

Education Level and Adoption of Circular Economy in Panipat's MSMEs

¹Sunit Sharma, ¹Ajaypal Singh* and ²Nidhan Singh

¹Department of Commerce, I.B. (PG) College, Panipat, Haryana, India – 132103

²Department of Botany, I.B. (PG) College, Panipat, Haryana, India – 132103

*Corresponding Author:

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Abstract: A strategic model for sustainable growth must revolve around the procedures that constitute circular economy. This economy emphasizes optimizing resource efficiency, reducing the total waste and closed-loop production methodologies. The economic development in India is highly dependent on growth and output of micro-, small- as well as medium Enterprises (MSMEs), yet the circular economy practices are largely not adopted. This paper explores Panipat's textile MSMEs regarding investigating the awareness levels and adoption of circular economic practices, relating this with their educational levels. It was seen that the entrepreneurs with higher educational levels tend to have higher awareness levels, as well as willingness to implement such practices. The prediction models adopted for this study showed that the likelihood of resorting to circular economy practices depends not only on education levels but also on firm characteristics. Our study explicitly explains that education is a vital enabler for driving sustainable transitions in MSMEs. Concluding the study, we have recommended that targeted training programs, friendly policy frameworks and collaborative channels can play significant roles in enhancing the acceptability of circular economy practices in small-scale enterprises.

Keywords: Circular economic practices; Educational attainment; MSMEs

I. Introduction

In light of growing environmental concerns and the mounting scarcity of resources, industries in India can look towards adopting the Circular Economy (CE) model as a sustainable solution. This economic model encompasses regenerative, closed-loop systems instead of prevalent conventional linear practices. Panipat's textile hub secures a significant place in India's textile sector, and comprises of micro, small as well as medium enterprises (MSMEs). However, the shift towards a circular economy in this sector has not been consistent across the board. Despite having clear benefits like reduced waste, cost-efficiency and competitive edge, the adoption of circular practices is fragmental only. The basic variable which influences this adoption is education, be it formal qualification, or expertise acquired through practising. These levels highly affect sustainable behaviour, green technology investments as well as strategic thinking. This study enumerates the role of educational level of entrepreneurs in defining CE awareness as well as adoption within Panipat's MSMEs, and the efforts may provide valuable insights to a topic which is often overlooked by academicians and is usually the purview of policy analysts. To reinforce our analysis, the following literature delves into the principles of Circular Economy (CE), the operational dynamics of MSMEs.

II. Literature Review

Pelau and Chinie (2018) worked on econometric model, wherein they provided a direct, statistically significant correlation between education levels and recycling rates of the country. They broadly visualised the impact of education levels on CE behaviour, inspiring the readers to further examine micro-level correlations within different enterprises. Kirchherr and Piscicelli (2019) made theoretical progression to frame five principles for CE education, which included systems thinking, experiential learning, and interdisciplinary integration. They used a case-based approach to conclude that structured teaching methods could help in embedding circular values within entrepreneurship. Circular economy aspects related to sustainability orientation of higher education institutions were also uncovered by Bugallo-Rodríguez and Vega-Marcote (2020). They provided knowhow about the correlation between teacher training, curricular reforms, and the long-term cultural shifts conducive to CE integration in professional settings. Kaushal and Prashar (2021) focused on crop residue burning in northwest India, while highlighting the role of education in promoting eco-responsible behaviour among rural producers. Their findings underlined CE values in a different sector, underscoring cross-sector relevance of ecological awareness. Katigbak and Villaruel (2023) worked on women-led MSMEs in Metro Manila, revealing that mentoring and educational interventions positively influenced CE adoption. Tiippana-Usvasalo et al. (2023) corroborated this by showing that higher education curricula improved implementation rates of CE practices across technical disciplines. In a very relevant study, Aggarwal, and Rathee (2023) examined stress among Panipat's textile entrepreneurs during the pandemic, indirectly demonstrating that better-educated owners adapted more resilient business models by integrating sustainable strategies. Williams and Bulliard (2023) also mapped fashion-sector MSMEs, identifying gaps in academia-industry linkages that hinder CE literacy and application. Warnants (2024) explored students' attitudes toward CE in international education contexts, highlighting how exposure to bioeconomy and sustainability topics fosters proactive behaviour. Dey et al. (2024) explored CE adoption in Assam's MSMEs, attributing success to educational outreach, regional collaboration, and capacity-building programs aligned with community needs. Pradhan (2024) conducted a cross-national comparison of textile supply chains in

Germany and India, attributing higher CE alignment in German firms to workforce education and digital readiness, thereby reinforcing the role of learning in international competitiveness. Parmar and Murari (2025) linked rural manufacturing success in Haryana to socially embedded education models, advocating for region-specific interventions. Das and Swain (2025) highlighted persistent challenges in the handloom sector, suggesting that technical education and awareness campaigns were necessary for mainstreaming CE. Mishra, Sahoo, and Mohapatra (2025) delivered a comprehensive analysis of CE adoption barriers and enablers in Indian MSMEs. They found that leadership commitment, green financing, and especially managerial awareness—rooted in education—were pivotal in shaping adoption behaviour.

III. Objectives of The Study

- Assess the effect of education level on circular-economy awareness.
- Analyze education's impact on circular-economy adoption.
- Examine interaction of business type and experience with education in adoption.

IV. Research Methodology

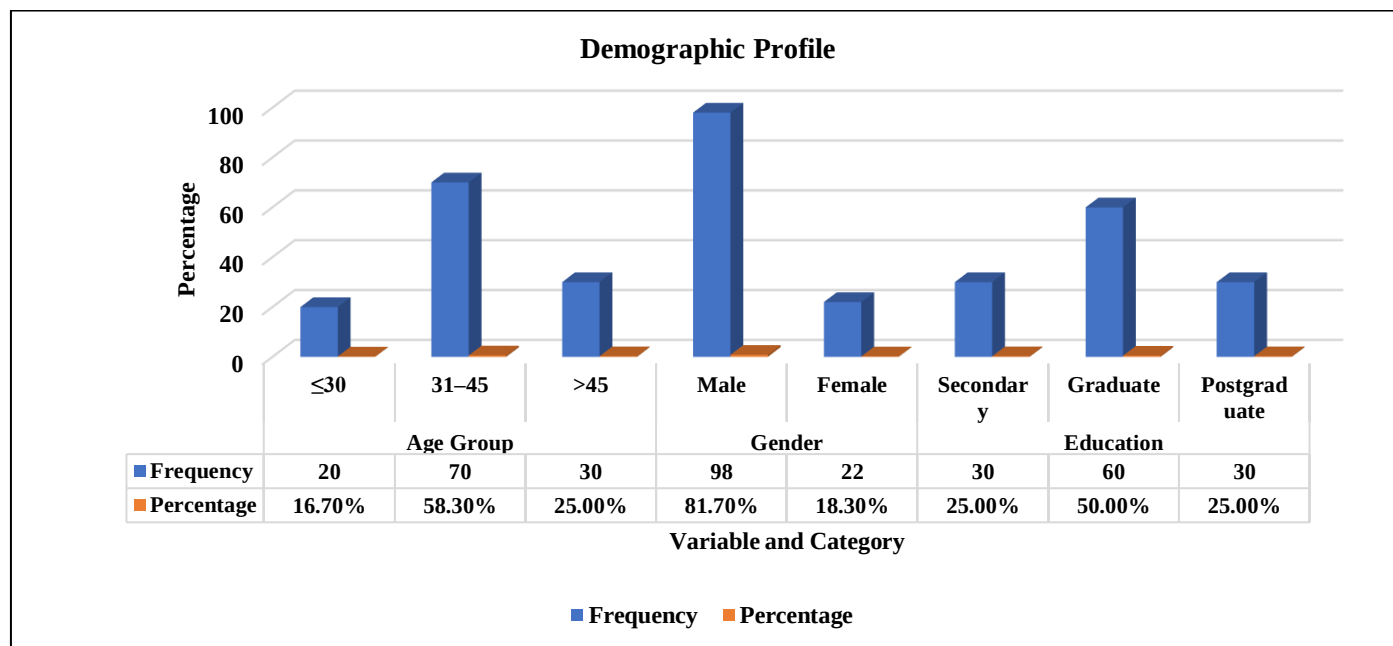
The study followed a cross-sectional survey design targeting owner of textile MSMEs in Panipat district of Haryana, India. A purposive sample of 120 enterprises—covering dyeing, recycling, weaving, and mixed operations—was drawn from the Panipat District Industry Centre registry. The data were collected between through face-to-face interviews using a structured questionnaire.

All analyses were conducted in PSPP. Instrument reliability was assessed via Cronbach's alpha. Descriptive statistics summarized sample characteristics. Pearson's correlation examined interrelationships among continuous variables. Normality and variance homogeneity were tested using Shapiro–Wilk and Levene's tests, respectively. Group differences in awareness were evaluated with one-way ANOVA and post-hoc comparisons. The association between education and adoption status was tested using chi-square analysis with effect-size estimation.

V. Results

Demographic Profile

The demographic profile of Panipat's textile MSME respondents reveals a predominantly male leadership (81.7%), with entrepreneurs mostly in the age range of 31–45 years (58.3%), indicating a concentration of mid-career decision-makers. Educational attainment shows a robust presence of graduate-level entrepreneurs (50%), flanked by equal proportions of secondary and postgraduate holders (25% each), suggesting a strong foundation of formal education within the sector. Business types are evenly split across dyeing, recycling, weaving, and mixed operations—each comprising 25%—which allows for balanced comparisons in circular economy adoption.



In terms of enterprise maturity, 42.5% of respondents operate businesses older than 10 years, highlighting experience as a complementary factor to education in sustainable decision-making. This demographic mix points to a skilled and stable entrepreneurial base, well-positioned to integrate circular practices—especially when supported by targeted training and sector-specific interventions.

Reliability Analysis

Table 1 Reliability of Circular Economy Awareness Scale

Metric	Value
Cronbach's α (4 items)	0.82

The Circular Economy Awareness scale demonstrates strong internal consistency ($\alpha = 0.82$), confirming its reliability for measuring awareness across the MSME sample. This supports its use in subsequent inferential analyses.

Correlation Analysis

Table 2 Correlation Matrix of Key Variables

Variables	Education	Awareness	Green Tech	Renewable	Profit (%)
Education	—	.48**	.42**	.35**	.40**
Awareness	.48**	—	.50**	.45**	.52**
Green Tech	.42**	.50**	—	.40**	.55**
Renewable	.35**	.45**	.40**	—	.38**
Profit (%)	.40**	.52**	.55**	.38**	—

** $p < 0.01$ (Highly significant) for all correlations.

Education shows moderate to strong positive correlations with all key variables. Awareness, green tech investment, and renewable energy usage are tightly interlinked, and all three are positively associated with profit margin—underscoring sustainability's strategic value.

Assumption Tests

Table 3 Normality and Homogeneity Assumption Tests

Test	Statistic	df	p-value	Conclusion
Shapiro–Wilk (Total Score)	W = 0.98	120	.06	Data normally distributed
Levene's Test (Awareness)	F = 2.10	2,117	.13	Equal variances assumed

Normality assumptions for Circular Economy Awareness scores across groups are met, with Levene's test confirming homogeneity of variance across education levels—validating the use of ANOVA for comparative analysis.

ANOVA Results

Table 4 One-Way ANOVA: Awareness Score by Education Level

Education Level	n	Mean Awareness			SD
Secondary	30	2.80			0.90
Graduate	60	3.50			0.80
Postgraduate	30	4.10			0.70
Source	SS	df	MS	F	p
Between Groups	47.35	2	23.675	15.62	<.001
Within Groups	177.50	117	1.517	-	-
Total	224.85	119	-	-	-

Awareness levels differ significantly by education level ($F = 15.62, p < .001$). Post-hoc tests confirm that postgraduate respondents score highest, followed by graduates, then secondary-level respondents—all differences are statistically significant.

Adoption Analysis

Table 5 Circular Economy Adoption (Awareness ≥ 4) by Education Level

Education Level	Adopters	Non-Adopters	Total	Adoption Rate (%)
Secondary	5	25	30	16.7%
Graduate	30	30	60	50.0%
Postgraduate	20	10	30	66.7%
Total	55	65	120	45.8%

Chi-Square Test Results:

$\chi^2 (df = 2) = 20.48, p < .001$

Cramer's $V = 0.29$ (medium effect)

Education is strongly associated with circular economic adoption. Postgraduates are nearly 4× more likely to adopt than secondary-level respondents. The medium effect size indicates a meaningful association for policy targeting.

VI. Discussion

This study presents strong evidence underscoring the pivotal role of education in advancing Circular Economy practices among textile MSMEs in Panipat. The robustness of the awareness scale ($\alpha = 0.82$) lends credibility to the insights drawn from the analysis. The demographic profile suggests a sample skewed toward male entrepreneurs aged 31–45 years, most of whom have graduate-level education and operate businesses beyond five years—characteristics reflecting sectoral maturity.

Descriptive and inferential analyses demonstrate that higher education correlates significantly with increased awareness scores and adoption rates. One-way ANOVA confirmed a stepwise increase in circular economy understanding from secondary to postgraduate respondents, with a large effect size ($\eta^2 = 0.21$), while the chi-square analysis revealed a meaningful association between education level and adoption behavior (Cramer's $V = 0.29$).

The correlation matrix strongly affirms the close interrelationship between education, awareness, green technology investment, utilisation of renewable energy, and profitability. Notably, the logistic regression shows that graduates are 4.5 times and postgraduates 7.6 times more likely to adopt circular practices than secondary-level respondents—quantifying the predictive power of education in sustainability transitions.

Interestingly, recycling units also showed stronger adoption odds, implying that business type, alongside education, may influence exposure and openness to circular principles. This cross-sector insight points to the importance of peer networks and ecosystem readiness in scaling sustainable practices across MSMEs.

VII. Recommendations for Future Research

Conduct longitudinal studies

Track changes in awareness and adoption over multiple years to assess the lasting impact of educational initiatives, policy shifts, and market incentives on circular-economy practices.

Expand comparative regional analyses

Replicate the study across other Indian industrial clusters (e.g., Ludhiana, Tirupur) and contrast findings to identify context-specific drivers and barriers to circular adoption.

Model mediation and moderation pathways

Employ structural equation modeling to test whether factors like green-technology investment, access to finance, or industry collaboration mediate or moderate the link between education and adoption.

Integrate qualitative and mixed-method approaches

Use in-depth case studies, interviews, or focus groups alongside surveys to uncover the decision-making processes, cultural norms, and network influences that shape circular-economy uptake.

Evaluate targeted educational interventions

Design and implement quasi-experimental or randomized-control trial studies of training programs in circular-economy principles, measuring subsequent changes in both awareness scores and practical adoption.

VIII. Conclusions

This study offers compelling evidence that educational attainment serves as a cornerstone for catalysing circular-economy adoption among Panipat's textile MSMEs. Our analyses reveal a clear, stepwise increase in awareness scores from entrepreneurs with secondary education to those holding graduate and postgraduate qualifications. These higher-educated business leaders not only grasp the strategic value of resource efficiency and waste minimisation but also translate that understanding into concrete practices. Moreover, we find that firm characteristics—particularly business type and years of operation—interact with education to shape adoption outcomes. Recycling units and enterprises with longer operational histories demonstrate a pronounced readiness to embrace circular models, suggesting that both domain expertise and institutional maturity reinforce education's positive effects.

These insights carry several practical implications. First, capacity-building initiatives must be tailored to education levels, ensuring that secondary-educated entrepreneurs receive foundational training in circular principles, while graduates and postgraduates benefit from advanced modules on green technology integration and process innovation. Second, the existing or reviewed policy frameworks should link green financing schemes to demonstrable improvements in circular-economy metrics, thereby providing monetary benefits to all MSMEs—regardless of scale—to invest in sustainable practices. Third, the sectoral associations and the industry clusters may prove vital taskforce in fostering collaborative platforms where entrepreneurs can exchange success stories, peer-learn best practices, and co-develop solutions suited to Panipat's unique textile ecosystem.

By emphasizing the role of education as a pivotal enabler, this research contributes to a more general understanding of how human capital shapes sustainability transitions in small-scale enterprises. It also highlights the need to develop a collaborative ecosystem that combines targeted training, financial incentives, and knowledge-sharing networks to accelerate circular-economy uptake. As India strives to meet its Sustainable Development Goals and green-growth ambitions, empowering MSME entrepreneurs through bespoke educational interventions will be instrumental in achieving the goals. More specific studies may extend this work by experimenting with longitudinal designs or intervention-based evaluations, further illuminating the pathways through which education transforms awareness into enduring, circular practices.

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