

Green Management Practices in Small Scale Industries: A Study on Thirumangalam Region (2023-2025)

¹M. Stella, ²Dr D. Deepa

¹Research Scholar, Department of Management Studies, School of Business Studies, Madurai Kamaraj University, Madurai - 21

²Assistant Professor, Department of Management Studies, School of Business Studies, Madurai Kamaraj University, Madurai - 21

Abstract: The transition toward green management practices has become a critical imperative for small-scale industries worldwide, driven by growing environmental concerns, regulatory pressures, and changing market demands. This study examines the adoption of green management practices among small-scale industries in the Thirumangalam region of Madurai District, Tamil Nadu, over the period 2023-2025. Thirumangalam, an emerging industrial hub within Madurai's expanding SME network, hosts a diverse range of small-scale enterprises spanning engineering, fabrication, packaging, plastic molding, and food processing sectors. Using a mixed-method research approach combining survey questionnaires and semi-structured interviews with 120 small-scale industrial units, this study assesses the current level of green practice adoption, identifies key drivers and barriers, and evaluates the impact of green management on operational and financial performance. The findings reveal that while awareness of green practices has increased significantly during the study period—largely due to government initiatives such as the 25% capital subsidy for green technologies and subsidized energy audits—actual implementation remains moderate. High initial investment costs, inadequate employee competence, limited consumer pressure, and lack of clear measurement systems emerge as the most significant barriers. However, enterprises that have adopted green practices report improved resource efficiency, reduced operational costs, and enhanced market competitiveness. The study concludes with policy recommendations for accelerating green transitions in the region's small-scale industrial sector.

Keywords: Green Management Practices, Small Scale Industries, Thirumangalam, Sustainability, MSMEs, Tamil Nadu

Introduction

The concept of green management has evolved from a niche environmental concern to a mainstream business imperative in the twenty-first century. As 'greening' the process has become the norm of the day, total quality management in the manufacturing sector becomes a reality only with green practices. Green management practices enable continuous improvement and sustainability, covering all aspects of reducing environmental impact through optimum use of available resources and reduction of waste.

Small and medium enterprises (SMEs) occupy a unique position in this green transition. While individually their environmental footprint may appear modest, their collective impact is substantial. Small and medium-sized firms are essential to all economies but also have a significant negative impact on the environment; their collective footprint equates to a major contribution to industrial pollution. Yet, SMEs are often not convinced of the necessity for behaviour change, and the time has come where ignoring environmental impacts of SMEs is no longer viable.

India's MSME sector forms the backbone of the country's industrial economy. According to the Udyam Portal, key segments within Tamil Nadu's food processing sector and leather sector account for about 1.45 lakh and 12,000 micro, small and medium enterprises respectively. While modest in size, these units are essential to



India's domestic and export aspirations, collectively employing large numbers and anchoring women's workforce participation.

Thirumangalam Context

Thirumangalam, a municipality in Madurai District of Tamil Nadu, has emerged as an important node in the region's industrial landscape. The Kappalur Industrial Estate, managed by the Small Industries Development Corporation (SIDCO), has emerged as a vibrant hub housing over 500 MSMEs across engineering, fabrication, packaging, and plastic molding. Nearby estates like Thirumangalam, Thirumohur, and Othakadai are now extensions of this growing network. The automotive component sector has seen a steady rise, with several SMEs supplying precision parts to larger OEMs in Tamil Nadu's automotive corridor, while others have begun exporting to Southeast Asian markets.

The region's industrial character is complemented by its strong agricultural base in pulses, millets, and oilseeds, which supports a growing cohort of food processing, cold storage, and agri-value addition enterprises. This diversity of industrial activity makes Thirumangalam an ideal setting for studying green management practices across different small-scale industry sectors.

The Green Imperative

The urgency of green transition in the small-scale industrial sector has been amplified by several converging factors. As India advances toward its 2070 net-zero goal, international buyers—especially in Europe and markets such as America and Southeast Asia—are demanding low-carbon products with traceable social and environmental footprints across the supply chain. Green manufacturing is now a 'business imperative' for Tamil Nadu's competitiveness and export readiness.

The Tamil Nadu government has responded with policy measures including a 25% capital subsidy for green technologies, support for energy audits, training, and implementation assistance. More than 1,000 MSMEs have benefited from subsidised audits and technology upgrades. Industry bodies have urged MSMEs to prepare for global carbon-regulation regimes such as CBAM and for India's emerging carbon market, and to measure product-level carbon footprints, shift to rooftop solar, adopt circular-economy models, and integrate sustainability into financial and operational decisions.

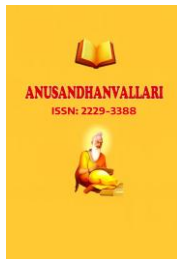
Rationale and Significance of the Study

Despite the growing policy attention and market pressures, research on green management practices in small-scale industries, particularly in emerging industrial clusters like Thirumangalam, remains limited. Most studies have focused on large corporations or specific sectors, leaving a gap in understanding the ground-level realities of green transitions in small-scale industrial contexts. This study addresses this gap by providing empirical evidence from the Thirumangalam region during the critical period of 2023-2025, when green transition has gained unprecedented momentum in Tamil Nadu's industrial policy.

The significance of this study lies in its potential to inform policymakers, industry associations, and small-scale entrepreneurs about the current state of green practice adoption, the challenges faced, and the opportunities available. By documenting the experiences of enterprises in Thirumangalam, this research contributes to the broader discourse on sustainable industrialization in emerging economies.

Scope and Period of the Study

This study covers small-scale industrial units operating in the Thirumangalam region, including the Thirumangalam industrial estate and surrounding industrial clusters within Madurai District. The study period spans 2023 to 2025, capturing the post-COVID recovery phase and the period of accelerated policy focus on



green manufacturing in Tamil Nadu. The research covers enterprises across engineering, fabrication, packaging, plastic molding, food processing, and automotive components sectors.

Statement of the Problem

The small-scale industrial sector in the Thirumangalam region faces a critical challenge: how to transition toward environmentally sustainable operations while maintaining competitiveness in an increasingly demanding market environment. Despite the growing recognition that green management practices are essential for long-term sustainability and market access, the adoption of such practices among small-scale industries remains uneven and often inadequate.

Several interrelated problems compound this challenge. First, many small-scale industrial units operate on thin margins, making capital-intensive green investments difficult to justify in the absence of clear and immediate returns. Second, there is a significant gap between awareness of green practices and their actual implementation, with many entrepreneurs expressing willingness to "go green" but lacking clear guidance on how to do so in a manner that makes business sense. Third, the absence of credible systems to measure and verify environmental benefits creates uncertainty around sustainability investments. Fourth, while government schemes and incentives exist, awareness and implementation remain limited.

The problem is further compounded by the diversity of industrial activities in the region and the varying levels of environmental impact across different sectors. Without a systematic understanding of the current state of green practice adoption, the barriers faced, and the factors that enable successful implementation, policy interventions and industry support programmes cannot be effectively targeted.

Literature Review

Green management practices in small-scale industries can be understood through several theoretical lenses. The Resource-Based View (RBV) suggests that green capabilities can serve as sources of competitive advantage. The Stakeholder Theory emphasizes the role of various stakeholders—customers, regulators, communities, and employees—in driving environmental practices. The Institutional Theory explains how coercive (regulatory), mimetic (competitive), and normative (social) pressures shape organizational responses to environmental concerns.

Green Management Practices: Conceptual Overview

Green management encompasses a range of practices aimed at reducing environmental impact while improving operational efficiency. Chithra (2023) identifies green manufacturing as the most emerging sustainable manufacturing practice that has the capability to solve most of the issues that Indian industries currently face. Green practices cover all aspects of reducing environmental impact through optimum use of available resources and reduction of waste.

Tamil Nadu's Green Transition

Tamil Nadu has emerged as a leader in promoting green manufacturing among its MSME sector. The state offers a 25% capital subsidy for green technologies, support for energy audits, training, and implementation assistance. More than 1,000 MSMEs have benefited from subsidised audits and technology upgrades.

In Vellore and Pallavaram, tanneries are piloting biogas from sludge, switching to solar thermal systems, and upskilling workers in circular practices. In the Salem cluster, spice processors are adopting solar drying to enhance product quality and sustainability. The state has also seen initiatives to bring sustainable, small and medium-scale industries to Tamil Nadu's delta districts. IIT Madras has played a significant role in technology deployment, deploying Electrochemical Ozone Oxidation Systems at Tirupur's textile cluster, purpose-built for smaller units, cutting RO infrastructure costs by 75%. The Kotak-IIT Madras Save Energy Mission has

completed more than 500 energy audits across India, helping MSMEs achieve annual savings of over Rs 96 crore and significantly reduce greenhouse gas emissions.

The Role of Industrial Clusters

Industrial clusters offer a powerful opportunity to scale sustainability solutions. Instead of each factory trying to solve the problem individually, clusters allow industries to adopt solutions collectively. Renewable energy infrastructure, cleaner fuel supply chains, and energy efficiency programmes become easier to implement when industries work together. Cluster-based approaches can also make it easier to deploy centralised monitoring and verification systems.

Research Gap

While the literature provides valuable insights into green practices in Indian SMEs and Tamil Nadu's policy environment, there is a notable gap in region-specific studies, particularly for emerging industrial clusters like Thirumangalam. Most research has focused on major industrial centres such as Chennai, Coimbatore, and Tirupur, leaving the experiences of smaller clusters under-documented. This study aims to fill this gap by providing empirical evidence from the Thirumangalam region during the critical policy period of 2023-2025.

Research Methodology

This study employs a mixed-method research design combining quantitative and qualitative approaches. The quantitative component involves a structured survey questionnaire administered to small-scale industrial units in the Thirumangalam region. The qualitative component involves semi-structured interviews with entrepreneurs, industry association representatives, and government officials to gain deeper insights into the experiences, perceptions, and challenges related to green practice adoption.

Study Area

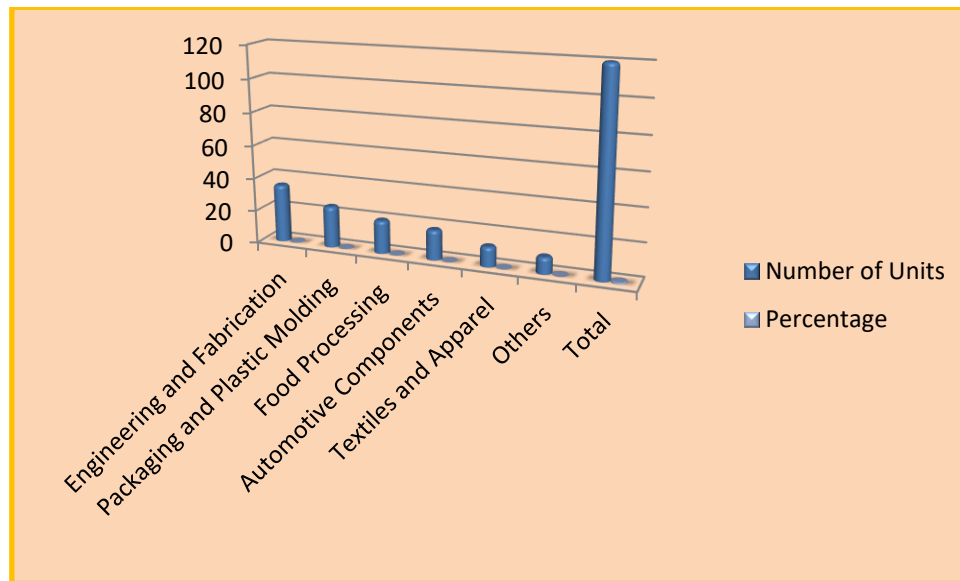
The study is conducted in the Thirumangalam region of Madurai District, Tamil Nadu. The area includes the Thirumangalam industrial estate and surrounding industrial clusters. According to census data, Thirumangalam has a population of approximately 51,194. The region has emerged as an extension of the Kappalur Industrial Estate network, which houses over 500 MSMEs.

Population and Sample

The target population consists of all small-scale industrial units operating in the Thirumangalam region during the period 2023-2025. Based on available data from the District Industries Centre and industry association records, approximately 200-250 small-scale industrial units are estimated to be operating in the region.

A sample of 120 units was selected using stratified random sampling, with stratification based on industrial sector. The sample distribution across sectors is as follows:company	Number of Units	Percentage
Engineering and Fabrication	35	29.2%
Packaging and Plastic Molding	25	20.8%
Food Processing	20	16.7%
Automotive Components	18	15.0%
Textiles and Apparel	12	10.0%

Others	10	8.3%
Total	120	100%



Reliability and Validity

The questionnaire was pilot-tested with 15 enterprises to assess clarity, relevance, and comprehensiveness. Cronbach's alpha was calculated for each scale to assess internal consistency:

Scale	Cronbach's Alpha	Interpretation
Green Practice Adoption	0.87	Excellent
Drivers of Green Adoption	0.82	Good
Barriers to Green Adoption	0.84	Good
Enterprise Performance	0.79	Acceptable
Government Support Perception	0.81	Good

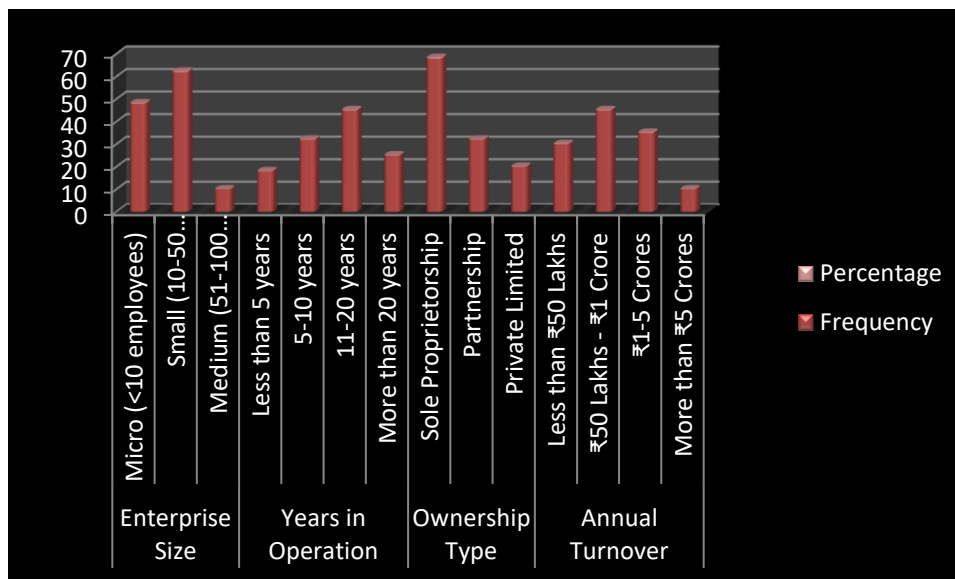
Content validity was established through expert review by academic researchers and industry practitioners. Construct validity was assessed through factor analysis.

Data Analysis and Interpretation

Characteristic	Category	Frequency	Percentage
Enterprise Size	Micro (<10 employees)	48	40.0%
	Small (10-50 employees)	62	51.7%

	Medium (51-100 employees)	10	8.3%
Years in Operation	Less than 5 years	18	15.0%
	5-10 years	32	26.7%
	11-20 years	45	37.5%
	More than 20 years	25	20.8%
Ownership Type	Sole Proprietorship	68	56.7%
	Partnership	32	26.7%
	Private Limited	20	16.7%
Annual Turnover	Less than ₹50 Lakhs	30	25.0%
	₹50 Lakhs - ₹1 Crore	45	37.5%
	₹1-5 Crores	35	29.2%
	More than ₹5 Crores	10	8.3%

Interpretation: The majority of enterprises (51.7%) fall into the small category, with micro-enterprises accounting for 40%. This distribution is consistent with the broader MSME landscape in Tamil Nadu. Over half of the enterprises (58.3%) have been in operation for more than 10 years, indicating a stable industrial base. Sole proprietorship is the predominant ownership form (56.7%), reflecting the traditional entrepreneurial culture of the region.



Conclusion

This study examined green management practices in small-scale industries in the Thirumangalam region of Tamil Nadu during the period 2023-2025. The key findings are: Adoption Level: The overall level of green



management practice adoption is moderate (mean GPA=2.97), with energy efficiency and waste management showing the highest adoption and renewable energy and green supply chain practices showing the lowest adoption.

Concluding Remarks

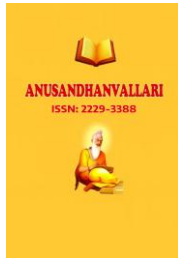
The transition toward green management practices in small-scale industries is no longer optional but imperative. As Tamil Nadu advances toward its trillion-dollar GDP vision and India pursues its 2070 net-zero goal, the small-scale industrial sector must play its part in the green transition. The Thirumangalam region, as an emerging industrial hub, represents both the challenges and opportunities of this transition.

The moderate level of green practice adoption observed in this study suggests that progress is being made, but there is significant room for improvement. The awareness-implementation gap, the financial barriers, and the skill deficiencies identified in this study point to the need for continued and strengthened policy support. However, the positive correlation between green practice adoption and enterprise performance provides a compelling business case for action.

The journey toward green industrialization is a collective endeavour requiring the collaboration of government, industry associations, financial institutions, and individual enterprises. By working together, these stakeholders can accelerate the green transition in the Thirumangalam region and beyond, creating a more sustainable and competitive small-scale industrial sector for the future.

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