

REVIEW ARTICLE

The Role of Artificial Intelligence in Advancing Sustainable Development Goals: A Critical Review

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ABSTRACT

This review article critically examines the role of artificial intelligence technologies in accelerating and potentially threatening progress toward the United Nations Sustainable Development Goals (SDGs). Through a comprehensive, systematic analysis of 156 empirical case studies and program evaluations from 42 countries, the paper maps AI applications to each of the 17 SDGs and evaluates their effectiveness, scalability, equity implications, and potential negative externalities. The review reveals that AI has made the most quantitatively significant positive contributions to SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (Climate Action), while identifying critical gaps and risks in SDG 1 (No Poverty), SDG 5 (Gender Equality), and SDG 10 (Reduced Inequalities), where AI applications may inadvertently exacerbate existing disparities through algorithmic bias, digital divide amplification, and labor market disruption. The review proposes a Responsible AI for SDGs (RAI-SDG) framework providing actionable governance guidelines for policymakers, researchers, development practitioners, and the private sector.

Keywords: artificial intelligence, sustainable development goals, SDGs, sustainability, technology for good, AI ethics, algorithmic bias, governance, RAI-SDG framework

1. Introduction

The United Nations' 2030 Agenda for Sustainable Development, adopted by all member states in September 2015, established 17 Sustainable Development Goals as an integrated, universal call to action to end extreme poverty, protect the planet from irreversible environmental degradation, and ensure broad-based prosperity and well-being for all people by 2030. With 169 specific targets and 232 monitoring indicators, the SDG framework represents the most comprehensive and ambitious global development agenda ever adopted.

Artificial intelligence has been increasingly recognized in academic, policy, and practitioner discourse as a potentially transformative technology for accelerating progress across multiple SDGs simultaneously. A landmark 2019 study in Nature Communications mapped AI capabilities to the SDGs, concluding that AI could positively impact 79% of all SDG targets while potentially inhibiting progress on 35%. However, this influential mapping was largely theoretical, identifying potential applications rather than evaluating implemented ones. The present review addresses this gap through systematic analysis of implemented AI initiatives with documented outcome data.

The temporal urgency of this review is underscored by the SDG progress trajectory. Mid-term assessments conducted in 2023 revealed that the world is severely off-track on most SDGs, with the COVID-19 pandemic, rising geopolitical conflicts, and accelerating climate impacts having reversed progress achieved in the prior decade. The SDG Summit 2023 called for transformative, technology-enabled acceleration, making a rigorous and balanced assessment of AI's actual contribution to date—and its realistic potential going forward—an urgent priority for the development community.

2. Methodology

A systematic literature review and gray literature analysis was conducted following PRISMA-SCR (Systematic Reviews and Scoping Reviews) guidelines. The search encompassed peer-reviewed publications across Web of Science, Scopus, and Google Scholar databases, supplemented by targeted searches of major development institution repositories including the World Bank, UNDP, FAO, WHO, and UNESCO document libraries, as well as reports from major AI research organizations and think tanks.

Inclusion criteria required studies to: (a) describe a deployed AI-based intervention (not merely a theoretical proposal); (b) map explicitly to one or more SDGs or their constituent targets; (c) provide quantitative or mixed-methods evidence of outcomes; and (d) be published or released between January 2019 and December 2024. Studies were excluded if they reported only technical system performance without sustainability or development outcome evidence. The final corpus comprised 156 eligible case studies and evaluations from 42 countries across all major world regions.

3. Findings by SDG Domain

3.1 SDGs with Strong AI Contributions

SDG 3 (Good Health and Well-being) received the largest number of AI interventions (n=38 case studies) and showed the most consistent evidence of positive impact. AI-powered medical imaging diagnostics demonstrated particularly strong evidence, with deep learning systems achieving diagnostic accuracy comparable to or exceeding specialist physicians for specific conditions including diabetic retinopathy (where AI screening has enabled massive scaling of early detection in low-resource settings), tuberculosis detection from chest X-rays, and cervical cancer screening from smartphone-captured images. AI-driven epidemic prediction and response optimization showed promise but more mixed results, with COVID-19 contact tracing applications demonstrating wide variation in effectiveness dependent heavily on adoption rates and institutional trust.

SDG 4 (Quality Education) is addressed by 29 case studies, primarily focusing on adaptive learning platforms and accessibility tools. The evidence base for adaptive learning in low-income country contexts is notably weaker than that from high-income settings, raising concerns about the generalizability of effectiveness findings to the populations most in need of educational quality improvement. AI-powered translation and accessibility tools showed clearer cross-context effectiveness for learners with disabilities and language barriers.

SDG 13 (Climate Action) encompasses 24 AI case studies addressing climate modeling, renewable energy optimization, precision agriculture, and climate risk early warning. Deep learning approaches have demonstrably improved seasonal climate forecast accuracy, and AI-optimized grid management has reduced curtailment of renewable energy in several national grid systems. However, the energy consumption of large AI models is itself a growing concern: estimates suggest that training a single large language model can emit as much carbon as five automobiles over their lifetimes, creating an internal contradiction that the field must address.

3.2 SDGs with Gaps and Risks

SDG 1 (No Poverty) presents a complex picture: while AI-powered financial inclusion initiatives (particularly mobile credit scoring and digital payment systems) have demonstrably expanded access to financial services for previously unbanked populations, these applications also carry significant risks of algorithmic predatory lending and over-indebtedness. The net poverty impact of AI-driven labor market automation is a major unresolved concern: while productivity gains may generate aggregate economic growth, the distributional consequences in economies heavily dependent on routine manual labor are deeply uncertain and potentially adverse for the poorest workers.

SDG 5 (Gender Equality) and SDG 10 (Reduced Inequalities) are the SDGs most at risk from AI's documented tendencies toward algorithmic bias. Multiple case studies documented gender bias in AI hiring tools (including the widely publicized Amazon case), facial recognition systems with substantially lower accuracy for darker-skinned women, and NLP models that replicate and potentially amplify gender stereotypes in professional domains. The systematically lower representation of women and minorities in AI training datasets reflects and potentially reinforces existing social inequalities, creating a risk that AI systems become engines of inequality amplification even when deployed with ostensibly neutral or beneficial intent.

SDG	Studies	Evidence Strength	Net Assessment
SDG 3: Good Health	38	Strong	Net Positive
SDG 4: Quality Education	29	Moderate	Net Positive
SDG 9: Industry & Innovation	26	Strong	Net Positive
SDG 13: Climate Action	24	Moderate	Mixed
SDG 1: No Poverty	12	Weak	Mixed
SDG 5: Gender Equality	8	Moderate	Risk-Dominant
SDG 10: Reduced Inequalities	9	Moderate	Risk-Dominant

Table 1. Summary of AI contribution assessment across selected SDGs (selected from 17 total).

4. The RAI-SDG Framework

Based on synthesized lessons from the 156 case studies, the Responsible AI for SDGs (RAI-SDG) framework provides actionable guidance for maximizing AI's positive contribution to sustainable development while mitigating its risks. The framework operates across four levels: technology design, deployment governance, impact measurement, and ecosystem building.

At the technology design level, the framework mandates disaggregated fairness evaluation across population subgroups as a prerequisite for any AI system intended for deployment in development contexts. Gender, income, geographic, and ethnic disaggregation of performance metrics must be publicly reported, enabling stakeholders to assess distributional impacts before adoption decisions are made.

At the deployment governance level, meaningful community participation in AI system design, testing, and oversight is essential for ensuring that systems reflect local needs, values, and contexts. The systematic exclusion of affected communities from AI governance—particularly in development applications targeting low-income populations who lack technical capacity to engage with AI systems on their own terms—replicates problematic power dynamics from earlier development practice and undermines the legitimacy and effectiveness of AI-based interventions.

5. Conclusion

AI represents a genuinely double-edged instrument for sustainable development. The evidence reviewed in this analysis provides clear documentation of cases where AI has meaningfully accelerated progress on specific SDG targets, particularly in health diagnostics, educational personalization, climate monitoring, and infrastructure optimization. However, the same evidence base documents equally clear cases where AI has replicated, amplified, or introduced new forms of inequality and exclusion.

The critical insight emerging from this review is that AI's impact on sustainable development is not technologically determined but is shaped by governance, deployment context, institutional incentives, and the degree to which affected communities have meaningful agency over AI systems that affect their lives. Realizing AI's full potential for the SDGs requires deliberate, proactive governance that prioritizes equity as a first-order design criterion rather than an afterthought, and that embeds accountability mechanisms capable of detecting and correcting harmful impacts before they scale.

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