Global Trends in Green Manufacturing Practices Pathways Toward Sustainable Industrial Development - Shahriar Habib.pdf

by Sanaul Haque

Submission date: 13-Oct-2025 09:42PM (UTC+0700)

Submission ID: 2779888673

File name: Global_Trends_in_Green_Manufacturing_Practices_Pathways_Toward_Sustainable_Industrial_Development_-_Shahriar_Habib.pdf (311.61K)

Word count: 1211

Character count: 7724

Research Proposal on

Global Trends in Green Manufacturing Practices: Pathways Toward Sustainable Industrial Development

Scholar Name
Shahriar Habib

Senior category

Scholar's Affiliation
Khulna University of Engineering & Technology

Country

Bangladesh

E-mail address

habibshahriar55@gmail.com

Date of Submission
29/09/2025

Introduction:

Manufacturing has historically driven global economic growth, but it is also responsible for nearly 30% of worldwide energy use and about 20% of carbon dioxide emissions [1]. Traditional production models are no longer sustainable under increasing pressures of climate change, resource scarcity, and societal demands for accountability. Green manufacturing has emerged as a transformative framework that integrates environmental sustainability into every stage of the industrial value chain. Globally, trends such as circular economy, decarbonization, Industry 4.0 technologies, and life-cycle assessment (LCA) are reshaping the sector [2]. However, fragmented policies, inconsistent data standards, and high costs still pose challenges [3]. This proposal seeks to study global practices in green manufacturing and evaluate research directions for aligning industrial growth with environmental sustainability.

Research Questions:

1. How effectively are global manufacturing industries adopting green manufacturing practices such as circular economy, decarbonization, and Industry 4.0 integration?
2. What are the primary barriers (economic, technological, and policy-related) to implementing green manufacturing at scale?
3. What future directions can strengthen the role of Industry 5.0, digital LCA, and global circular supply chains in sustainable industrial development?

Literature Review: Research shows that circular materials, eco-design, and industrial symbiosis are central to the circular economy [4]. The European Union's Circular Economy Action Plan and China's "Made in China 2025" provide strong policy frameworks [5][6], while private corporations like BMW and Unilever are pioneering modular and recyclable product designs [7]. Decarbonization efforts, such as hydrogen-based "green steel" in Sweden and Germany, highlight potential breakthroughs [8]. However, SMEs face challenges due to high capital costs [9]. Industry 4.0 applications, including digital twins, AI-driven predictive maintenance, and blockchain-based supply chain transparency, show promise for efficiency and traceability [10]. Life-cycle assessment remains the gold standard for measuring environmental impacts [11], though inconsistencies in methodology and lack of biodiversity or social metrics reduce comparability [12]. Future research emphasizes Industry 5.0, real-time digital LCA, and global circular supply chains as the next phase of development [13].

Proposed Methodology: The study will follow a qualitative and comparative research design:

1. Data Collection: Review global policy documents (EU Green Deal, U.S. Inflation Reduction Act, China's Green Industrial Development Plan) and peer-reviewed literature (2020–2025).

2. Comparative Analysis: Compare regional trends (Europe, China, U.S., Global South) in green manufacturing adoption.

3. Case Study Evaluation: Examine industry case studies such as green steel projects, circular industrial parks in China, and AI-driven eco-design in Europe.

4. Thematic Analysis: Identify recurring opportunities and barriers across technological, economic, and regulatory dimensions.

5. Research Synthesis: Propose a roadmap integrating Industry 5.0, digital LCA, and circular global supply chains for sustainable manufacturing.

Figures and Tables:

Region	Circular Economy Adoption	Decarbon-ization Initiatives	Industry 4.0 Integration	Policy Support
Europe	High (CEAP, Eco-Design)	Hydrogen steel, renewable clusters	Strong (Digital twins, AI)	EU Green Deal [5]
China	Moderate–High (Industrial symbiosis, recycling parks)	Renewable clusters, green industrial parks	Rapid expansion	Made in China 2025 [6]
United States	Moderate (Private initiatives)	IRA-funded EV & clean energy projects	High in large firms	Inflation Reduction Act [10]
Global South	Low–Moderate (pilot programs)	Limited due to capital constraints	Emerging, uneven adoption	Limited frame works [7]

Table 1. Adoption of Key Green Manufacturing Technologies Across Regions

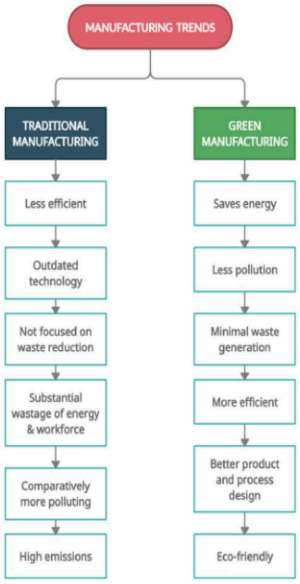

Fig. 1 Comparison flowchart for traditional and green manufacturing

Expected Outcomes

1. A structured evaluation of global green manufacturing practices.
2. Identification of barriers (cost, policy gaps, technological limitations) and opportunities (Industry 4.0, digital tools, eco-design).
3. A research roadmap for integrating sustainability in manufacturing, emphasizing Industry 5.0 and just transitions.
4. Recommendations for harmonized policy and industrial frameworks that balance economic growth with environmental sustainability.

Potential Limitations

1. Regional disparities may lead to uneven data availability.
2. Methodological inconsistencies in life-cycle assessments limit comparability.
3. High variability in industrial practices across developed and developing regions may constrain generalization of findings.

Conclusion

This research will contribute to understanding global trends in green manufacturing and propose pathways to overcome challenges through innovation, digitalization, and policy alignment. By integrating insights from policy, industry, and academia, the study will aim to provide actionable recommendations for sustainable industrial development worldwide.

Project Practicalities: The project will take approximately 10 months:

1. Months 1: Literature review and policy analysis.
2. Months 2-3: Comparative analysis and case study evaluation.
3. Month 4: Thematic synthesis and roadmap development.
4. Month 5: Drafting of final report.
5. Month 6: Review, editing, and submission for journal publication.

Post-program Plan: The results will be refined in collaboration with academic mentors and submitted to peer-reviewed journals in sustainability, industrial engineering, and policy. Outcomes may also be presented at international conferences on green manufacturing and sustainable development.

References

[1] International Energy Agency, *Global Energy Review 2025: Global Trends*. Paris: IEA, 2025.https://iea.blob.core.windows.net/assets/5b169aa1-bc88-4c96-b828-aaa50406ba80/GlobalEnergyReview2025.pdf.

[2] M. Despeisse, "A systematic review of empirical studies on green manufacturing," *J. Clean. Prod.*, vol. 300, p. 126789, 2022. doi: 10.1080/21693277.2022.2127428.

[3] Center for Strategic & International Studies, *Green Industrial Policy: A Holistic Approach*. CSIS, Feb. 2024. https://csis-website-prod.s3.amazonaws.com/s3fs-public/2024-02/240227_Mazzocco_Industrial_Policy.pdf

[4] Organization for Economic Co-operation and Development, *Green Industrial Policies for the Net-Zero Transition*. OECD Publishing, Oct. 2024. https://www.greenpolicyplatform.org/research/green-industrial-policies-net-zero-transition.

[5] European Commission, *Circular Economy Action Plan*. Brussels, 2020. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52020DC0098.

[6] China Daily, "Policy promotes greening of manufacturing sector," Mar. 2024https://english.www.gov.cn/policies/policywatch/202403/13/content_WS65f1132ac6d0868f4e8e50bb.html.

[7] TNI, *"Challenges and prospects for 'green' industrial policy in the Global South."* Amsterdam, Netherlands: Transnational Institute, 2025. https://www.tni.org/en/open-call/challenges-and-prospects-for-green-industrial-policy-in-the-global-south.

[8] SSAB, "HYBRIT: The world's first fossil-free steel." Company Report, 2024. https://www.ssab.com/en/-/media/files/company/investors/annual-reports/2024/ssab_annual_report_2024.pdf?m=20250320120634.

[9] A. F. Carvajal and T. Didier, "*Boosting SME Finance for Growth: The Case for More Effective Support Policies*." Washington, DC: The World Bank, 2024. https://hdl.handle.net/10986/42213

[10] U.S. Congress, *Inflation Reduction Act*. Public Law 117–169, 2022. https://www.congress.gov/bill/117th-congress/house-bill/5376.

[11] International Organization for Standardization, *ISO 14040/44 Standards for Life Cycle Assessment*, 2006. https://www.iso.org/standards.html
[12] Y. Bouchery, C. J. Corbett, J. C. Fransoo, and T. Tan, Eds., *Sustainable Supply Chains: A Research-Based Textbook on Operations and Strategy*. Cham, Switzerland: Springer International Publishing, 2017. doi: 10.1007/978-3-319-29791-0..

Global Trends in Green Manufacturing Practices Pathways Toward Sustainable Industrial Development - Shahriar Habib.pdf

ORIGINALITY REPORT

13%	13%	9%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Beatrice Bais, Margherita Molinaro, Guido Orzes. "Assessing circular economy at company level: Comparison of tools and methodological challenges", Sustainable Production and Consumption, 2025 Publication	2%
2	Tianguang Lu, Xinning Yi, Jing Li, Shaocong Wu. "Collaborative planning of integrated hydrogen energy chain multi-energy systems: A review", Applied Energy, 2025 Publication	2%
3	americafirstpolicy.com Internet Source	1%
4	publuu.com Internet Source	1%
5	nauchforum.ru Internet Source	1%
6	www.yfcss.com Internet Source	1%
7	www.jetir.org Internet Source	1%
8	www.mdpi.com Internet Source	1%
9	ijirem.org Internet Source	

		1 %
10	Rick Hayes, Philip Wallage, Peter Eimers. "Principles of International Auditing and Assurance", Routledge, 2025 Publication	1 %

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	Off		