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Mapping the Research Landscape of Artificial Intelligence and the Sustainable Development Goals (SDGs): A Bibliometric and Scientometric Analysis (2003–2025)

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Abstract:

This research offers a thorough bibliometric assessment of worldwide studies that intersect Artificial Intelligence (AI) with the Sustainable Development Goals (SDGs) between 2023 and 2025, utilizing data from 1,349 documents indexed in Scopus. The results indicate that this rapidly evolving yet varied field is marked by significant thematic diversity, moderate growth, and early citation impact. India stands out as the leader in research output, while nations such as Malaysia and Saudi Arabia demonstrate strong rates of international collaboration. Conceptual mapping highlights two primary clusters: one cantered on practical sustainability applications and another on core AI methodologies and education. Despite the increasing momentum, challenges persist concerning metadata consistency, ethical incorporation, and the conversion of knowledge into practical initiatives. This study serves as an essential reference for enhancing the AI-SDG research field, aiming for improved coherence, inclusivity, and global policy development.

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1. Introduction: The intersection of Artificial Intelligence (AI) and the Sustainable Development Goals (SDGs) signifies a significant change in the global research focus, offering groundbreaking solutions to some of the most urgent issues facing the world. As AI technologies develop, they present unparalleled opportunities to hasten progress toward fulfilling the 17 SDGs established by the United Nations, covering domains such as poverty reduction, quality education, climate action, and sustainable urban development. Nevertheless, the incorporation of AI into the SDG framework is a complex and interdisciplinary task that necessitates a comprehensive understanding of how technological advancements correspond with policy, ethics, and social consequences [1-3]. Recently, the academic community has shown increasing interest in exploring the intersection of AI and sustainable development. This emerging research domain spans a wide array of disciplines, ranging from computer science and environmental studies to economics and public policy. Yet, despite the growing body of literature, there is a lack of consolidated knowledge about the structure, trends, and collaborative dynamics of this research landscape [4-6]. To address this gap, the present study conducts a comprehensive bibliometric analysis of global research linking AI and the SDGs. Using the Scopus database, the largest abstract and citation database of peer-reviewed literature, a total of

1,370 documents were retrieved using the search query “Sustainable Development Goals” AND “Artificial Intelligence” applied to article titles, abstracts, and keywords.

The study period extends from 2023 to 2025, encompassing the latest contributions to this rapidly evolving field. Data analysis was conducted using RStudio and the Biblioshiny package, which facilitated the visualization and extraction of key bibliometric indicators. The remainder of the paper is structured as follows:

- Section 2 details the methodology, including the search strategy, inclusion and exclusion criteria, and the quality of metadata.
- Section 3 provides essential information regarding the dataset, such as document distribution, citation patterns, and collaboration metrics.
- Section 4 highlights the most significant publication sources, while
- Section 5 investigates the primary contributing affiliations.
- Section 6 evaluates the countries of corresponding authors, focusing on trends in international collaboration.
- Section 7 employs a Word Cloud to illustrate frequently used keywords and thematic priorities.
- Section 8 examines the co-occurrence network, highlighting clusters of conceptual relationships and research trajectories.

This thorough approach seeks to identify structural patterns, key contributors, and emerging themes in AI research aimed at sustainable development, thereby providing a valuable framework for scholars, policymakers, and practitioners within this expanding interdisciplinary field.

2. Literature Review:

2.1 **Theoretical Foundations and Early Contributions:** The use of artificial intelligence (AI) to the Sustainable Development Goals (SDGs) has attracted a lot of academic interest. Early research has examined the various ways AI can help achieve particular SDGs, like improving healthcare delivery (SDG 3), maximizing energy use (SDG 7), and promoting climate resilience (SDG 13). These studies demonstrate the adaptability of AI and its potential to advance a variety of industries [11–14].

Building on this framework, later studies have explored the intricate relationship between AI technologies and sustainable development programs. Researchers have looked at how AI might help or hamper the SDGs, highlighting the significance of governance structures and ethical issues to guarantee that AI applications support sustainability goals [15].

2.2 **Bibliometric Analyses and Research Trends:** Bibliometric analyses have played a crucial role in charting the changing dynamics of research focused on artificial intelligence (AI) and the Sustainable Development Goals (SDGs). Investigations utilizing bibliometric techniques have shown a notable rise in publications in recent years, reflecting an increasing academic engagement in this interdisciplinary area. Prominent research themes that have emerged include the use of AI in enhancing energy efficiency, promoting sustainable agriculture, and advancing smart city initiatives. Furthermore, these analyses have underscored the predominance of contributions from developed nations, highlighting the necessity of incorporating more viewpoints from the Global South. This aligns with ongoing concerns regarding the digital divide and the fair distribution of the advantages of AI.

2.3 **AI Applications in Specific SDGs:** The application of AI across various Sustainable Development Goals (SDGs) has been extensively documented. In the healthcare sector (SDG 3), AI has been utilized for disease prediction, personalized medicine, and efficient resource allocation. For example, machine learning algorithms have been developed to forecast disease outbreaks and optimize treatment plans, thereby enhancing health outcomes.

In the context of sustainable cities (SDG 11), AI technologies have supported smart urban planning, traffic management, and waste reduction. Predictive analytics and real-time data processing have allowed cities to improve operational efficiency and minimize environmental impacts.

With respect to climate action (SDG 13), AI has been applied to model climate scenarios, monitor environmental changes, and aid in disaster response strategies. These applications illustrate AI's significant potential to contribute to climate resilience and adaptation efforts.

2.4 **Ethical Considerations and Challenges:** Despite the promising applications of artificial intelligence (AI) in furthering the Sustainable Development Goals (SDGs), ethical concerns remain prevalent. Issues such as data privacy, algorithmic bias, and the potential to exacerbate social inequalities have been highlighted. Scholars have warned that without careful governance, AI could inadvertently obstruct progress on certain SDGs, particularly those related to equity and justice.

Moreover, the environmental impact of AI technologies, including high energy consumption and electronic waste, presents challenges to sustainability. Researchers advocate for the establishment of green AI practices and policies that align technological advancement with environmental stewardship.

2.5 **Future Directions and Research Gaps:** The literature highlights the necessity for more inclusive and context-specific research concerning AI and the Sustainable Development Goals (SDGs). There is a demand for studies that integrate diverse cultural, economic, and geographic perspectives to ensure that AI solutions are equitable and effective on a global scale. Furthermore, interdisciplinary collaborations among technologists, policymakers, and social scientists are crucial for tackling the complex challenges at the intersection of AI and sustainable development. In summary, while AI presents considerable potential for advancing the SDGs, realizing this potential necessitates addressing ethical concerns, promoting inclusive research practices, and encouraging cross-sectoral collaborations. Ongoing bibliometric analyses and empirical studies will be essential in guiding the responsible integration of AI into sustainable development initiatives.

3. Methodology: This study utilized a structured bibliometric analysis approach to examine global research trends that connect Artificial Intelligence (AI) with the Sustainable Development Goals (SDGs). The methodology included a well-defined search strategy, criteria for inclusion and exclusion, and systematic data analysis conducted using RStudio and the Biblioshiny package.

3.1 **Search Strategy:** The bibliographic data were obtained from the Scopus database, chosen for its comprehensive and multidisciplinary coverage of peer-reviewed scientific literature. Scopus is widely acknowledged as a trustworthy source for bibliometric research, owing to its stringent indexing standards, extensive international reach, and detailed metadata fields. A total of 1,370 documents were retrieved using the advanced search query: "Sustainable Development Goals" AND "Artificial Intelligence" (Search fields: Article Title, Abstract, and Keywords). This query was specifically crafted to identify scholarly works that explicitly connect AI with the SDGs, concentrating solely on works that mention both concepts in the primary metadata fields to ensure thematic relevance.

3.2 **Inclusion and Exclusion Criteria:** To maintain the focus and relevance of the analysis, the following criteria were applied:

• Inclusion Criteria:

- Articles published between 2023 and 2025, ensuring a contemporary overview of emerging trends.
- Publications in any language (Scopus metadata indicated no missing values in the Language field).
- All document types indexed in Scopus, including research articles, conference papers, and reviews.
- Availability of complete metadata in core fields (Title, Authors, Abstract, Journal Source, and Publication Year).

Exclusion Criteria:

- Documents with entirely missing critical metadata such as Title, Authors, or Journal Name (although none were found missing in these fields).
- Studies not relevant to the dual theme of AI and SDGs upon closer inspection during data curation.
- Duplicate records or improperly indexed entries.

3.3 **Study Selection:** The dataset originally comprised 1,370 records exported from Scopus. These records were then processed using the Biblioshiny interface of the bibliometrix package in RStudio (R programming environment). Upon loading into Biblioshiny, the dataset resulted in 1,349 valid documents, with minor discrepancies attributed to metadata parsing issues or the exclusion of incomplete records.

An assessment of metadata quality revealed that while core fields (Document Type, Journal, Title, Year, Citations, and Language) were fully intact, certain fields exhibited partial or significant data omissions (see Table I).

TABLE .I. SUMMARIZES THE METADATA COMPLETENESS:

Metadata Field	Missing Count	Missing %	Quality
Abstract	19	1.41%	Good
Author	21	1.56%	Good
Affiliation	30	2.22%	Good
DOI	62	4.60%	Good
Keywords (DE)	199	14.75%	Acceptable
Corresponding Author	353	26.17%	Poor
Keywords Plus (ID)	553	40.99%	Poor
Cited References (CR)	1349	100.00%	Completely Missing
Science Categories	1349	100.00%	Completely Missing

4. Main Information on the Bibliographic Data Set: The bibliometric dataset examined in this study covers the years 2023 to 2025, providing a contemporary and focused overview of global scholarly output at the intersection of Artificial Intelligence (AI) and the Sustainable Development Goals (SDGs). A total of 1,349 documents were sourced from 824 distinct publications, including journals, books, and conference proceedings. The annual growth rate of publications during this period is a modest 3.34%, indicating a steady, albeit not rapid, increase in research output. The average age of the documents is 0.984 years, highlighting the recency of the works and confirming that this research area is both emergent and evolving. Despite their relative youth, the documents demonstrate a healthy average citation rate of 5.047 per document, indicating early academic engagement and relevance within the scientific community.

As depicted in Figure 1, the dataset demonstrates a significant diversity in document types. Peer-reviewed articles represent the largest portion, comprising 534 documents, followed by book chapters with 242 and conference papers totaling 296. The inclusion of 168 reviews further underscores the increasing maturity of the field and the consolidation of existing knowledge. Notably, there are a few hybrid entries, such as "article article" or "book chapter conference paper," which indicate inconsistencies in metadata classification, likely due to Scopus export anomalies previously mentioned.

The content analysis reveals a pronounced focus on keyword utilization, with 6,422 'Keywords Plus' (automatically generated from Scopus) and 3,746 author-defined keywords, suggesting a rich and varied thematic landscape. This finding correlates with the interdisciplinary nature of the topic, where various researchers may articulate similar concepts using different terminologies.

From the authorship and collaboration perspective, the dataset comprises 4,785 unique authors, with 159 documents authored by a single individual and a total of 190 single-authored documents. The average number of co-authors per document is 3.86, indicating a moderate level of collaborative effort. Additionally, 35.73% of all publications involved international collaboration, which is in alignment with the global significance of the Sustainable Development Goals (SDGs) and the transdisciplinary scope of AI research.

Overall, these statistics illustrate a growing, internationally engaged, and diverse research ecosystem focused on AI applications for sustainable development. The variety of source types, the diversity of keywords, and the wide authorship base reflect the complexity and inclusiveness of the field, even at this relatively early stage of bibliographic development.

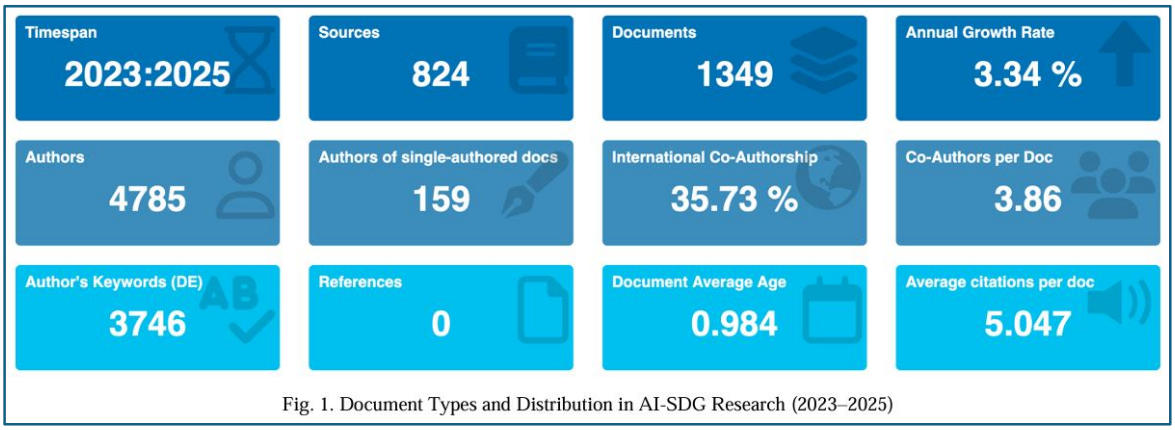

Fig. 1. Document Types and Distribution in AI-SDG Research (2023–2025)

5. Most Relevant Sources: The analysis of the most prolific publication sources indicates a concentrated yet diverse array of platforms actively contributing to the intersection of Artificial Intelligence and the Sustainable Development Goals. As illustrated in Figure 2, the journal Sustainability (Switzerland) stands out significantly, with 55 publications, establishing it as the leading outlet for research in this domain. The journal's open-access model, combined with its broad thematic focus on sustainability issues, likely enhances its volume of relevant publications.

Following closely are several conference proceedings and specialized book series. The Lecture Notes in Networks and Systems account for 22 publications, reflecting the technical and systems-oriented nature of much of the AI-related SDG research. In a similar vein, the Philosophical Studies Series, with 18 entries, presents an intriguing contrast, suggesting that the philosophical and ethical dimensions of AI for sustainable development are also being actively examined, indicating a cross-disciplinary approach.

The Communications in Computer and Information Science (CCIS) series, with 17 publications, along with Discover Sustainability and Sustainable Development, each contributing 13 papers, exemplify a balance

between computing-focused and sustainability-oriented venues. Their prominence in the top tier underscores the increasing integration of applied computer science within broader developmental contexts.

Additionally, the Lecture Notes on Data Engineering and Communications Technologies, with 12 contributions, and IEEE Access, with 10 papers, reflect ongoing initiatives in technical innovation, data-driven methodologies, and open-science dissemination. The inclusion of CEUR Workshop Proceedings, with 9 publications, highlights the significance of preliminary and emerging research often presented at workshops and symposia prior to journal publication. Finally, the specialized source Machine and Deep Learning Solutions for Achieving the Sustainable Development Goals, also featuring 9 entries, underscores the growing interest in thematic compilations dedicated exclusively to AI applications in sustainability.

Collectively, these sources demonstrate a multifaceted publishing ecosystem where open-access journals, conference proceedings, and interdisciplinary book series converge. This diversity reflects the thematic richness and methodological plurality of the field, encompassing everything from engineering and data science to ethical theory and policy-oriented discussions.

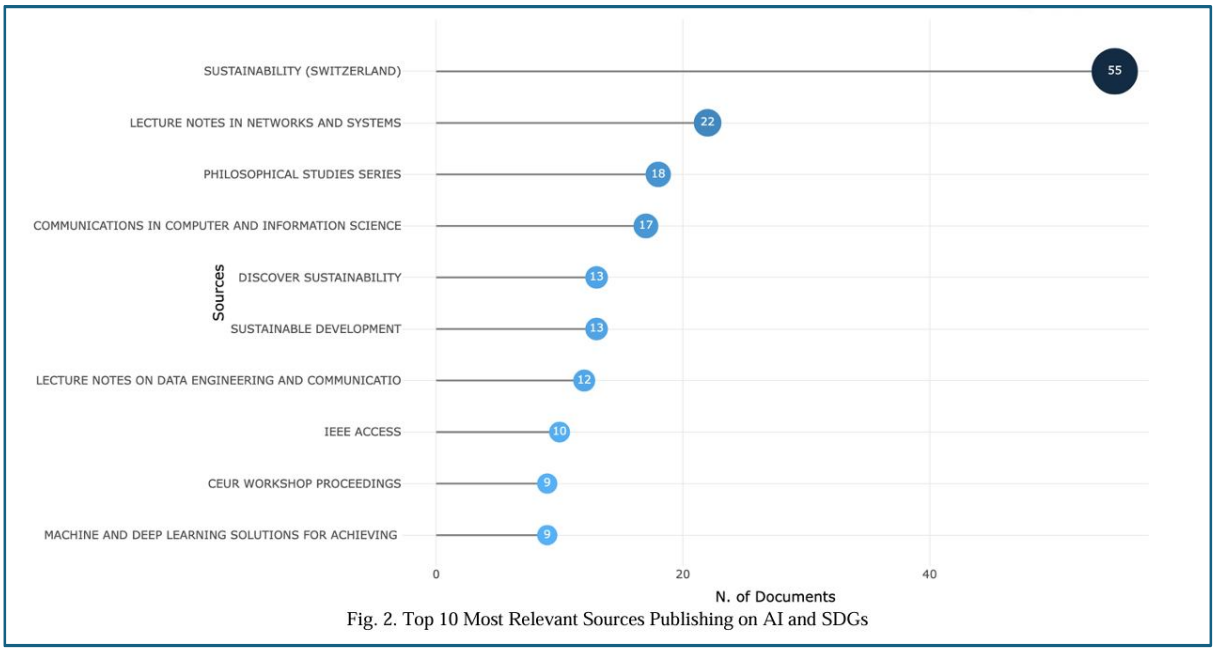

Fig. 2. Top 10 Most Relevant Sources Publishing on AI and SDGs

6. Most Relevant Affiliations: The analysis of the most productive affiliations in the field of Artificial Intelligence applied to the Sustainable Development Goals reveals a globally distributed network of institutions, with significant activity observed in Asia, the Middle East, and Europe. As depicted in Figure 3, Uttaranchal University stands out as the leading contributing institution, with 28 publications, indicating a pronounced institutional emphasis on sustainability-driven AI research. This robust performance may reflect strategic research priorities or internal funding mechanisms designed to align with the Sustainable Development Goals (SDG) agenda.

Following closely is the University of Johannesburg, which has produced 26 publications, underscoring Africa's growing visibility in global sustainability research. The contributions from this university may signify a regional initiative to integrate AI solutions into the developmental challenges faced by the Global South, particularly in addressing issues of inequality, resource management, and public infrastructure.

The University of Delhi, a prominent institution in India, ranks third with 17 publications, aligning with the country's broader academic engagement in AI and sustainable development. Its output is comparable to that of Amrita School of Business (16 publications) and Chitkara University Institute of Engineering and

Technology (15 publications), collectively illustrating a strong cluster of Indian institutions dedicated to applied research at the intersection of AI and the SDGs.

Qatar University, KTH Royal Institute of Technology in Sweden, and King Fahd University of Petroleum and Minerals in Saudi Arabia, each contributing 15 or 14 publications, highlight the diverse geographical representation within this field. These affiliations suggest that both oil-rich economies and technologically advanced nations are actively exploring the role of AI in facilitating a transition toward more sustainable practices.

Amity University and the National University of Singapore, each contributing 13 publications, complete the top ten list, with the latter representing a highly research-intensive environment recognized for its AI initiatives. Singapore's involvement further affirms the increasing prominence of Southeast Asia in the AI-for-Good research landscape.

Together, these affiliations exemplify a rich tapestry of institutional leadership across various regions. The concentration of outputs among Indian institutions reflects both capacity and strategic orientation, while the inclusion of universities from Africa, the Middle East, and Europe illustrates a global commitment to leveraging AI in support of the SDGs. This distributed authorship landscape also complements the previously noted 35.73% international co-authorship rate, reinforcing the collaborative and transnational nature of this emerging research field.

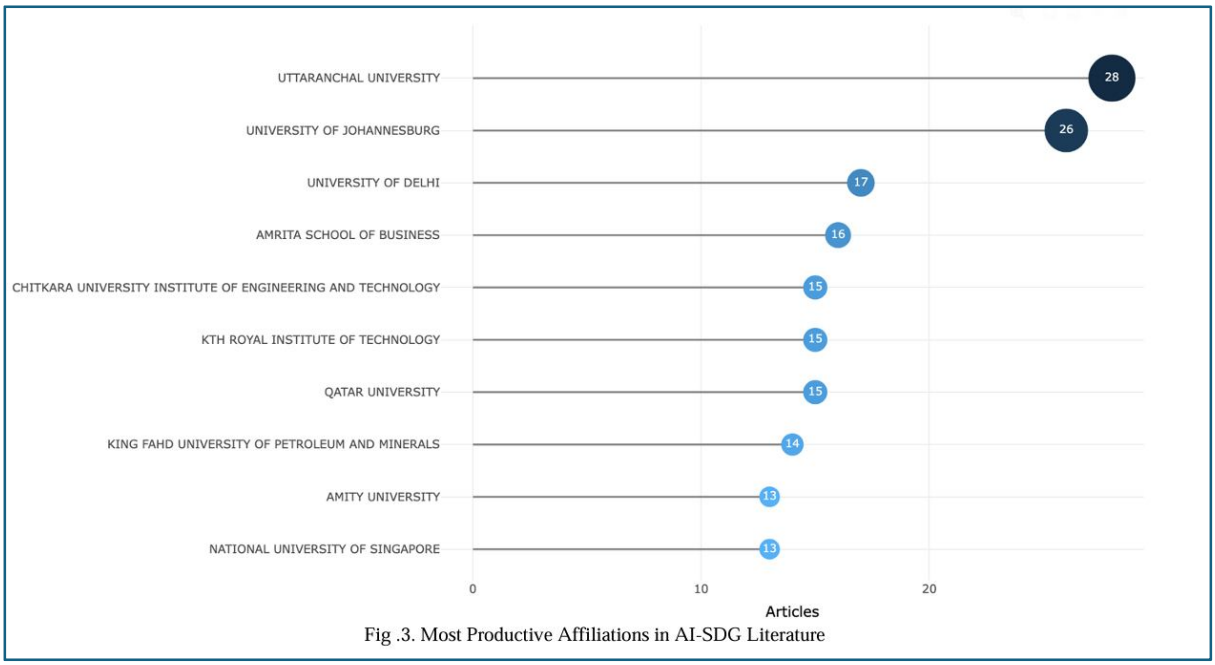

Fig .3. Most Productive Affiliations in AI-SDG Literature

7. Corresponding Author's Countries: The distribution of corresponding authors by country, as illustrated in Figure 4, reveals a globally diverse research landscape in the field of Artificial Intelligence and the Sustainable Development Goals. India leads with 188 articles, representing 13.9% of total contributions. Of these, 135 are single-country publications (SCP), while 53 are multi-country publications (MCP), resulting in a 28.2% MCP rate. This indicates India's significant presence in domestic research output while also engaging in a considerable number of international collaborations.

China ranks as the second-highest contributor with 101 articles (7.5%), which include 63 SCPs and 38 MCPs, yielding a 37.6% international collaboration rate. This balance suggests that China maintains a robust internal research base while actively partnering with other countries, exceeding India in the proportion of internationally co-authored work.

Spain, Italy, and the USA exhibit similar output levels with 38, 34, and 33 articles, respectively, yet they differ in collaboration dynamics. The USA is notable for its 45.5% MCP rate, indicating a strong preference for international partnerships. Similarly, Italy and Spain demonstrate healthy MCP rates of 32.4% and 31.6%, respectively, suggesting that European institutions are actively involved in cross-border scientific networks.

Although Malaysia and Saudi Arabia contribute fewer papers (30 and 27 articles, respectively), they show remarkably high MCP percentages of 63.3% and 70.4%. These figures suggest that researchers in these countries are significantly engaged in global research collaborations, likely leveraging international partnerships to enhance local research capabilities and visibility.

The United Kingdom and Australia also exhibit high collaboration tendencies. The UK has an equal distribution between SCP and MCP (15 each), resulting in a 50% international collaboration rate, while Australia exceeds this with a 54.5% MCP, indicating that over half of its corresponding author contributions are internationally co-authored.

In contrast, South Africa, with 25 articles and only 5 MCPs (20%), appears to be more nationally focused in its contributions. This may reflect localized research priorities or constraints within international funding networks, especially when compared to other countries with similar output levels.

In summary, this distribution highlights the dominance of certain countries in absolute output, particularly India and China, while emphasizing the essential role of international collaboration in shaping the field. The high MCP rates in countries such as Saudi Arabia, Malaysia, and Australia reinforce the collaborative ethos underpinning AI for sustainable development, highlighting its inherently global and interdisciplinary nature.

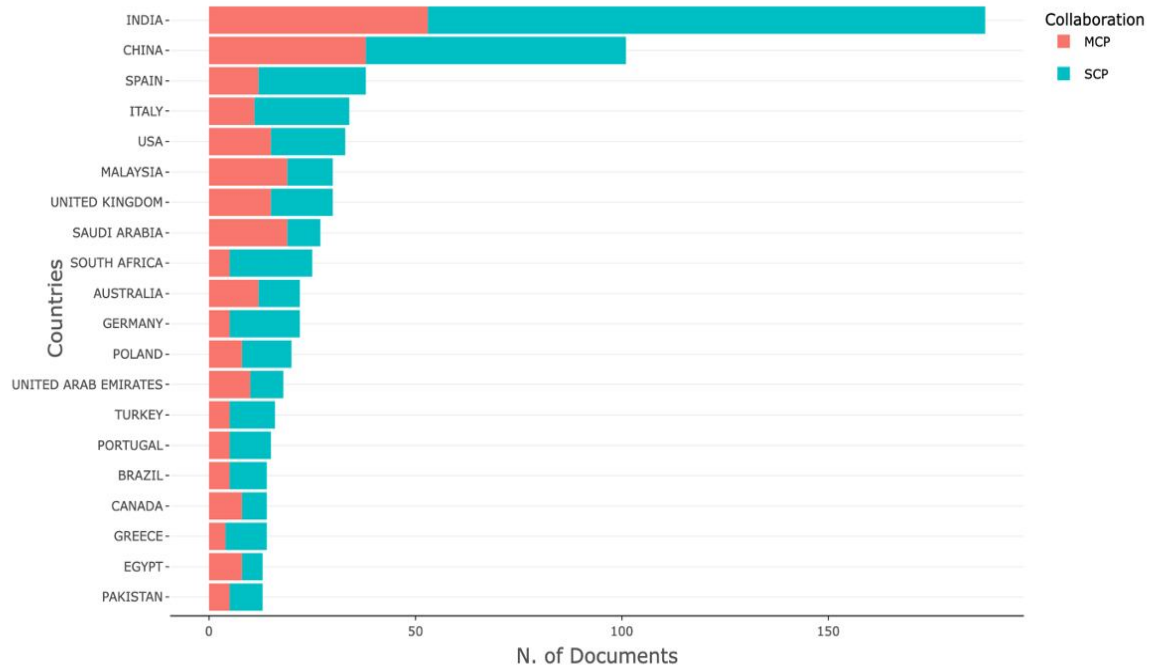

Fig .4. Corresponding Authors' Countries and International Collaboration

8. Wordcloud Analysis: The WordCloud visualization, as depicted in Figure 5, provides a thematic overview of the most frequently occurring terms within the analyzed dataset. Central to the research landscape is the term "artificial intelligence," which appears with a frequency of 490, underscoring its

pivotal role in the literature. This is closely followed by "sustainable development goal" (339 occurrences) and "sustainable development" (306 occurrences), emphasizing the dual thematic focus of the dataset and affirming the alignment of AI technologies with global sustainability agendas.

Notably, both the singular and plural forms of "sustainable development goal" and "sustainable development goals" are represented separately with significant frequencies (339 and 198, respectively). This variation indicates differences in author keyword usage and suggests a need for standardization in keyword practices to enhance discoverability. When considered collectively, these terms greatly enhance the visibility of content related to the Sustainable Development Goals (SDGs).

The prominence of "machine learning" (140) and its hyphenated variant "machine-learning" (96) further illustrates the methodological foundation of numerous studies within the corpus. This dual representation suggests inconsistency in keyword formatting while also reflecting the extensive application of machine learning techniques in sustainability contexts.

Other frequently utilized terms, such as "human" (98) and "united nations" (91), highlight the human-centric and policy-oriented focus of the research. The specific mention of "United Nations" reinforces the institutional framework within which many discussions on sustainable development are situated, thereby underscoring the connection to the official SDG framework established by the UN.

Keywords such as "sustainability" (79) and "climate change" (73) indicate that environmental dimensions continue to be a dominant concern within the AI-for-Good literature. Their high frequency suggests that research is not only aligned with overarching sustainability goals but also addresses more specific challenges, including climate action.

In summary, the WordCloud analysis reveals a robust convergence between advanced technologies like artificial intelligence and machine learning, and pressing global challenges encapsulated by the SDGs. The interaction between technological keywords and sustainability-related terms underscores the multidisciplinary and application-driven nature of this field.

9. Co-Occurrence Network Analysis: The co-occurrence network, depicted in Figure 6, illustrates the conceptual relationships among key research terms, highlighting the frequency and proximity of various themes in the literature. Each node within the network signifies a keyword, with its size and position indicating its centrality and significance in linking research themes, analogous to intersections in a city road map where some hubs serve as major roundabouts while others function as side streets.

The analysis revealed two primary clusters. The most prominent, Cluster 2, encompasses terms such as "sustainable development goals," "machine learning," and "deep learning." Among these, "sustainable development goals" exhibits the highest betweenness centrality (37.509), serving as a crucial bridge that connects diverse research themes. Metaphorically, it operates like a central train station, linking various lines, including AI, policy, energy, and urban studies, thus establishing itself as a vital transit point in the intellectual landscape.

"Machine learning" also occupies a critical role, with elevated closeness and PageRank scores (0.018 and 0.035, respectively), indicating not only its frequency but also its strategic position at the core of the network. It functions as a reliable expressway, directly connecting to numerous other keywords such as "deep learning," "energy," and "sustainable city." This underscores the foundational role of machine learning methods in fostering innovations within sustainable applications.

On the periphery, yet still significant within Cluster 2, are terms such as "circular economy," "energy," and "sustainable city," each possessing modest but meaningful centrality scores. These terms represent emerging

pathways in the map that, while less traversed than the primary highways, are becoming increasingly critical as the field progresses towards practical, domain-specific applications of AI for sustainability.

In contrast, Cluster 1 represents a more technical and educational subgroup, including terms like "adversarial machine learning," "contrastive learning," "students," and "case studies." Although these nodes exhibit lower PageRank and betweenness values, they reflect a more concentrated exploration of machine learning pedagogy and robustness. For instance, "contrastive learning" and "adversarial machine learning" display nearly identical closeness and betweenness, suggesting a conceptual interconnection, often co-occurring in literature that addresses advanced AI techniques or vulnerabilities. The presence of "students" and "case studies" implies a practical or educational focus, indicating that Cluster 1 may resemble a university campus—less central to the transportation network yet essential for knowledge cultivation and training.

Together, these clusters delineate the dual nature of contemporary research: one stream emphasizing high-impact, policy-aligned outcomes (Cluster 2) and another rooted in technical innovation and education (Cluster 1). Their interconnections reflect the increasing maturity and multidimensionality of AI research in alignment with sustainable development goals.

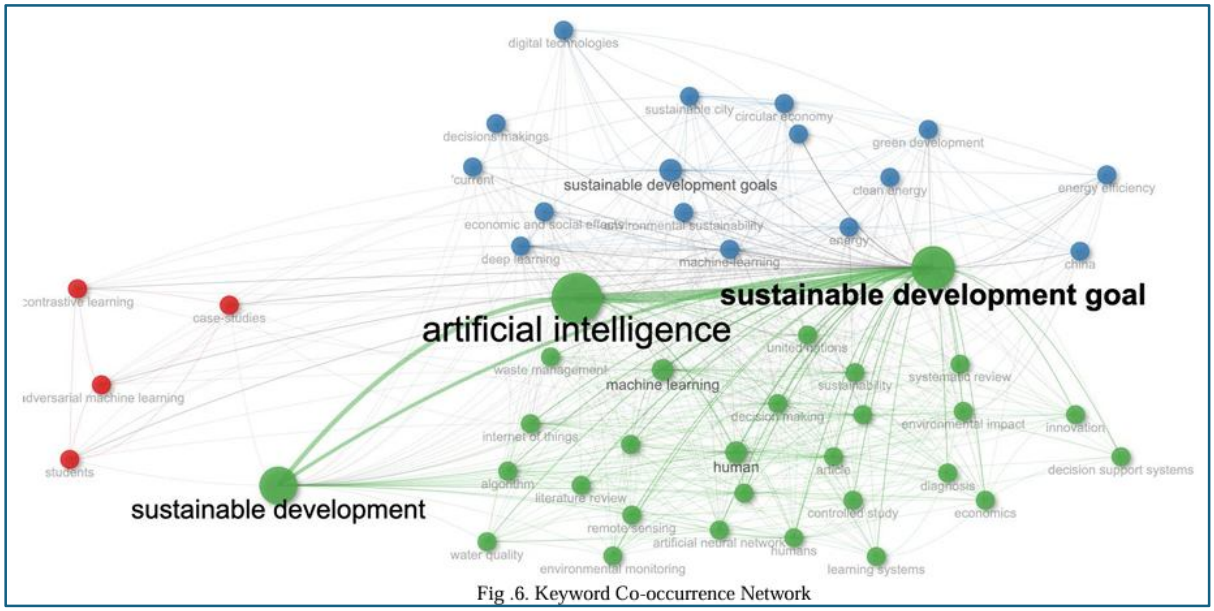

Fig .6. Keyword Co-occurrence Network

10. Discussion: The intersection of Artificial Intelligence (AI) and the Sustainable Development Goals (SDGs) has developed into a dynamic interdisciplinary research area, as demonstrated by bibliometric data obtained from Scopus for the years 2023 to 2025. This discussion provides a comprehensive interpretation of the empirical findings, moving beyond simple reporting to elucidate the structural, thematic, and geographical dynamics of the field, while positioning them within broader academic and policy frameworks. The analysis highlights the emerging nature of AI-SDG scholarship and identifies significant gaps and tensions that need to be addressed for the field to enhance its scope, coherence, and global significance.

10. 1 A Youthful Field with Rapid Uptake The temporal profile of the dataset characterized by an average document age of less than one year and a moderate annual growth rate signals a field in its formative stage. Despite the recency of contributions, the average citation rate exceeding five citations per document reflects early scholarly traction. Such citation density, typically associated with more established domains, suggests that AI-SDG research is not only timely but also rapidly acquiring intellectual legitimacy. This dynamic is reinforced by the wide diversity of document types. Journal articles dominate the dataset, yet the high volume of book chapters and conference proceedings underscores the provisional and exploratory nature of

much of the discourse. The presence of 168 review articles further affirms that the community is actively engaged in knowledge consolidation, aiming to anchor this interdisciplinary inquiry within a more stable theoretical and methodological scaffold. 10. 2 Structural Pluralism and Knowledge Dispersion The dispersion of publications across 824 unique sources reflects structural pluralism and thematic richness. Sustainability (Switzerland), by far the most prolific source, exemplifies the dominant role of open-access, generalist sustainability journals in shaping the discourse. Meanwhile, the inclusion of highly specialized series such as Lecture Notes in Networks and Systems and Philosophical Studies Series reveals the intellectual breadth of the field spanning technical, philosophical, and applied dimensions. This multiplicity of publication venues is mirrored in the diverse keyword landscape. The dataset features more than 10,000 combined Keywords Plus and author-defined keywords, indicating a lack of terminological standardization. The coexistence of variants such as “machine learning” and “machine-learning” or “sustainable development goal” and “sustainable development goals” points to a structural dissonance that may inhibit metadata harmonization and literature discoverability. The field would benefit from a concerted effort to unify taxonomies, enhancing semantic interoperability and cross-disciplinary citation visibility. 10. 3 Global Distribution and Epistemic Shifts A key contribution of this study lies in its unpacking of the global geography of knowledge production. India emerges as the most prolific country, followed by China, Spain, Italy, and the USA. This distribution contrasts with traditional science geographies, marking a shift in epistemic authority. Indian institutions not only lead in output but also dominate among the most productive affiliations. This rise aligns with broader national strategies promoting AI innovation for development.

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10. 4 Thematic Landscapes: From Application to Infrastructure The Word Cloud and co-occurrence network analyses provide a window into the thematic architectures shaping the discourse. Central terms such as "artificial intelligence," "sustainable development goals," and "machine learning" dominate, establishing the field's epistemic anchors. Yet, the co-occurrence network reveals deeper structure: two primary thematic clusters demarcating distinct epistemological orientations. Cluster 2, the more influential, is anchored around applied sustainability themes—"sustainable city," "energy," "circular economy," and "climate change." These terms exhibit high centrality metrics, suggesting that much of the literature is outcome-oriented, aimed at deploying AI tools to address specific SDG challenges. The pervasiveness of terms like "deep learning" within this cluster indicates a strong methodological consistency grounded in data-intensive AI approaches. Cluster 1, by contrast, is more inward-looking and methodological, containing terms such as "adversarial machine learning," "contrastive learning," "students," and "case studies." This cluster maps onto a pedagogical and theoretical core, reflecting research on algorithmic robustness, AI education, and instructional design. The coexistence of these clusters illustrates the field's bifocal nature: simultaneously building theoretical infrastructure and pursuing applied impact.

10. 5 Alignments and Tensions Between Structure and Function Comparing these thematic clusters with institutional and geographic data reveals structural tensions. For instance, institutions and countries with high publication counts but low MCP rates appear more aligned with Cluster 1 themes suggesting a domestic emphasis on capacity building and foundational research. Meanwhile, actors with higher collaboration rates are more engaged with Cluster 2 themes, often tackling global challenges through joint research agendas. This pattern indicates that transnational collaboration may be a proxy for problem-oriented research, while nationally concentrated outputs reflect investments in disciplinary infrastructure. Another tension emerges from the disparity between the conceptual focus of the literature and the nature of the publication formats. Despite strong thematic emphasis on practical, policy-relevant issues (e.g., climate change, smart cities), a considerable portion of the dataset consists of book chapters and conference proceedings. These formats, though valuable for disseminating preliminary work, may lack the empirical rigor or policy traction needed to influence decision-making at scale. The field may benefit from increased representation in high-impact, peer-reviewed journals to translate ideas into actionable evidence. Moreover, ethical and institutional considerations though present in the WordCloud through terms like "human" and "United Nations" are relatively marginal in the co-occurrence network. This marginality may reflect either the novelty of ethical debates in AI-SDG literature or a lack of integration with technical and applied domains. Addressing this gap is crucial. As AI interventions scale within development contexts, the normative frameworks guiding their deployment must be as robust as the algorithms themselves.

10. 6 Toward a Future Research Agenda This discussion yields several implications for the future trajectory of AI-SDG scholarship. First, greater emphasis must be placed on harmonizing metadata and terminologies. The observed inconsistency in keyword formatting and concept labeling hinders the traceability and synthesis of knowledge across platforms and disciplines. Second, the field should embrace a more intentional integration of ethical, legal, and social implications (ELSI) into mainstream research. As the volume of technical literature grows, questions of accountability, transparency, and justice must not remain peripheral. Journals, funding bodies, and institutional ethics boards can play catalytic roles in mainstreaming ELSI considerations. Third, enhancing methodological rigor particularly in conference and chapter contributions will be essential. Given the applied ambitions of much of the literature, ensuring reproducibility, validation, and real-world applicability must become central evaluation criteria. This shift will also help bridge the gap between academic outputs and policy uptake. Fourth, cross-regional collaborations should be incentivized, particularly those that bridge Global North and Global South actors. Such partnerships can mitigate knowledge asymmetries, diversify epistemic perspectives, and co-produce context sensitive AI applications that resonate with local sustainability needs. Finally, the bifocal structure of the field application versus infrastructure should not be seen as a dichotomy but as a symbiosis. Technical

and theoretical advancements are foundational to scaling impactful AI solutions, while real-world challenges provide fertile ground for refining methodologies and exposing blind spots.

11. Conclusion: This study presents the first comprehensive bibliometric mapping of scholarly activity at the intersection of Artificial Intelligence (AI) and the Sustainable Development Goals (SDGs) during the crucial period of 2023–2025. Through a methodologically rigorous analysis of 1,349 documents indexed in Scopus, it reveals a rapidly evolving research landscape that is intellectually broad, geographically varied, and thematically complex.

The findings indicate that AI-SDG scholarship is still in its early stages; however, it is already characterized by significant citation engagement, diverse document types, and dynamic keyword usage. This reflects both the enthusiasm of the research community and the urgency of the societal challenges it aims to address. The identified dual thematic clusters—encompassing applied sustainability interventions and foundational technical methodologies—illustrate a field that seeks to connect practical utility with conceptual advancement.

Patterns of institutional and national participation reveal a decentralizing geography of innovation. Countries such as India and South Africa are demonstrating strong independent output, while others, particularly Malaysia, Saudi Arabia, and Australia, are engaging through intensive international collaborations. This diversification of knowledge production is vital for embedding contextual relevance and global equity into AI-driven sustainable development solutions.

Nevertheless, several structural and epistemic challenges persist. Issues such as terminological inconsistency, limited integration of ethical considerations, and the predominance of exploratory formats over policy-oriented outputs impede the translation of research into systemic impact. Addressing these limitations necessitates the harmonization of metadata practices, enhanced methodological rigor, and a renewed focus on ethical, legal, and social dimensions within mainstream technical research.

Ultimately, AI for the SDGs represents not merely a technological endeavor but a socio-technical paradigm shift. As the field progresses, its success will hinge not only on algorithmic sophistication but also on its capacity to promote inclusive governance, cross-regional collaboration, and shared epistemologies. By elucidating the current state of the field—its strengths, gaps, and trajectories—this study provides a crucial foundation for shaping its future evolution.

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