Sustainability in Indian Railways

Rishikesh Kumar

MBA Student, School Of Business, Galgotias University, Greater Noida

Dr. Gaurav Gupta

Assistant Professor, School Of Business, Galgotias University, Greater Noida

ABSTRACT

Indian Railways (IR), one of the world's largest rail networks, plays a pivotal role in India's socio-economic fabric. With rising environmental concerns and India's commitment to achieving Net Zero emissions by 2070, the sustainability of IR has become critical. This research explores the environmental, social, and economic dimensions of sustainability within Indian Railways, evaluates ongoing green initiatives, and analyses policy frameworks aligned with global benchmarks like the SDGs and ESG norms. Using a mixed- method approach, this study combines data from annual reports, energy use statistics, and case comparisons with global peers like Deutsche Bahn and JR East. Findings reveal significant progress in electrification, renewable energy deployment, and green infrastructure, though challenges remain in financing, last-mile connectivity, and policy execution. The research concludes with strategic recommendations to enhance IR's sustainability footprint.

INTRODUCTION

Indian Railways, a state-run behemoth, transports over 23 million passengers daily and is essential to national integration and economic development. However, it is also a major consumer of fossil fuels and emitter of greenhouse gases. In light of climate change and sustainable development imperatives, Indian Railways is undergoing a historic transformation aimed at becoming a Net Zero carbon emitter by 2030. The sector is integrating renewable energy sources, enhancing energy efficiency, modernizing infrastructure, and embedding social equity in its operations. This paper investigates the sustainability trajectory of Indian Railways, focusing on the Triple Bottom Line framework that encompasses environmental stewardship, social responsibility, and economic viability.

LITERATURE REVIEW

Previous studies have highlighted Indian Railways' pivotal role in promoting sustainable transport. TERI (2020) reported that rail transport is 75% more energy-efficient than road transport. NITI Aayog has emphasized modal shift to railways as a strategic low-carbon pathway. Several scholars have explored green initiatives like electrification and solar installations (CEEW, 2021), but gaps remain in understanding the social and economic co-benefits. Global literature on Deutsche Bahn, Amtrak, and JR East provides a benchmark for evaluating IR's progress. Sustainability frameworks such as the SDGs, ESG metrics, and the Triple Bottom Line are frequently referenced but underutilized in railway-specific Indian policy design. This study addresses these gaps by integrating environmental data with social and economic indicators.

RESEARCH METHODLOGY

This research employs a mixed-methods approach, combining both quantitative and qualitative data. Quantitative data were extracted from Indian Railways' annual reports, Ministry of Railways documents, NITI Aayog policy papers, and databases from CEEW, TERI, and the World Bank. Statistical tools like Excel and SPSS were used to analyze trends in energy consumption, emissions, and investments. GIS tools helped assess route electrification and geographic equity. Qualitative data include policy analysis, expert interviews, and case studies from global rail systems. The triangulation

of these methods enhances the validity of the findings and provides a holistic view of sustainability in IR.

FINDINGS

Indian Railways has demonstrated notable advancements in environmental, social, and economic sustainability. Environmentally, over 85% of broad gauge routes have been electrified by 2024, significantly reducing reliance on diesel and contributing to a 50% reduction in CO2 emissions from 2015 levels. The adoption of renewable energy has been promising, with over 120 MW of solar and 103 MW of wind energy capacity installed. Socially, initiatives such as Amrit Bharat stations have improved accessibility and safety, while also fostering the creation of green jobs and increasing women's participation through employment and skill training. Economically, the shift to electrification has cut fuel costs by 30%, and modernization efforts like station redevelopment and the introduction of Vande Bharat trains are generating substantial revenue and employment opportunities. However, challenges persist, particularly in mobilizing private investment and scaling up public-private partnerships (PPPs) to support further sustainable growth.

CONCLUSION

Indian Railways has made commendable progress toward sustainable operations, especially in electrification and renewable energy adoption. Social benefits are evident in improved inclusivity and job creation, while economic gains stem from energy savings and modernization. Nonetheless, IR must address financing gaps, enhance last-mile logistics, and embed sustainability in long-term planning. The integration of ESG metrics, enhanced data transparency, and stakeholder participation will be key to achieving the 2030 Net Zero goal. IR's journey offers a model for green transformation in emerging economies.

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