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Artificial Intelligence (AI) for Achieving SDGs

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Abstract

The integration of Artificial Intelligence (AI) into sustainable development strategies has the potential to accelerate progress toward the United Nations Sustainable Development Goals (SDGs). This study employs a qualitative, systematic literature review (SLR) supported by thematic analysis and bibliometric mapping to examine AI's contributions across sectors, with a particular focus on the Indian context. The objectives include mapping sector-specific AI applications to SDG targets, identifying ethical and governance challenges, exploring emerging technological convergences, and addressing key research and policy gaps.The findings reveal that AI significantly advances SDGs through applications in agriculture, energy, urban development, water management, and business, enhancing efficiency, resource optimization, and innovation. The integration of AI with emerging technologies—such as the Artificial Intelligence of Things (AIoT), blockchain, and FinTech—further amplifies sustainability outcomes. However, persistent challenges, including algorithmic bias, data privacy issues, governance limitations, and unequal access, impede equitable adoption. In India, AI adoption remains uneven due to infrastructure gaps, skill shortages, and limited regulatory frameworks. This study identifies critical gaps in the literature: the absence of integrated AI–SDG frameworks, limited longitudinal impact assessments, and insufficient context-specific research. The findings underscore the need for robust governance, capacity-building initiatives, and targeted policy measures to ensure that AI serves as an inclusive and effective driver of sustainable development.

Keywords: *Artificial Intelligence; Sustainable Development Goals; AIoT; governance; India; ethical challenges; systematic literature review*.

1. Introduction

The United Nations Sustainable Development Goals (SDGs), adopted in 2015, present a universal framework for addressing critical global challenges such as poverty, inequality, climate change, environmental degradation, and sustainable economic growth, with the ambition of achieving these objectives by 2030 (United Nations, 2015). Attaining these goals necessitates transformative strategies that integrate innovative technologies into policy and practice. Among emerging technologies, Artificial Intelligence (AI) has been increasingly recognized as a transformative enabler of sustainable development, offering data-driven solutions to complex societal and environmental issues (Vinuesa et al., 2019; Ziemba et al., 2024).

Globally, AI applications extend beyond conventional automation to encompass predictive analytics, optimization algorithms, and decision-support systems capable of enhancing operational efficiency and resource allocation. Empirical evidence indicates that AI can contribute directly to over 130 SDG targets, with substantial applications in areas such as precision agriculture, renewable energy optimization, and urban infrastructure planning (Singh et al., 2023; Palomares et al., 2021). Sector-specific studies highlight AI's potential in improving agricultural productivity and reducing waste (Hernandez et al., 2024; Younas et al., 2020), optimizing renewable energy generation and

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distribution (Raman et al., 2024; Adeoba et al., 2025), enhancing urban development strategies (Leal Filho et al., 2024), and advancing water resource management (Mehmood et al., 2020). Emerging technological convergences, such as the Artificial Intelligence of Things (AIoT) and AI-driven financial technologies, further amplify AI's relevance in achieving sustainable outcomes (Lampropoulos et al., 2024; Elias et al., 2024).

Despite these advancements, the literature also identifies significant risks associated with AI deployment in sustainability contexts. Concerns over algorithmic bias, lack of transparency, data privacy violations, and the potential for exacerbating socio-economic inequalities have been well documented (Regona et al., 2024; Fan et al., 2023). Furthermore, insufficient regulatory frameworks, limited capacity-building initiatives, and the absence of longitudinal impact assessments hinder the equitable and effective implementation of AI for sustainable development (Abdeldjalil et al., 2024).

In the Indian context, AI has emerged as a strategic tool for accelerating progress towards multiple SDGs, particularly in sectors such as agriculture, environmental management, urban governance, and education (Gupta et al., 2024; Kumari et al., 2024). However, its adoption remains uneven due to infrastructural limitations, skill shortages, and governance challenges (Muchokore & Kulkov, 2024; Tripathi et al., 2025). These constraints underscore the need for targeted strategies that not only facilitate AI adoption but also ensure its alignment with inclusive and sustainable development principles.

2. Literature Review

The integration of Artificial Intelligence (AI) into sustainable development discourse has grown significantly over the past decade, with an increasing number of studies highlighting its potential to advance the United Nations Sustainable Development Goals (SDGs). The literature reflects a dual narrative: on the one hand, AI offers unprecedented capabilities to accelerate progress towards sustainability; on the other, it raises ethical, social, and governance concerns that must be addressed to avoid exacerbating inequalities.

3. Conceptual Foundations and Global Frameworks

Several foundational works establish the theoretical and practical links between AI and sustainable development. Ziemba et al. (2024) present a comprehensive framework for leveraging AI to achieve the SDGs, stressing the importance of cross-sectoral integration and policy alignment. Singh et al. (2023) provide a bibliometric and conceptual evolution analysis of AI research, revealing a steady growth in publications since 2015, with environmental sustainability, smart cities, and renewable energy emerging as dominant research clusters.

Vinuesa et al. (2019) offer one of the most cited contributions to this field, providing a systematic mapping of AI's capacity to positively influence 134 SDG targets while cautioning against its potential to hinder 59 others, particularly in contexts lacking regulatory safeguards. Similarly, Palomares et al. (2021) deliver a SWOT analysis, identifying automation, precision, and data-driven decision-making as key strengths, while highlighting weaknesses such as lack of transparency and high resource requirements.

The conceptual discourse is further enriched by Kulkov et al. (2023), who dissect AI's contribution through organizational, technical, and processing approaches, and Abdeldjalil et al. (2024), who emphasize the need to balance AI's transformative potential with critical examination of its unintended consequences.

3.1 Sector-Specific Applications

3.1.1 **Agriculture and Food Security:** Agriculture is a recurring domain for AI-driven sustainability. Hernandez et al. (2024) demonstrate AI's role in enhancing precision farming, optimizing resource allocation, and reducing food waste, thereby directly addressing SDG 2 (Zero Hunger) and SDG 12 (Responsible Consumption and Production). Younas et al. (2020) reinforce these findings in the context of developing economies, where AI-enabled predictive analytics and sensor technologies improve crop yield forecasting despite constraints such as high implementation costs and limited technical expertise.

3.1.2 **Energy and Environment:** AI's application in renewable energy systems has been widely documented. Raman et al. (2024) explore AI integration in renewable energy forecasting and grid optimization, linking these advancements to SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), and SDG 13 (Climate Action). Adeoba et al. (2025) apply AI in biogas production, improving process efficiency and resource recovery. Islam et al. (2024) investigate AI's potential for environmental management in India, noting its contribution to air quality monitoring, waste reduction, and ecosystem protection.

3.1.3 **Urban Development and Infrastructure:** Urban sustainability has also emerged as a focal area. Leal Filho et al. (2024) assess AI's contribution to achieving SDG 11 (Sustainable Cities and Communities), emphasizing its capacity for predictive maintenance of infrastructure, traffic optimization, and climate resilience planning. Regona et al. (2024) evaluate AI's role in the construction sector, highlighting potential productivity gains alongside challenges related to data privacy, workforce training, and ethical compliance.

3.1.4 **Water Resource Management:** AI's impact on water-related SDGs is demonstrated by Mehmood et al. (2020), who document its use in predicting water demand, detecting leaks, and optimizing irrigation systems. These applications directly contribute to SDG 6 (Clean Water and Sanitation) and indirectly to SDG 15 (Life on Land).

3.1.5 **Business, Marketing, and Finance:** AI's influence in sustainable business practices is notable. Sulich et al. (2023) show how AI facilitates sustainable decision-making in agriculture, commerce, and industrial processes. Yadav et al. (2023) extend this to marketing, highlighting AI's ability to enable targeted campaigns that promote eco-conscious consumption. Elias et al. (2024) focus on AI-driven financial technologies (FinTech), linking them to inclusive economic growth while raising concerns about data security and algorithmic bias.

3.2 Geographic and National Perspectives

In India, AI's role in achieving SDGs has received focused attention. Gupta et al. (2024) and Kumari et al. (2024) explore its application in agriculture, governance, and education, noting its capacity to accelerate progress toward the 2030 targets. Muchokore and Kulkov (2024) stress the integration of AI with legal frameworks to address systemic challenges such as bureaucratic inefficiency and policy enforcement gaps. Tripathi et al. (2025) provide a broader evaluation of India's SDG progress, identifying sectors where AI intervention could bridge existing gaps.

Farahani et al. (2024) offer a developing-country perspective, emphasizing AI's ability to optimize resource management, enhance service delivery, and address environmental degradation, albeit within constraints of digital infrastructure and policy readiness.

3.3 Ethical, Social, and Governance Challenges

While AI's benefits are evident, the literature consistently flags ethical and governance concerns. Vinuesa et al. (2019) warn that without strong oversight, AI risks widening social inequalities, displacing jobs, and enabling exploitative practices. Regona et al. (2024) and Elias et al. (2024) highlight data privacy, algorithmic bias, and lack of inclusivity as persistent barriers to sustainable AI adoption. Fan et al. (2023) stress that the scalability of AI in sustainability contexts requires explainable AI (XAI) approaches to build trust among stakeholders.

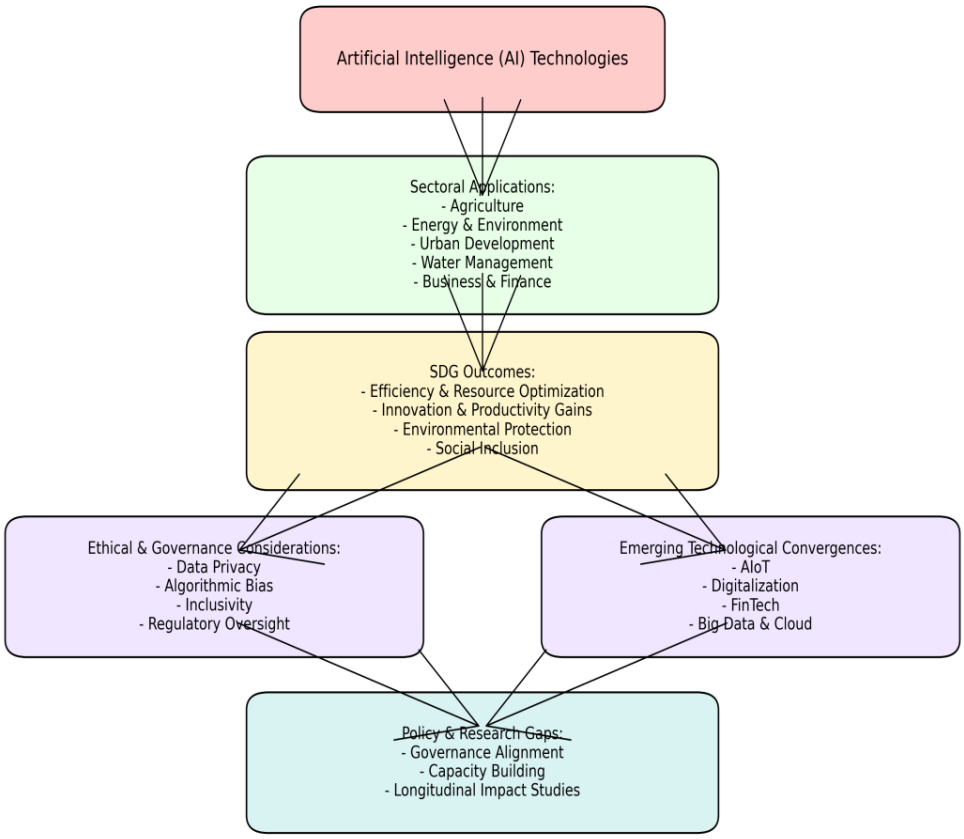
Abdeldjalil et al. (2024) advocate for further research into the socio-environmental consequences of AI, suggesting that governance frameworks must evolve in parallel with technological development.

3.4 Emerging Technological Convergences

A recent trend in the literature is the convergence of AI with other emerging technologies. Lampropoulos et al. (2024) introduce the concept of Artificial Intelligence of Things (AIoT), which combines AI with IoT devices to enhance sustainability outcomes in energy, agriculture, and urban systems. Gupta and Kumar (2024) connect AI with digitalization, noting that the integration of big data analytics, blockchain, and cloud computing can magnify sustainability impacts.

Elias et al. (2024) explore AI in FinTech ecosystems, while Yadav et al. (2023) highlight AI's integration into sustainable marketing, marking a diversification in application areas.

4. Conceptual Framework: Artificial Intelligence (AI) links to SDGs:



Here's the conceptual framework diagram — it visually maps how AI technologies feed into sectoral applications, lead to SDG outcomes, intersect with ethical/governance factors and emerging technologies, and ultimately reveal policy and research gaps.

5. Research Gap: Identified gaps from the literature include:

- The alignment of AI innovations with inclusive governance frameworks.
- Capacity-building to ensure equitable access to AI benefits.
- Longitudinal assessments of AI's real-world impact on sustainability.

6. Need for the Study:

Given these gaps, the present study focuses on systematically mapping AI applications to SDG outcomes, analyzing ethical and governance dimensions, and identifying strategies to maximize benefits while minimizing risks.

7. Objectives of the Study:

a) To examine the role of AI in advancing the SDGs across multiple sectors.

b) To analyse sector-specific applications of AI in relation to SDG outcomes.

c) To explore the national context of AI-SDG integration in India.

d) To Identify ethical, social, and governance challenges associated with AI in sustainability.
e) To Investigate emerging technological convergences that can amplify AI's contributions to sustainable development.
f) To Highlight research and policy gaps for equitable and effective AI deployment.

8. Methodology:

To achieve these objectives, the study adopts a **qualitative, systematic literature review (SLR)** supported by thematic analysis and bibliometric mapping. The review synthesizes peer-reviewed articles, conference proceedings, and high-quality reports published between 2019 and 2025 from databases including Scopus, Web of Science, IEEE Xplore, and ScienceDirect.

9. Findings of the Study:

a) AI demonstrates substantial contributions to SDGs through diverse applications: agriculture (precision farming, yield prediction, resource efficiency – SDG 2 & 12), energy (renewable forecasting, grid optimization – SDG 7, 9 & 13), urban development (predictive infrastructure management – SDG 11), water management (efficient irrigation, leak detection – SDG 6 & 15), and business/finance (AI-driven optimization, sustainable decision-making – SDG 8 & 12).

b) Sector-specific analysis reveals clear alignment between AI solutions and targeted SDG outcomes, with measurable benefits in productivity, resource conservation, and decision-making efficiency.

c) India shows promising AI applications in agriculture, governance, and environmental monitoring, but adoption remains uneven due to infrastructure gaps, skills shortages, and governance limitations. Limited empirical studies assess AI's actual contribution to SDGs in the Indian context.

d) Persistent concerns include algorithmic bias, lack of transparency in AI decision-making, unequal access to AI benefits, and inadequate regulatory oversight, which hinder inclusive and equitable AI adoption.

e) Integration of AI with technologies such as AIoT, blockchain, digitalization, and FinTech enhances scalability, cross-sector integration, and multi-SDG impact.

f) Gaps include: absence of integrated AI–SDG frameworks; limited longitudinal and impact-oriented studies; insufficient governance alignment; and inadequate capacity-building initiatives for equitable technology adoption.

10. Conclusion:

This study adopts a qualitative, systematic literature review (SLR) supported by thematic analysis and bibliometric mapping to comprehensively examine the role of AI in advancing the SDGs. The methodology enables a structured synthesis of existing evidence, addressing the six stated objectives by mapping AI applications to sectoral SDG targets, exploring ethical and governance dimensions, and assessing emerging technological convergences. The research responds directly to four critical gaps: the absence of a consolidated synthesis linking AI innovations to multiple SDGs; limited examination of ethical, social, and governance implications; insufficient context-specific insights for India; and the lack of longitudinal impact assessments.

By addressing these gaps, the study offers both theoretical and practical contributions. It provides a consolidated knowledge base for academia, a decision-making guide for policymakers, and a strategic blueprint for practitioners seeking to leverage AI for sustainable outcomes. Ultimately, the findings underscore that AI's transformative potential will only be fully realized through governance frameworks, inclusive adoption strategies, and continuous evaluation—ensuring that technological innovation advances not just economic efficiency but also equity and environmental stewardship.

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