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AI for Social Good: Using Artificial Intelligence to Advance the Sustainable Development Goals (SDGs)

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ABSTRACT
Artificial intelligence (AI) offers powerful methods to accelerate progress toward the United Nations' Sustainable Development Goals by improving measurement, prediction, and resource allocation. However, AI systems can also reproduce social biases, erode privacy, concentrate power, and increase environmental burdens-outcomes that can directly undermine SDG aims. This review synthesizes the literature on how ethical design, governance, and technical practice can align AI with SDG delivery. We summarize evidence of AI's enabling roles, detail the major ethical risks, review governance instruments and technical mitigations, present illustrative case studies, and close with actionable recommendations and a research agenda. Throughout, we emphasize that ethical AI for sustainable development requires combining technical safeguards - fairness, privacy, low-carbon design - with participatory governance, capacity building, and impact-aware evaluation.

I. INTRODUCTION

The 2030 Agenda for Sustainable Development enumerates 17 interconnected SDGs that are together intended to eradicate poverty, promote health and education, protect the environment, and ensure strong inclusive institutions [1, 2, 3]. Artificial intelligence, defined here as systems capable of perception, learning from data, and action at scale, has emerged as a potentially transformative tool for achieving these goals. Through the analysis of large, heterogeneous datasets, the prediction of emergent risks, and optimizing the allocation of scarce resources, AI offers unparalleled opportunities to accelerate progress across diverse sectors, from the fields of public health and education to energy, agriculture, and disaster management. AI is not, however, value neutral. Design choices, training datasets, deployment contexts, and governance structures embody social values and trade-offs, shaping whether AI accelerates or undermines progress toward sustainable development objectives. Evidence from theoretical analyses and empirical studies suggests that while AI can make possible many SDG targets, such as improvements in health care delivery, increased access to education, better resource efficiency, and early warning systems for climate-related and health crises, it can also sharpen inequalities, deepen biases, and generate environmental costs if ethical considerations are not taken into consideration. In light of these dual potentials, there has been a proliferation of ethics frameworks from international and regional bodies, such as UNESCO, the OECD, and the European Commission, articulating high-order principles, such as fairness, transparency, accountability, human rights protection, and well-being. Parallel initiatives by academia, such as AI4People, and practical tools, like algorithmic impact assessments, translate high-level principles into operational guidance, allowing for project-level

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review, risk mitigation, and monitoring. Yet even so, adoption and enforcement remain patchy, particularly in low- and middle-income contexts where technical capacity and governance structures are more limited. Against this background, this review addresses the question at its core: How might the ethical use of AI be operationalized to advance the SDGs with no increase in harm or exacerbation of existing inequalities? Drawing on cross-disciplinary evidence from technical, social, and policy domains, we propose a practical, ethics-first roadmap for researchers, implementers, and policymakers, laying out strategies to align AI development and deployment with sustainable development priorities, while protecting equity, accountability, and environmental sustainability [4, 5, 6, 7].

II. MATERIAL AND METHOD

This review first sets the scene in terms of scoping the topic and laying foundational context before investigating key areas of interest: theoretical frameworks on how AI can support the achievement of the SDGs; evidence of AI functions; ethical risks that may undermine SDG objectives; governance and normative frameworks; technical approaches for implementing ethical AI in SDG contexts; lessons learned from practical applications; and cross-cutting challenges and trade-offs. It goes on to present recommendations in the form of an ethics-first roadmap, outlines a research agenda with open questions, and concludes with an overview of the barriers to progress and enabling conditions for successful deployment. The critical analysis of each of the topics was used to develop an overall understanding of these intertwined themes. A systematic review of the literature across major academic databases using targeted keywords to capture relevant concepts was conducted. Sources included key international agency reports and peer-reviewed studies; materials were thematically organized and reviewed in depth. The search covered leading databases such as Scopus, JSTOR, Web of Science, and Google Scholar through the use of pre-defined keywords to ensure comprehensive coverage of the field.

III. HOW AI CAN ENABLE SDG DELIVERY: FUNCTIONS AND EVIDENCE

AI can support SDGs in four ways: improving measurement, prediction, optimization, and decision-making across various sectors. First, measurement and monitoring leverage machine learning applied to remote sensing, satellite imagery, and large administrative datasets that track environmental changes, crop yields, infrastructure conditions, and population movements with unprecedented granularity and timeliness, significantly improving indicators for SDG 2, SDG 11, SDG 13, and SDG 15. Second, prediction and early warning systems leverage models trained on epidemiological, climatic, and socio-economic data to forecast disease outbreaks, floods, droughts, and food-security shocks, enabling pre-emptive interventions and resource allocation in support of SDG 3, SDG 11, and SDG 13. Third, optimization and resource allocation use reinforcement learning and combinatorial optimization to enhance energy grid management, transportation efficiency, and social protection distribution that directly advance SDG 7, SDG 11, and SDG 1. Fourth, decision support and personalized services apply AI-driven diagnostic tools, adaptive learning platforms, and agricultural advisory systems to extend reach and personalization of health, education, and extension services in support of SDG 3, SDG 4, and SDG 2. While a comprehensive synthesis shows that AI has the potential to accelerate progress across dozens of SDG targets, it also brings out risks when equity, governance, and environmental impacts are overlooked and emphasizes the need for an “ethics-first” approach that makes social and sustainability considerations foremost while deploying AI in development contexts. Collectively, these capabilities illustrate AI's transformative potential to address global challenges while underscoring the importance of careful design, oversight, and alignment with ethical and sustainable development principles [4, 8, 9].

IV. ETHICAL RISKS THAT CAN UNDERMINE SDG OBJECTIVES

AI has enormous potential to advance the SDGs, yet its benefits are inextricably linked with ethical risks that—when left unaddressed—may potentially undo global development efforts. Biased algorithms can reproduce or widen historical inequities while deepening disparities in health, welfare, and economic opportunity; data-intensive systems pose serious threats to privacy and civil liberties, often first causing harm to vulnerable communities; and the concentration of AI expertise and infrastructure in a few countries risks furthering both digital and economic divides. Simultaneously, the environmental cost of large model training will challenge commitment to climate and sustainability concerns, while the

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opaqueness of systems diminishes institutional accountability and public trust. Considerably extending these concerns, this next period of AI-for-SDG work demands not only technical safeguards-fairness testing, privacy-preserving architecture, and transparent documentation-but it also requires inclusive governance and international capacity building in concert with binding regulatory frameworks that guarantee equitable benefits from AI. A responsible pathway forward should involve embedding human rights principles across the AI lifecycle, investing in green resource-efficient AI, and building global coordination mechanisms so that technological progress reinforces, rather than undermines, sustainable development [10, 11].

V. GOVERNANCE AND NORMATIVE FRAMEWORKS

International and regional bodies have developed ethics frameworks that guide AI in ways to be aligned with the SDGs through a human rights, fairness, transparency, environmental sustainability, and inclusivity lens. UNESCO's Recommendation on the Ethics of Artificial Intelligence 2021 links ethical AI with development goals, highlights protection of vulnerable populations, and calls for global cooperation, while the 2019 AI Principles of the OECD promote trustworthy AI respecting human rights and fairness and widely inform national strategies. The Ethics Guidelines for Trustworthy AI developed by the European Commission outline seven requirements-human agency, technical robustness, privacy, transparency, fairness, societal well-being, and accountability-which have shaped regulatory discussions and implementation checklists. Academic frameworks, such as AI4People, and practical tools, such as algorithmic impact assessments (AIAs), are translating high-level principles into project-level evaluation, risk review, and mitigation strategies, and governments are increasingly piloting or mandating AIAs in public sector deployments. Yet, the reception and implementation continue to be very uneven, underlining the need to translate principles into actionable, context-sensitive policies, supported by capacity building, mechanisms of accountability, and resourcing for low- and middle-income countries. In practice, AI can advance the SDGs through prediction and early warning systems that identify disease outbreaks, climate risks, and food-security shocks, enabling proactive interventions (SDGs 3, 11, and 13); optimization and resource allocation techniques that enhance energy grids, transportation, and social protection efficiency (SDGs 1, 7, and 11); and decision support and personalized services that extend healthcare, education, and agricultural advisory services (SDGs 2, 3, and 4). While AI has the potential to enable progress across many SDG targets, it also poses risks to equity, governance, and environmental sustainability, underlining the importance of an "ethics-first" approach that treats social and environmental impacts as primary criteria in the development and deployment of AI systems [12, 13].

VI. TECHNICAL APPROACHES TO ETHICAL AI FOR SDGS

Technical strategies can significantly mitigate the risk that AI systems undermine SDGs at every step of the AI lifecycle by embedding fairness, privacy, transparency, efficiency, good data governance, and human oversight. Fairness-aware machine learning integrates algorithmic techniques with participatory design to ensure contextually appropriate definitions of equity. Privacy-preserving methods such as differential privacy and federated learning help protect sensitive data in high-risk sectors like health and social protection. Explainability tools and documentation practices enable meaningful oversight, appeals, and trust, while low-energy model design reduces the environmental footprint of AI deployments. Strong data governance-including the tracking of provenance and community involvement-improves representativeness and mitigates extractive data practices. Finally, continuous monitoring, evaluation, and human-in-the-loop mechanisms ensure that AI systems stay aligned with human rights and distributional equity over time.To make these strategies effective in real development contexts, they would have to be combined with institutional capacity building, localized standards, and sustainable funding models. For adapting these methods in their actual regulatory and infrastructural realities, low- and middle-income countries may need tailored toolkits, open-source resources, and regional cooperation. Embedding these practices within public procurement, government digital strategies, and multilateral development programs can enable AI not only to do no harm but to catalyze action toward the SDGs themselves through supporting inclusive service delivery, strengthening accountability, and fostering community-led innovation [14, 15].

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VII. CASE STUDIES: LEARNING FROM PRACTICE

This section presents illustrative cases that highlight both the promise and risks of AI for the advancement of the SDGs, and, where possible, lessons on responsible deployment. In health diagnostics, CNN-based dermatology classifiers achieved dermatologist-level accuracy on curated datasets, promising the ability of AI to expand diagnostic capacity in underserved regions. However, performance often degraded when applied to diverse populations or lower-quality images, highlighting the need for representative training data, external validation, clinician oversight, and transparency in reporting intended use. Satellite imagery and computer vision enable frequent monitoring of crop conditions and yield estimation in precision agriculture, targeting intervention and providing early support for farmers. But these gains raise critical ethical considerations regarding the ownership of data, the affordability of services, and ensuring farmers maintain control over both their data and insights gleaned from that data. AI applied to satellite and aerial imagery has allowed near-real-time tracking of deforestation, land-use changes, and marine conditions, informing conservation efforts and evidence-based policy decisions. Open pipelines and accessible tools foster transparency and civic engagement, but closed commercial approaches risk the re-concentration of informational power in a few actors. In contrast, automated social-welfare targeting illustrates the dangers of proxy-based decision-making. Although administrative efficiency improved, reliance on imperfect proxies like mobile usage or remote sensing disproportionately harmed vulnerable populations. The demands for ethical imperatives are therefore one of transparency, appeals processes, and conservative deployment in high-stakes contexts. Taken together, these cases illustrate that the impact of AI on the SDGs is not determined by technological capability alone but depends critically on context-aware design, inclusivity, ethical safeguards, accountability mechanisms, and participatory approaches engaging stakeholders at all stages. If scaling AI for sustainable development is to be achieved, there will be a need for robust frameworks for cross-sector collaboration, continuous validation across diverse environments, adaptive governance, and capacity-building among local communities so that innovation translates into equitable, durable, and socially beneficial outcomes [16, 17].

VIII. CROSS-CUTTING CHALLENGES AND TRADE-OFFS

Applications of AI toward the SDGs face a complex array of entangled issues that go beyond technical performance. Many leading models are optimized for broad benchmarks, but their effectiveness for SDG impact will require nuanced local contextualization of cultural norms, institutional constraints, and ecological realities; over-emphasis on generalizability risks misaligned solutions, rendering codesign and iterative field evaluation necessary. Standard machine learning metrics such as accuracy or F1 do not capture critical dimensions like distributional fairness, human rights impacts, or environmental costs. For this, SDG-aligned indicators—such as disaggregated outcomes, carbon intensity, or human rights risk scores—are required, to prevent perverse incentives by which performance appears to improve superficially while causing harm to already marginalized groups. Governance and regulatory frameworks are fragmented, with often non-binding international guidelines lacking in harmonization and enforcement, leaving low-resource contexts vulnerable to both exploitative AI deployment and exclusion from beneficial technologies. Of parallel importance are data rights, sovereignty, and benefit-sharing: AI systems often depend on data originating from communities in a position of limited bargaining power; explicit consent, local ownership, and equitable return—monetary or in terms of capacity building—form part of an ethical imperative consonant with the SDG principle of leaving no one behind. These challenges call for integrated strategies across international norms, national legislation, sectoral standards, and community-level governance, together with sustained interdisciplinary collaboration in ensuring AI contributes to inclusive, equitable, and context-sensitive sustainable development [4, 8].

IX. RECOMMENDATIONS

For realigning AI with the SDGs, ethics, accountability, and sustainability need to be baked into every stage of the AI lifecycle. Specifically, this involves embedding participatory problem framing, fairness-aware modeling, the protection of privacy, explainability, and continuous impact monitoring-whenever possible-alongside algorithmic impact assessments for high-risk applications. Evaluation should be underpinned by metrics aligned with the SDGs that cover distributional outcomes, human rights, and environmental footprints, with transparency a

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condition of public funding. Technical and governance capacity in low-and middle-income countries needs to be strengthened; equitable co-design partnerships forged; and neo-colonial technology transfer avoided. High-stakes AI deployments should be subject to enforceable sector-specific regulation, independent audits, and appeal mechanisms, while energy-efficient, contextually appropriate AI architectures are prioritized to minimize environmental and infrastructural burdens. Open science should be advanced through model cards, datasheets, shared datasets, and community-managed data to underpin reproducibility, civil-society oversight, and local capacity building. Participatory governance and benefit-sharing mechanisms will ultimately ensure that communities that generate data-which are used to make or improve AI systems-are actively involved in relevant decision-making and benefit visibly from the operation of such systems. This reinforces ethical, inclusive, and sustainable AI for global development.

X. CONCLUSION

AI technologies can provide valuable accelerants to the SDGs through improved measurement, prediction, optimization, and personalized services. Nevertheless, these advantages are not guaranteed: without ethical integration in the forms of fairness, privacy, environmental stewardship, and participatory governance, AI may entrench inequalities, erode rights, and create environmental harms that undercut sustainable development. International normative instruments offer convergent principles to guide ethical development and deployment-such as UNESCO, OECD, and the EU-yet these must be operationalized through enforceable standards, capacity building, and contextually grounded technical practice. An ethics-first approach that incorporates technical safeguards, inclusive codesign, impact-aware evaluation, and multi-level governance will ensure that AI actually supports equitable and sustainable development. Farzpourmachiani and Farzpourmachiani [18] offer a critical view of entrepreneurship, emphasizing that not every entrepreneurial endeavor necessarily benefits societal wealth or promotes sustainable development. The authors suggest that, if applied correctly, artificial intelligence has the potential to integrate sustainability and wealth in human life.

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