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AI-DRIVEN GREEN INNOVATION: ENHANCING TWO-STAGE EFFICIENCY IN SOUTH ASIAN MANUFACTURING ENTERPRISES

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Abstract

This study investigates the influence of artificial intelligence (AI) on the two-stage green innovation efficiency of 1,200 listed manufacturing firms in India, Bangladesh, and Sri Lanka from 2015 to 2024. The research addresses critical gaps in understanding how AI enhances stage-specific green innovation processes in resource-constrained emerging economies. Employing a slack-based measure, Data Envelopment Analysis, we decompose green innovation into green technology R&D efficiency (GTE) and green achievement efficiency (GAE). Granted, AI invention patents serve as a proxy for AI development. Econometric and mediation analyses reveal that a 2.72-fold increase in AI patents is associated with a 0.45% improvement in GTE and a 0.49% improvement in GAE, with 32% of the GTE effect mediated by talent density and 28% of the GAE effect mediated by information optimization. Heterogeneity analyses show stronger AI impacts on outcome transformation in Bangladesh's textile sector and on R&D in India's electronics sector, particularly under stringent regulatory regimes. Analysis of the supply chain reveals significant forward spillovers to downstream customers (coef. = 0.031, $p < 0.05$) but negligible backward spillovers from suppliers. The findings underscore AI's role in bolstering human capital, enhancing information flows, and generating asymmetric ecosystem effects, and they inform policy measures to foster AI adoption, cross-country innovation hubs, small enterprise technology uptake, and regulatory support for sustainable industrial growth in South Asia.

Key words: artificial intelligence, green innovation efficiency, R&D spillovers, South Asia, supply chain optimization, sustainable manufacturing

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