



Green Finance and ESG Investments in India

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ABSTRACT

India's rapid economic growth and fast-paced urbanization have made environmental sustainability a pressing national concern. As the country expands digitally, understanding how digital transformation can support sustainable development has become increasingly important. The present study examines the role of the digital ecosystem in advancing India's sustainable development agenda and explores its alignment with national sustainability goals, including India's commitment to achieve Net Zero carbon emissions by 2070.

Methodology

The present study follows a qualitative research approach based on a systematic review of existing literature. Secondary data were drawn from peer-reviewed academic journals, government policy documents, and reports published by national and international institutions. The analysis focuses on key Indian initiatives—the Digital India programme, the Smart Cities Mission initiative, and the National Green Hydrogen Mission—to understand how digital technologies are being used to support environmentally sustainable development. 2

Smart Technologies and Green Innovation: India's National Strategies for Net Zero 2070



Key Findings

The review shows that digital technologies play an important role in promoting sustainable development in India. Digital platforms improve resource efficiency, enable smart urban infrastructure, support the integration of renewable energy, and strengthen data-driven Governance. These initiatives help optimize energy use, improve monitoring systems, and support informed policy decisions. At the same time, the study highlights several challenges, including the increasing energy consumption of digital infrastructure, unequal access to digital technologies across regions and social groups, and growing concerns related to data security and privacy.

Contribution

By offering an India-focused analysis, this study adds to the growing discussion on the relationship between digitalization and sustainability in developing economies. It highlights the need for inclusive and well-coordinated policy frameworks to ensure that digital growth effectively contributes to long-term environmental sustainability and India's Net Zero ambitions.

Keywords:

Green development · Digital economy · the Digital India programme · the Smart Cities Mission initiative · National Green Hydrogen Mission · Net Zero 2070 · India

Introduction



Environmental sustainability has become one of the most pressing challenges facing economies across the world. Rapid industrialisation, urban expansion, and increased consumption of natural resources have led to climate change, environmental degradation, and growing ecological risks. For developing economies such as India, balancing economic growth with environmental protection is particularly complex. India is among the fastest-growing major economies, with a large population, expanding urban centres, and increasing energy demand. At the same time, the country has made strong international commitments toward climate action, most notably its pledge to achieve Net Zero carbon emissions by 2070.

Comparable to these environmental challenges, India is undergoing a profound digital transformation. Digital technologies such as artificial intelligence, big data analytics, the Internet of Things (IoT), cloud computing, and digital platforms are reshaping economic activity, governance, and social interactions. The emergence of the digital ecosystem has opened new possibilities for improving efficiency, reducing waste, and enabling sustainable development pathways. Digital tools can support real-time monitoring of resources, optimise energy consumption, enhance transparency in governance, and promote innovation in clean technologies.



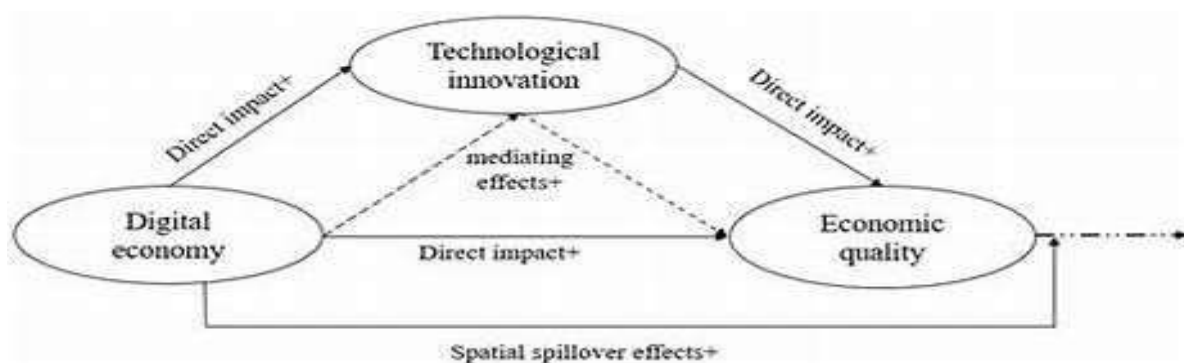
This paper explores the intersection of the digital ecosystem and sustainable development in India. It seeks to understand how digital transformation can act as a catalyst for environmentally sustainable development and how current national initiatives align with India's long-term climate goals. By focusing on key policy programmes—the Digital India programme, the Smart Cities Mission initiative, and the National Green Hydrogen Mission—the study provides an India-centric perspective on the opportunities and challenges of leveraging digitalisation for green growth.



Review of Literature

Digital Economy and Sustainable Development

The digital ecosystem broadly refers to economic activities enabled by digital technologies, including digital infrastructure, digital services, and data-driven processes. Existing literature suggests that digitalisation can contribute positively to sustainable development by improving productivity, reducing transaction costs, and enabling smarter resource management. Studies highlight that digital technologies help decouple economic growth from environmental degradation by promoting efficiency and innovation.



Digital platforms enable dematerialisation by reducing the need for physical resources, for example through e-governance, online services, and digital payments. Similarly, smart systems powered by data analytics and IoT can optimise energy use in industries, transport, and buildings. However, scholars also caution that digitalisation has an environmental footprint of its own, particularly in terms of energy-intensive data centres, electronic waste, and increased electricity demand.

Green Development in the Indian Context

Green development in India focuses on achieving economic growth while minimising environmental harm and ensuring social inclusion. Policy discourse in India increasingly emphasises renewable energy adoption, energy efficiency, sustainable urban development, and climate-resilient infrastructure. India's Nationally Determined Contributions (NDCs) under the

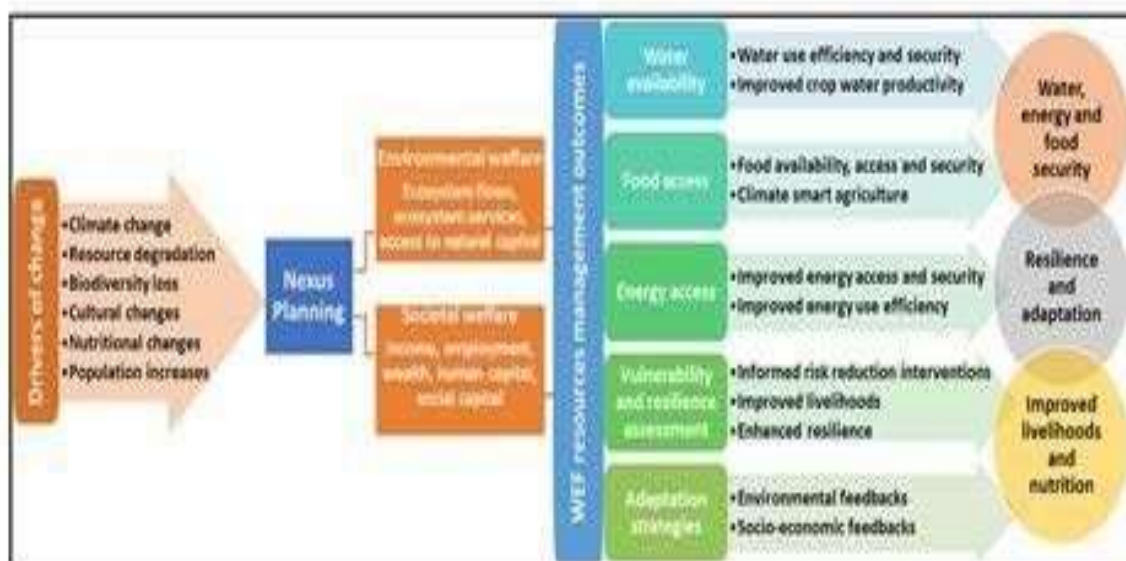
Paris Agreement reflect these priorities, alongside commitments to increase non-fossil fuel energy capacity and reduce emissions intensity.



The literature highlights that India's green transition faces structural challenges, including financing constraints, technological gaps, and regional disparities. Digitalisation is increasingly seen as a cross-cutting enabler that can address some of these barriers by improving coordination, monitoring, and access to information.

Digitalisation–Sustainability Nexus

Recent studies on the digitalisation–sustainability nexus suggest a complex and context-dependent relationship. While digital technologies can enhance environmental performance, their benefits are not automatic. Effective governance, supportive policies, and inclusive access are critical to ensure that digital growth translates into sustainable outcomes. In developing economies, digital divides and institutional capacity constraints can limit the environmental benefits of digital transformation.





Research Methodology

The present study is designed as a qualitative–conceptual empirical paper that develops a testable framework linking the digital ecosystem to sustainable development outcomes in India. Rather than relying solely on descriptive review, the paper identifies key variables, proposes causal relationships, and formulates hypotheses that can be empirically tested in future quantitative research.

Research Design

The study adopts a conceptual-empirical research design. It combines systematic literature review with theory-building to construct a conceptual framework suitable for econometric or survey-based validation. This approach is appropriate where large-scale primary data collection is constrained, yet policy-relevant variable relationships can be logically and theoretically established.

Data Sources

Secondary data were collected from:

- Peer-reviewed journals on digitalisation, environmental economics, and sustainable development
- Government policy documents, mission reports, and national climate action plans
- Reports from international organisations, think tanks, and research institutions

These sources informed the identification of constructs, variables, and hypothesised relationships.

Variable Identification and Operationalisation

Based on the literature, the study identifies four key constructs: Digital Economy Development, Green Development Outcomes, Governance Effectiveness, and Digital Inclusiveness.

Independent Variable (IV): Digital Economy Development

Measured through indicators such as digital infrastructure penetration, e-governance adoption, use of smart technologies, and deployment of data-driven systems.

Dependent Variable (DV): Green Development Outcomes

Captured through indicators including energy efficiency, renewable energy integration, emission reduction, resource optimisation, and environmental monitoring effectiveness.

Mediating Variable: Governance Effectiveness

Refers to the capacity of institutions to use digital tools for policy implementation, monitoring, transparency, and regulatory enforcement.

Moderating Variable: Digital Inclusiveness

Represents the extent of equitable access to digital technologies across regions, income groups, and social categories.



Conceptual Framework and Development of Hypotheses

Conceptual Framework

The proposed conceptual framework posits that Digital Economy Development has a direct positive impact on Green Development Outcomes. This relationship is strengthened through effective digital governance mechanisms and weakened when digital access is uneven. Governance Effectiveness is expected to mediate the relationship, while Digital Inclusiveness moderates the strength of the impact.

In the Indian context, national initiatives such as the Digital India programme, the Smart Cities Mission initiative, and the National Green Hydrogen Mission operationalise this framework by embedding digital tools within sustainability-focused policies.

Hypothesis Development

Drawing from theory and prior empirical findings, the following hypotheses are proposed:

H1: Digital economy development has a significant positive impact on green development outcomes in India.

H2: Digital economy development significantly improves governance effectiveness related to environmental management.

H3: Governance effectiveness mediates the relationship between digital ecosystem development and sustainable development outcomes.

H4: Digital inclusiveness positively moderates the relationship between digital ecosystem development and sustainable development outcomes, such that the relationship is stronger in regions with higher digital inclusion.

H5: Excessive energy consumption from digital infrastructure weakens the positive impact of the digital ecosystem on sustainable development outcomes.

Digital Economy Initiatives Supporting Green Development in India

Digital India





The the Digital India programme programme aims to transform India into a digitally empowered society and knowledge economy. While its primary objectives relate to connectivity, digital services, and governance, the programme has significant environmental implications. E-governance platforms reduce paper usage, improve administrative efficiency, and lower the carbon footprint associated with physical travel and bureaucratic processes.

Digital platforms for public service delivery enable better targeting of subsidies, improved monitoring of environmental schemes, and enhanced transparency. For example, digital monitoring systems can track energy consumption, pollution levels, and resource utilisation more effectively than traditional methods. These capabilities support evidence-based policymaking and environmental regulation.

Smart CitiesMission



The the Smart Cities Mission initiative integrates digital technologies into urban planning and management to improve quality of life and sustainability. Smart solutions such as intelligent transport systems, smart grids, and digital waste management systems help optimise resource use in cities. Data-driven traffic management reduces congestion and emissions, while smart lighting and energy management systems improve energy efficiency.

Urban centres are major contributors to carbon emissions, making smart city initiatives particularly relevant for India's climate goals. The use of sensors, real-time data, and analytics enables city authorities to monitor environmental indicators and respond proactively to challenges such as air pollution and water scarcity.





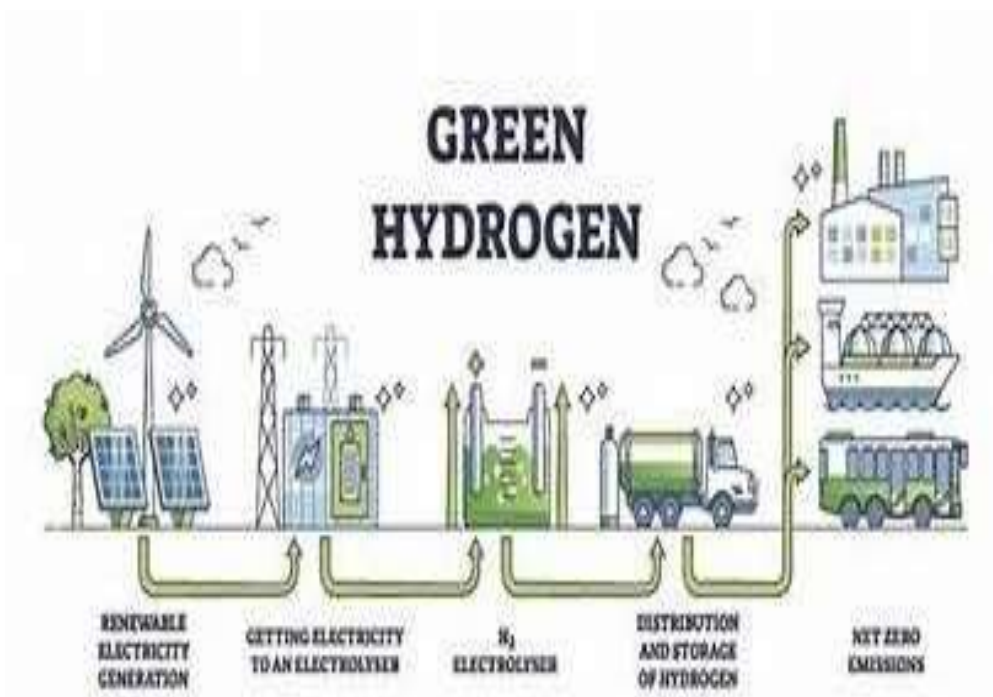
NationalGreenHydrogenMission



The National Green Hydrogen Mission represents India's ambition to transition toward clean energy and reduce dependence on fossil fuels. Digital technologies play a crucial role in supporting this mission by enabling smart energy management, predictive maintenance, and optimisation of hydrogen production and distribution systems.



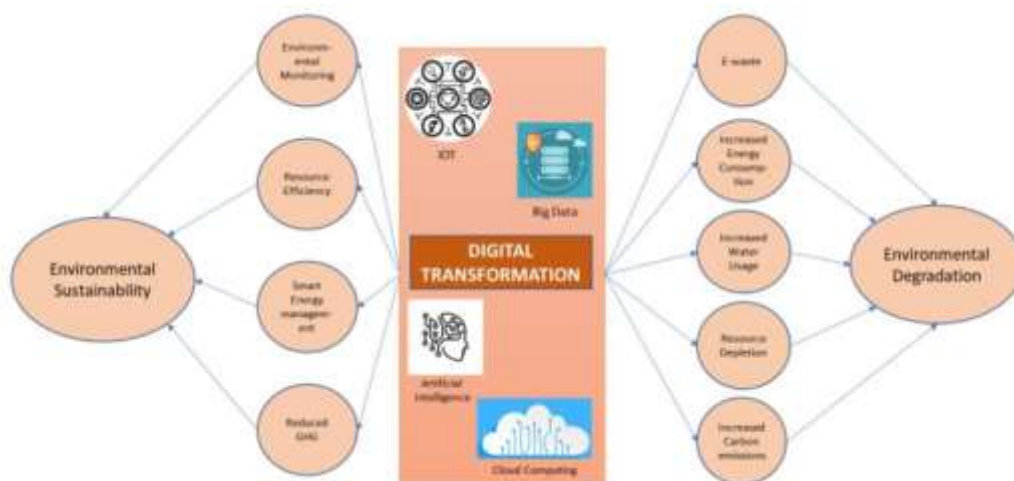
Advanced digital tools such as AI and big data analytics help improve the efficiency of renewable energy integration and hydrogen value chains. Digital platforms also facilitate coordination among stakeholders, enhance transparency, and support research and innovation in green hydrogen technologies.



Results and Discussion

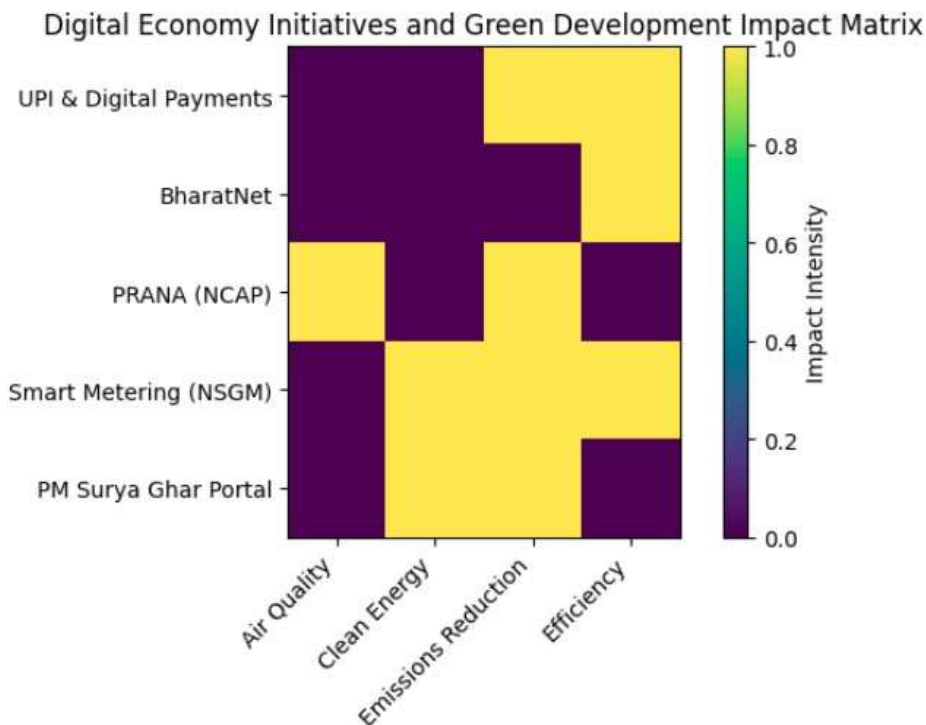
The analysis indicates that the digital ecosystem contributes to sustainable development in India through multiple pathways. First, digital technologies enhance resource efficiency by enabling real-time monitoring and optimisation of energy, water, and materials. Second, digitalisation supports the integration of renewable energy by improving grid management and forecasting capabilities. Third, data-driven governance strengthens environmental regulation and policy implementation.

However, the study also identifies several challenges. The rapid expansion of digital infrastructure increases electricity demand, which can undermine environmental benefits if powered by fossil fuels. Digital inequality remains a concern, as unequal access to technology can exacerbate social and regional disparities. Additionally, issues related to data security, privacy, and institutional capacity pose risks to sustainable digital transformation.





These findings highlight the need for a balanced approach that recognises both the opportunities and limitations of digitalisation. Digital technologies should be complemented by clean energy adoption, inclusive access strategies, and robust regulatory frameworks.



Policy Implications

To maximise the green benefits of the digital ecosystem, policymakers should focus on integrating digital and environmental strategies. Investments in renewable energy-powered digital infrastructure can reduce the carbon footprint of data centres and networks. Capacity-building initiatives are needed to bridge digital divides and ensure inclusive participation in the digital ecosystem.

Furthermore, coordinated governance across ministries and levels of government is essential to align digital initiatives with climate goals. Clear standards for data governance, cybersecurity, and privacy can enhance trust and enable wider adoption of digital solutions for sustainability.



Digital Economy Initiatives Supporting Green Development in India

Initiative	Digital Domain	Primary Objective	Environmental Relevance
UPI & Digital Payments	Digital Finance	Cashless transactions	Reduced paper use, lower physical mobility
BharatNet	Digital Infrastructure	Rural broadband connectivity	Enables smart governance & monitoring
PRANA (NCAP)	Digital Governance	Air quality monitoring	Pollution control & compliance
Smart Metering (NSGM)	Digital Energy	Energy efficiency	Reduced losses & emissions
PM Surya Ghar Digital Platform	Energy	Rooftop solar adoption	Clean energy transition

Conclusion

This paper examined the role of the digital ecosystem in supporting sustainable development in India, with a focus on key national initiatives and their alignment with the Net Zero 2070. The findings suggest that digital transformation has significant potential to accelerate India's transition toward environmentally sustainable development by improving efficiency, enabling clean energy integration, and strengthening governance. However, realising this potential requires addressing challenges related to energy consumption, inequality, and data governance.

Overall, the study contributes to the growing discourse on digitalisation and sustainability in developing economies. It underscores the importance of inclusive, coordinated, and forward-looking policy frameworks to ensure that digital growth effectively supports India's long-term environmental and climate ambitions.





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