Bridging Tradition and Technology: Green Management and Responsible Business in Indian Small – Scale Industries through AI in the Madurai Region

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Abstract

The intersection of traditional business practices and emerging artificial intelligence (AI) technologies presents a transformative opportunity for small-scale industries in India. This study examines how AI-enabled green management strategies can foster responsible business practices among micro, small, and medium enterprises (MSMEs) in the Madurai region of Tamil Nadu. Drawing upon an analytical and descriptive methodology, the research synthesizes evidence from policy initiatives, empirical studies, and documented case examples to assess the current state of AI adoption for sustainability purposes. The findings indicate that AI-driven tools ranging from inventory management applications to comprehensive sustainability assessment platforms offer viable pathways for Madurai's small enterprises to enhance operational efficiency while simultaneously reducing environmental impact. However, adoption remains constrained by limited digital literacy, capital constraints, and infrastructural gaps. The study identifies institutional partnerships, particularly those linking academic institutions with industry bodies, as critical enablers of technology diffusion. The research concludes that bridging tradition and technology in Madurai's small-scale sector requires a dual approach: preserving the region's characteristic resource-efficient practices while strategically deploying accessible AI solutions to meet contemporary sustainability and competitiveness imperatives.

Keywords: Green Management, Responsible Business, Artificial Intelligence, MSMEs, Madurai, Sustainability, Digital Transformation, Tamil Nadu

Introduction

The small-scale industrial sector occupies a foundational position in India's economic architecture, contributing significantly to employment generation, regional development, and export earnings. In Tamil Nadu, micro, small, and medium enterprises (MSMEs) constitute a vital component of the state's industrial ecosystem, with the Madurai region serving as a distinctive cluster encompassing textile manufacturing, food processing, handicrafts, and retail trade. These enterprises, often characterized by family ownership and intergenerational knowledge transfer, embody a form of "traditional" business practice that has historically emphasized resource efficiency born of necessity rather than formal environmental management systems.

The contemporary global economic landscape, however, increasingly demands that businesses of all scales demonstrate environmental responsibility. International buyers, regulatory frameworks, and consumer preferences are converging to make sustainability a prerequisite for market access and long-term viability. For Madurai's small-scale industries, this shift presents both a compliance burden and a competitive opportunity. The capacity to adopt green management practices and articulate responsible business conduct has become intertwined with the ability to access global value chains, green finance, and premium market segments.

Artificial intelligence emerges within this context as a potentially democratizing force. AI applications designed for small business contexts can lower the barriers to sustainability adoption by automating assessment processes, optimizing resource utilization, and enabling data-driven decision-making without requiring extensive technical expertise. Recent collaborative initiatives, such as the partnership between the Federation of Indian Chambers of Commerce and Industry (FICCI) and Global Logic to launch an AI-powered Business Resilience Platform for MSMEs, signal institutional recognition of this potential . Similarly, the Tamil Nadu government's engagement with IIT Madras to drive AI adoption across the state's MSME ecosystem reflects policy-level commitment to digital transformation.

This paper examines the intersection of these dynamics within the specific socio-economic context of Madurai. It seeks to understand how AI-enabled green management can bridge the gap between traditional small-scale industrial practices and contemporary responsible business expectations. The analysis proceeds from a recognition that

sustainability transitions in regions like Madurai cannot simply replicate models developed for large corporations or urban technology hubs; they must be attuned to local institutional capacities, business cultures, and resource constraints.

Research Problem

Despite growing policy attention to MSME digitalization and sustainability, significant gaps persist in understanding how these twin transitions unfold in specific regional contexts. The existing literature on green management in Indian small-scale industries has primarily focused on major industrial clusters such as Coimbatore, Tiruppur, and the National Capital Region. The Madurai region, while economically significant within Southern Tamil Nadu, has received comparatively limited scholarly attention regarding its MSME sustainability practices and technology adoption trajectories.

Furthermore, the discourse on AI and sustainability has tended to privilege large enterprise applications, with limited investigation into how AI tools can be adapted for the resource-constrained, relationship-driven, and tradition-steeped environments of small-scale industries. The assumption that AI adoption follows a linear pathway from awareness to implementation overlooks the complex interplay of institutional support, peer networks, and perceived relevance that shapes technology uptake in smaller enterprises.

The specific research problem addressed in this study can be stated as follows: What are the current patterns, enabling factors, and barriers to AI-enabled green management adoption among small-scale industries in the Madurai region? And what pathways exist for integrating AI-driven sustainability tools with the traditional resource-efficient practices characteristic of these enterprises?

This problem is examined through the following subsidiary questions:

- How do Madurai's small-scale industries currently conceptualize and implement green management and responsible business practices?
- What AI applications are available and accessible to these enterprises for sustainability-related purposes?
- What institutional mechanisms exist to facilitate AI adoption for green management in the Madurai region?
- What challenges constrain the integration of AI tools with traditional business practices in this context?

Review of Literature

The literature on green management in Indian MSMEs has evolved considerably over the past decade. Early studies focused primarily on regulatory compliance and pollution control, reflecting the command-and-control orientation of Indian environmental policy. More recent scholarship has adopted a broader conception of green management as encompassing resource efficiency, waste reduction, sustainable sourcing, and stakeholder engagement.

Selvaraj's study of micro and small corporations in Madurai identifies multiple environmental factors influencing the adoption of "green commercial enterprise" practices. The research emphasizes that green enterprise serves as a potential mediator of financial-environmental relations, with adoption influenced by pressures from customers, employees, government regulators, and other stakeholders. Financial sustainability manifested in sound cash, capital, and investment management emerges as a critical determinant, suggesting that environmental practices are not adopted in isolation from economic considerations.

The study further notes that local byelaws and techniques related to environmental issues, including pollution and effluents control, constitute significant macro-environmental factors affecting small corporations. The volatile nature of business practices, oriented toward competitive advantage and core competency development, shapes the integration of environmental considerations into enterprise strategy. Selvaraj concludes that a persistent development technique integrating fiscal, environmental, and business rules is necessary for achieving key outcome regions of micro and small corporations.

The AI adoption landscape for Indian MSMEs has undergone rapid transformation in recent years. Yadav et al. provide a comprehensive analysis of AI-driven pathways for net-zero supply chain transformation in SMEs, identifying critical success factors through structural equation modeling and artificial neural network approaches. Their findings indicate that strategic adoption and stakeholder engagement constitutes the most influential factor in predicting AI adoption for net-zero outcomes, followed by smart manufacturing and process optimization, and energy efficiency and emissions reduction. This research underscores that successful AI integration for sustainability requires attention to organizational strategy and stakeholder alignment, not merely technological availability.

A significant institutional development is the FICCI-GlobalLogic partnership, which has produced an AI-powered Business Resilience Platform specifically designed for MSMEs . The platform assesses readiness across sustainability, workforce management, governance, and operations, and enables tracking of year-on-year emission trends. It benchmarks performance against 49 key indicators, providing MSMEs with structured data templates and dashboards to improve data quality and transparency. The platform also facilitates access to green finance and global markets by providing a standardized evaluation framework aligned with Indian and global norms.

In the Tamil Nadu context, IIT Madras has partnered with FaMe TN (Bureau for Facilitating MSMEs) to accelerate AI adoption across the state's industrial ecosystem. The collaboration aims to develop a state-level MSME Digital Readiness and Adoption Index to assess digital maturity across Tamil Nadu. The initiative emphasizes low-cost, user-friendly solutions suitable for MSMEs requiring accessible and scalable technologies without significant capital investment. Key focus areas include AI-enabled workflows, shop-floor digitization, and Industry 4.0 adoption through digital readiness assessments and capacity-building programs.

Rubigha and Palaniswamy provide empirical evidence on sustainability and energy efficiency strategies among textile SMEs in Tamil Nadu, including Madurai as a focus area . Their mixed-methods study, encompassing 1,250 SMEs across spinning, weaving, dyeing, and clothing manufacturing, demonstrates strong correlations between energy efficiency measures and improved operational performance, as well as between sustainable practices and financial performance. The research identifies obstacles to the adoption of energy-efficient technologies, underscoring the need for targeted interventions to overcome these barriers.

The study's use of structural equation modeling to examine these relationships provides methodological rigor and confirms that sustainability and energy efficiency are not merely ethical imperatives but contribute substantively to textile SMEs' competitiveness. This finding is particularly relevant for Madurai, where textile and related industries constitute a significant portion of the small-scale industrial base.

Research on Indian plastic MSMEs examines the intersection of green finance, AI adoption, and circular economy strategies. The study, which surveyed 425 plastic-based MSMEs across India, finds that circular product design significantly enhances environmental performance, while remanufacturing bolsters economic and social outcomes. Green financing partially mediates these relationships, and AI adoption serves as a moderator that strengthens the effectiveness of circular economy strategies. The research conceptualizes governance as a structural conditioning system that shapes the deployment of these strategies, with implications for how policy and institutional frameworks can support MSME sustainability transitions.

While large-scale empirical studies provide valuable aggregate insights, documented case examples from the Madurai region illustrate the practical application of AI tools in small business settings. Ravi, a grocery shop owner in Madurai, utilized free AI tools to implement smart inventory management, WhatsApp-based ordering through an AI chatbot, sales forecasting, and professional marketing materials. Within eight months, his customer base grew by 40% and monthly profits doubled. Similarly, Kavitha, another Madurai shop owner, adopted AI-powered billing, inventory management, customer engagement through WhatsApp AI chat, and local advertising. Her results included a 40% revenue increase, 25% reduction in wastage, and acquisition of over 50 loyal home-delivery customers within six months.

These cases, while focused on retail rather than manufacturing, demonstrate that AI tools can be effectively deployed by small enterprises with limited technical backgrounds when applications are designed for accessibility and the tools are freely available. The reduction in wastage documented in Kavitha's case is particularly relevant to green management, as waste reduction represents a direct environmental benefit alongside the economic gains.

Analytical and Descriptive Study Methodology and Approach

This study employs an analytical and descriptive approach, synthesizing evidence from multiple sources to construct a comprehensive picture of AI-enabled green management among small-scale industries in the Madurai region. The methodology involves: (a) systematic review of published research on green management, AI adoption, and MSME

sustainability in Tamil Nadu and India; (b) analysis of policy documents and institutional initiatives related to MSME digitalization and sustainability; and (c) examination of documented case examples of AI adoption by small enterprises in the Madurai context.

The analytical framework draws upon the natural resource-based view of the firm, which posits that competitive advantage derives from capabilities that enable effective management of environmental resources. AI adoption for green management is conceptualized as a dynamic capability that enables small enterprises to sense and seize sustainability opportunities while adapting their operations to evolving regulatory and market conditions.

Green Management Practices in Madurai's Small-Scale Industries

The evidence suggests that green management practices among Madurai's small-scale industries are shaped by a combination of traditional resource-consciousness and emerging regulatory and market pressures. Selvaraj's research underscores that financial sustainability considerations are paramount, with environmental practices adopted when they align with economic viability. Local environmental regulations addressing pollution and effluent control constitute significant external pressures, particularly for manufacturing units in textile dyeing, food processing, and chemical-adjacent sectors.

The traditional practices of Madurai's small enterprises often embody principles that align with contemporary green management frameworks. Resource efficiency, rooted in the economic necessity of minimizing waste in low-margin businesses, represents a form of "implicit sustainability" that predates formal environmental management systems. The challenge lies in making this implicit sustainability explicit and measurable, which is where AI-enabled tools offer potential value.

AI Applications Relevant to Green Management

Several categories of AI applications are relevant to green management objectives in small-scale industrial contexts:

- Inventory and Resource Optimization: AI-powered inventory management tools can reduce overstocking and associated waste, optimize raw material utilization, and predict demand patterns to align production with actual market needs. The

documented cases of Madurai shopkeepers using AI for inventory management demonstrate the accessibility of such tools.

- Energy Efficiency and Emissions Tracking: AI systems can monitor energy consumption patterns, identify inefficiencies, and suggest optimization measures. The FICCI-Global Logic Business Resilience Platform specifically enables MSMEs to track year-on-year emission trends and benchmark their performance against key indicators.
- Supply Chain Transparency and Circular Economy: AI can facilitate traceability of materials, support circular economy approaches such as remanufacturing, and enhance transparency within supply chains. Research on Indian plastic MSMEs confirms that AI adoption moderates the effectiveness of circular economy strategies for sustainable performance.
- Sustainability Assessment and Reporting: Structured AI-driven platforms can guide small enterprises through sustainability assessments, generate standardized reports, and prepare data required for green finance applications. The Business Resilience Platform's readiness heat maps and resilience scorecard exemplify this application.

Institutional Ecosystem and Enabling Mechanisms

The institutional ecosystem for AI-enabled green management in Madurai is in an emergent phase, with several key actors and initiatives shaping the landscape:

- Academic-Industry Partnerships: The IIT Madras-FaMe TN collaboration represents a significant institutional intervention aimed at accelerating AI adoption across Tamil Nadu's MSMEs. The partnership's focus on developing low-cost, user-friendly solutions is particularly relevant for Madurai's resource-constrained enterprises. The proposed MSME Digital Readiness and Adoption Index will provide a baseline for measuring progress.
- Industry Associations and Advocacy: The Software Industries Development Association (SIDA), headquartered in Madurai, has actively advocated for government procurement opportunities for software MSMEs, industry-academia collaboration for skill development, and support for AI adoption. SIDA's engagement with the Tamil Nadu IT Secretary reflects organized efforts to create an enabling policy environment for technology adoption in Southern Tamil Nadu.

- National-Level Platforms: The FICCI-GlobalLogic Business Resilience Platform, while national in scope, provides tools that can be accessed by MSMEs across India, including those in Madurai. The platform's emphasis on data transparency and green finance linkages addresses critical barriers to sustainability adoption.
- Corporate Social Responsibility and Green Initiatives: Local corporate social responsibility initiatives, such as the Star Home Project in Madurai organized by the Rotary Club of Madurai Metro Heritage and a private soap company, contribute to environmental awareness and community engagement. While not directly AI-focused, such initiatives create a broader ecosystem of environmental consciousness that can support technology-enabled sustainability efforts.

Barriers to AI-Enabled Green Management Adoption

Despite the availability of tools and institutional support, several barriers constrain AI-enabled green management adoption among Madurai's small-scale industries:

- Digital Literacy and Technical Capacity: Many small enterprise owners lack familiarity with AI concepts and applications, requiring capacity-building interventions. The IIT Madras-FaMe TN collaboration explicitly addresses this through capacity-building programs and technology demonstrations.
- Capital Constraints: While free and low-cost AI tools exist, comprehensive sustainability platforms may require investments that strain the limited capital available to micro and small enterprises. The emphasis on low-cost solutions in institutional initiatives reflects recognition of this constraint.
- Infrastructure Limitations: Reliable internet connectivity, computing devices, and data infrastructure are prerequisites for AI adoption that may be unevenly available across Madurai's industrial areas.
- Perceived Relevance and Trust: Small enterprise owners may perceive AI as irrelevant to their business context or may be skeptical of technology-driven approaches that seem disconnected from their practical experience and traditional practices.
- Data Quality and Availability: AI systems depend on data for effective operation. Small enterprises often lack systematic record-keeping and data management practices, creating a foundation problem for AI adoption.

Bridging Tradition and Technology

The analysis suggests that successful integration of AI-enabled green management in Madurai's small-scale industries requires a bridging approach that respects and leverages traditional practices while introducing appropriate technological enhancements. Key elements of this approach include:

- Building on Existing Resource Efficiency: AI tools should be positioned as augmenting rather than replacing the resource-conscious practices already embedded in small enterprise operations. The waste reduction documented in Kavitha's case illustrates how AI can enhance traditional efficiency rather than displace it.
- Starting with Accessible Applications: Entry-level AI tools addressing immediate pain points (inventory management, billing, customer engagement) can build digital confidence and familiarity before advancing to more comprehensive sustainability platforms.
- Leveraging Institutional Anchors: Academic institutions (IIT Madras), industry associations (SIDA), and business organizations (FICCI) serve as trusted intermediaries that can facilitate technology transfer and capacity building.
- Connecting to Market Incentives: The linkage between sustainability disclosure, green finance access, and global market participation provides tangible economic incentives for adoption, as emphasized in the Business Resilience Platform design.

Conclusion

This study has examined the intersection of tradition and technology in Madurai's small-scale industrial sector, focusing specifically on the potential for AI-enabled green management to foster responsible business practices. The analysis reveals a landscape of both opportunity and constraint.

The opportunity lies in the convergence of several favorable factors: the availability of accessible AI tools designed for small business contexts, institutional initiatives at both national and state levels to promote MSME digitalization and sustainability, and the traditional resource-consciousness of Madurai's small enterprises that provides a cultural foundation for green management. Documented cases demonstrate that even the smallest enterprises can achieve significant improvements in efficiency and waste reduction through AI adoption when tools are appropriately designed and supported.

The constraints are equally evident. Digital literacy gaps, capital limitations, infrastructural deficits, and data management weaknesses pose significant barriers to widespread adoption. These constraints are not insurmountable, but they require targeted interventions that address the specific circumstances of small enterprises in regional contexts like Madurai.

References

Dinamalar. "பசுமையான தமிழகத்தை உருவாக்க திட்ட | Madurai | 5 Small Green Duties for the Next Generation." Dinamalar TV, May 26, 2026.

FICCI. "FICCI - GlobalLogic Announce Strategic Partnership to Launch AI-Powered Business Resilience Platform for Indian MSMEs." Press Release, October 1, 2025.

MOH AI TECH. "How Ravi's small shop became a digital success with AI." LinkedIn, September 15, 2025.

Selvaraj N. "Analysing the Elements Influencing Macro Surroundings of Micro and Small Corporations in the Direction of Inexperienced Commercial Enterprise Practices in Madurai - Tamilnadu." ICTACT Journal on Management Studies, vol. 8, no. 4, 2022, pp. 1654-1658.

GlobalLogic. "FICCI and GlobalLogic Announce Strategic Partnership to Launch AI-Powered Business Resilience Platform for Indian MSMEs." GlobalLogic India Press Room, September 29, 2025.

News18. "IIT Madras, Tamil Nadu MSME body join hands to drive AI adoption." News18, July 28, 2026.

Rubigha K, Krishna, and Nalini Palaniswamy. "Framework for implementing energy efficiency strategies in textile SMEs to achieve sustainability and business growth." Industria Textila, vol. 76, no. 3, 2025, pp. 441-447.

"Green Finance and Artificial Intelligence in Circular Economy Strategies: Evidence From Indian Plastic MSMEs." Business Strategy and the Environment, Wiley Online Library, March 31, 2026.

MOH AI TECH. "How Kavitha's Grocery Shop Thrived with AI." LinkedIn, September 14, 2025.

Selvaraj N. "Analysing the Elements Influencing Macro Surroundings of Micro and Small Corporations in the Direction of Inexperienced Commercial Enterprise Practices in Madurai - Tamilnadu." DOAJ, 2022.

Yadav, Alok, et al. "Artificial Intelligence-Driven Pathways for Net-Zero Supply Chain Transformation in SMEs." Arabian Journal for Science & Engineering, vol. 51, no. 14, 2026, p. 17373.

MaduraiCity. "SIDA Strengthens Southern Tamil Nadu's Software Future with Key Meeting." MaduraiCity.co.in, June 5, 2026.



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