al*. (2025) [11] critically evaluated the entire trajectory of circular economy of India. They pointed out existing gaps in regional implementation, along with emphasizing the role of MSMEs in localizing SDG frameworks. Reim *et al*. (2025) [12], presented their findings about the strategies of SMEs for adopting circular business models. They also asserted that regional collaboration and shared innovation platforms may favour sustainability. Babber & Mittal (2025) [4] discussed the advantages of integration methods of innovative systems while highlighting the significance of lean and agile systems. They opined that the Indian MSMEs can achieve sustainability, through the strategic transformation, in lines with national industrial policy. Singh & Devi (2025) [14] also reinforced the importance of MSMEs in economic and sustainable development, while they advocated for government support that can bridge awareness and investment gaps.

The reviewed literature consistently affirms that the sustainability practices including assessing resource efficiency and integration of circular economy offer visible business benefits to MSMEs. Yet, the studies reveal persistent gaps in awareness, technological investment, and region-specific data to accumulate sufficient data for chalking out actionable strategies. The Panipat textile cluster presents a proper and ideal ground for such an inquiry as proposed in this paper, given its industrial density, network and environmental footprint. This research meets its expectations by addressing a clear void by empirically linking green technology investment to profitability outcomes. Additionally, it also analyzes awareness and energy usage through rigorous statistical testing. It promises policy-relevant insights for scaling sustainability in MSMEs in general, aligning economic growth with ecological responsibility, and clearer insights specifically for local MSME ecosystem.

3. Objectives of the study

1. To evaluate the impact of green technology investment on the profit margins of textile MSMEs in Panipat.
2. To compare levels of circular economy awareness among different MSME business types.
3. To investigate the relationship between renewable energy usage and production cost trends among MSMEs.

4. Research Methodology

The present study can be understood as a cross-sectional descriptive research design, with the primary aim to examine the impact of sustainability practices on business performance among textile MSMEs in Panipat, Haryana. This industrial region, owing to its ideal location on NH-44 and proximity with Delhi, the national capital of India, is a city with established industrial units. The major domains of industrial setups consist of dyeing, weaving, recycling, and composite textile units. This makes the place very suitable and ideal for capturing diverse operational patterns at a single locality. For this study, 120 MSME entrepreneurs of Panipat district in Haryana, India were selected, based on business type, educational background, and years of operation. Primary data collection was done through a structured questionnaire covering demographic variables, green technology investment levels, awareness of circular economy principles, renewable energy usage, and economic indicators such as profit margin and production cost trends. While gathering the responses, ethically considerations were followed, ensuring anonymity and voluntary participation. Upon data collection, statistical analysis was conducted using PSPP software, enabling quantitative comparison of sustainability variables and their association with business outcomes. The methodology ensures both analytical rigor and practical relevance for guiding policy and cluster-level interventions.

5. Results and Discussion

Demographic Profile of MSME Textile Entrepreneurs

The demographic profile (Table 1) of MSME textile entrepreneurs in Panipat reveals a balanced yet insightful landscape for sustainability engagement. A significant majority (58.3%) fall within the 31-45 age group, indicating a dominant presence of mid-career individuals who blend experience with adaptability. The sector is notably male-dominated (81.7%), underscoring the need for greater gender inclusivity. Educationally, half the sample comprises graduates, with an additional 25% holding postgraduate degrees—suggesting a promising capacity for adopting innovative practices and engaging with policy frameworks. Business operations are evenly distributed across dyeing,

recycling, weaving, and mixed sectors, providing a robust base for comparative analysis. Notably, over 42% of units have operated for more than a decade, signifying stability and maturity, while the 22.5% of newer ventures reflect an emerging entrepreneurial energy ideal for targeted sustainability programs and capacity-building initiatives.

Table 1: Demographic Profile

Variable	Category	Frequency	Percentage
Age Group	≤30	20	16.7%
	31-45	70	58.3%
	>45	30	25.0%
Gender	Male	98	81.7%
	Female	22	18.3%
Education	Secondary	30	25.0%
	Graduate	60	50.0%
	Postgraduate	30	25.0%
Business Type	Dyeing	30	25.0%
	Recycling	30	25.0%
	Weaving	30	25.0%
	Mixed	30	25.0%
Years of Operation	<5	27	22.5%
	5-10	42	35.0%
	>10	51	42.5%

Green Tech Investment vs. Profit Margin

The analysis (Table 2) reveals a clear and statistically significant relationship between the level of green technology investment and profit margins among textile MSMEs in Panipat. Based on PSPP-generated tables, entrepreneurs with high investment in green tech achieved an average profit margin of 25.31%, nearly double that of those with low investment, who averaged 12.48%. This difference was validated through an independent samples t-test (The minimal variance and consistent upward trend in profitability for high-investing units suggest that sustainability is not merely a compliance choice it's increasingly becoming a strategic economic advantage in MSME ecosystems.

Table 3), yielding a t-value of 20.83 and a p-value < .001, confirming the strength of the correlation.

Table 2: Group Statistics

Green Tech Investment	N	Mean	Std. Deviation	Std. Error Mean
Low	27	12.48	1.92	0.37
High	48	25.31	2.76	0.4

The minimal variance and consistent upward trend in profitability for high-investing units suggest that sustainability is not merely a compliance choice it's increasingly becoming a strategic economic advantage in MSME ecosystems.

Table 3: Independent Samples t-test

Levene's test for equality of variances	F	Sig.	T	DF	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower 95% CI	Upper 95% CI
Equal variances assumed	1.02	.315	20.83	73	< .001	12.83	0.62	11.59	14.07

The observed trend also emphasizes the importance of easy availability of financial support and avenues for technical training to enable widespread adoption of green technologies. This is particularly crucial for smaller units operating with limited resources.

Circular economy awareness by business type

The analysis of circular economy awareness across different business types among Panipat textile MSMEs reveals substantial variation (Table 4), as validated by an ANOVA test (Table 5). Entrepreneurs, which are engaged in recycling-based operations demonstrated the highest mean awareness score of 4.2, which indicates that they are highly familiar with sustainable practices, mainly material recycling and closed-loop systems.

Table 4: Descriptive Statistics

Business Type	N	Mean	Std. Deviation	Std. Error
Dyeing	30	2.9	0.8	0.15
Recycling	30	4.2	0.5	0.09
Weaving	30	3.3	0.6	0.11
Mixed	30	3.6	0.7	0.13

Table 5: ANOVA

Source	Sum of Squares	DF	Mean Square	F	Sig.
Between Groups	46.7	3	15.56	21.36	< .001
Within Groups	86.2	116	0.743		
Total	132.9	119			

On the contrary, MSMEs in the form of dyeing units registered the lowest average score of 2.9. This is suggestive of their limited awareness or compliance levels, and they are not well engaged with circular frameworks necessary for sustainability. ANOVA results (Table 5) showed a significant effect of business type on awareness levels, with an F-value of 21.36 and a p-value < .001, confirming that these differences are not due to random variation. These results highlight the need to develop strategies for targeted outreach programs, particularly for dyeing and weaving MSMEs, which have shown low awareness levels. Collaborative approach is required, to bridge knowledge gaps and promote cross-sector learning from recycling units that lead in sustainability adoption. Need-based and such tailored interventions are needed to be developed, and they can accelerate Panipat evolution into a circular economy-driven textile cluster.

Renewable energy usage vs. production cost trend

The cross-tabulated analysis (Table 6) of renewable energy usage and production cost trends in Panipat textile MSMEs revealed a noteworthy association between sustainability-oriented operations and cost efficiency. As anticipated, among the units adopting renewable energy, 31 out of 92 reported decreasing production costs, while only 8 out of 28 non-adopters experienced the same.

Table 6: Cross tabulation

Production cost trend	Renewable Energy: Yes	Renewable Energy: No	Total
Decreasing	31	8	39
Stable	52	15	67
Increasing	9	5	14

Table 7: Chi-Square Test

Statistic	Value	DF	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.88	2	.019
Likelihood Ratio	8.02	2	.018
Linear-by-Linear	6.54	1	.011
No of Valid Cases	120		

Chi-square test results (Table 7) corroborate the strength of this relationship, yielding a Pearson Chi-Square value of 7.88 with a p-value of .019, indicating statistical significance at the 95% confidence level. These findings suggest that renewable energy integration is not only an environmental imperative but also a viable strategy for cost containment. MSMEs investing in solar dyeing, biomass boilers, or energy-efficient looms may be reaping long-term operational savings. This evidence supports policy action to expand access to green financing and technical support, enabling wider adoption and easing the financial burden for small units. In sum, Panipat data offers a compelling case for aligning energy transitions with MSME competitiveness.

Conclusion

This study clearly demonstrates that the economic performance of textile MSME sector of Panipat can be significantly improved through adopting sustainability practices. It became evident from our study that the enterprises resorting to higher levels of green technology investment consistently achieved superior profit margins compared to their lower-investing counterparts. This underscores the business value of eco-innovations, which may be easily overlooked to be insignificant. An inconsistency in awareness about circular economy has been observed during this study, and it is seen that circular economy awareness is quite uneven across business types. Whereas the recycling units have shown high levels of familiarity, the dyeing and weaving units lagged. This brings out the need to develop efficient strategies and highlights the opportunities for targeted knowledge-building initiatives. It is also worthwhile noting that the firms that integrated renewable energy sources in their set-ups reported significant declines in production costs. This suggests that such energy transitions provide dual benefits, economic as well as ecological, i.e. they not only benefit the environment but also enhance operational efficiency.

It is imperative to note that the findings of this study carry clear implications for policymakers, industry associations, and financial institutions. If tailored training programs and advisory services can be prioritized for under-exposed segments, they can provide multiple advantages to these sectors. In addition, green financing schemes must be designed to lower entry barriers and economic security for smaller units. Industrial clusters like Panipat can accelerate their sustainability journeys by fostering collaborative platforms where MSMEs are open to sharing their best practices and jointly access clean-technology infrastructure for mutual benefits.

The limitation of this study lies in its being region-specific, a barrier for the work to be generalized. However, a cross-sectional design with the rigorous statistical analysis provides a solid baseline for further inquiry. Future research could adopt a longitudinal approach, expanding the canvas to other textile hubs or even industry types. This can ensure a guideline to explore the interplay between sustainability practices and supply-chain integration. It can be concluded that the textile MSMEs can gain competitive advantage and long-term resilience by using a balanced approach of alignment with environmental stewardship along with strengthening business strategies as per need.

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