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Mapping Trend of Artificial Intelligence (AI) in Green Jobs Through Bibliometrics Analysis

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ABSTRACT

The entire world is becoming increasingly concerned about the rising birth rates and the uncontrolled growth of industry, which is becoming more detached from norms and ethics day by day. This is further exacerbated by the emergence of AI technology, which has triggered public fear over job scarcity, potentially leading to a loss of public awareness regarding the importance of maintaining environmental integrity and sustainability in the pursuit of livelihood. At the same time, the United Nations' Sustainable Development Goals (SDGs) have become a trending framework for regulating industrial growth in the era of Society 5.0, in which green jobs are seen as a hopeful solution to the ongoing dilemma. Given these conditions, this study aims to analyze whether the trend of AI usage in various aspects of life can serve as a bridge to achieving the SDGs, particularly in environmental sustainability through green jobs. This study employs a qualitative approach, utilizing bibliometric analysis based on data from the past decade (2015–2025) via the VOSviewer software. A total of 421 research publications is retrieved from Scopus using the keywords "Artificial Intelligence" and "green job". The study then examines the author's trends, subject areas, and keyword patterns. This study will describe the trends in the contribution of AI and green jobs, offering recommendations for the government to formulate policies aligned with the vision and mission of the SDGs, while also optimizing the role of AI in managing the overgrowth of the labor force. Additionally, the study will deepen the analysis of AI usage in the transformation of the workforce to support environmental sustainability.

Keywords: *AI, Green Jobs, Bibliometrics, SDGs*

1. INTRODUCTION

Environmental and nature conservation have long been important global issues, and now in the 21st century, technological advances are the distinguishing factor between the current generation and previous generations. With the widespread adoption of technology in the industrial world, there are numerous positive impacts felt by all of humanity in terms of economic growth and operational efficiency (Park & Choi, 2019). However, on the other hand, technology has also accelerated the growth of industries that often disregard ecological and ethical norms (Heikkurinen, 2016). particularly the rapid increase in consumption and unregulated industrial expansion have been major drivers of environmental degradation

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(Usman & Balsalobre-Lorente, 2022). As stated in a study, industrial growth and population growth are the main factors related to groundwater contamination in some countries (Taufiq et al., 2019). Without an effective response, this issue could threaten humanity's primary goal of preserving the environment and natural resources.

In the condition of widespread adoption of technology in the industrial sector, artificial intelligence has emerged as the most influential technology of the 21st century, with innovation and efficiency being the key values offered by AI. Countries are also embracing and rushing to adopt AI on a massive scale in their industrial sectors. In this regard, the United States and China are the most ambitious nations in terms of investing in AI (Liberto, 2025) As efficiency standards in the industrial world rise due to AI, this could trigger a domino effect leading to job losses and the replacement of human labor with automated intelligent machines (Mirbabaie et al., 2021) In the United States, 71% of the population fears that AI will permanently take their jobs (Lange & Alexandra, 2025). This contradiction reiterates the urgency for the global community to discuss this matter.

Amidst this confusing situation, green jobs are believed to be a solution to address the problem of many jobs losing their ecological ethics and also help restore public optimism towards the labor market, amidst the advancement of technology and artificial intelligence. Green jobs themselves are jobs that contribute significantly to environmental preservation and restoration, whether in the agricultural, service, or industrial sectors. According to the United Nations, green jobs can even create 24 million new jobs worldwide by 2030 (United Nation, 2019). This is in line with the Sustainable Development Goals (SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure), which emphasize sustainable resource management and also encourage industrial efficiency while still maintaining environmental sustainability goals. And the presence of AI can be a unique potential that can encourage the combination of Sustainable Development Goals, especially in these two points. AI can easily accelerate the birth of innovations in efforts to maintain a balance between industrialization and environmental sustainability.

Over the past few years, there has been a growing trend in researching the relationship between artificial intelligence and sustainability, and several bibliometric studies have focused on these two areas. For example, Artificial Intelligence in Green Management and Sustainability (Niftiyev, 2025), Artificial Intelligence and Green Collaborative Innovation (Lu & Li, 2025), and Machine Learning and Artificial Intelligence in the Circular Economy (Noman et al., 2022). This demonstrates that the topic of sustainability and technology has received significant attention in academia However, most of these studies still discuss these two fields separately without showing a clear relationship between AI development and sustainable labor dynamics. In addition, the approaches used emphasize thematic analysis rather than mapping conceptual relationships across fields. To date, no bibliometric study has explicitly linked Artificial Intelligence to green jobs within the framework of the Sustainable Development Goals (SDGs). Thus, there is a gap in research that has yet to be filled, namely the absence of

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bibliometric studies that comprehensively map how AI relates to green jobs in the context of the SDGs.

This separate academic portrait creates a research gap that must be addressed. The absence of bibliometric studies that map trends, countries, and the connections and intersections between artificial intelligence and green jobs can result in a lack of analytical evidence for policymakers and practitioners to rely on. In fact, a more structured understanding of the relationship between AI development and sustainable workforce transformation is essential for identifying the direction of research and its implications. Although bibliometric methods have been widely used to identify knowledge structures and emerging themes, this approach has not been specifically applied to the context of AI and green jobs, leaving this area of study open for further exploration.

To address this gap, this study applied bibliometric analysis to research on artificial intelligence (AI) and green jobs published between 2015 and 2025, using Scopus as the main data source and VOSviewer for visualization. A total of 421 publications were identified using the keywords "AI" and "green jobs." The results of this mapping were then linked to the Sustainable Development Goals (SDGs), specifically SDG 8 (Decent Work and Economic Growth) and SDG 9 (Industry, Innovation, and Infrastructure), to analyze the relevance of research developments to labor-related policies. Based on this framework, the objectives of this study are as follows:

1. To map research trends related to Artificial Intelligence (AI) and green jobs from 2015 to 2025 using Scopus data as a basis
2. To analyze publication patterns by country, as well as the most influential fields of study in this topic
3. To explore the co-occurrence of keywords to describe the knowledge structure and direction of AI-green job research development.

This study is also expected to contribute to filling gaps in literature and serve as a reference for policymakers in formulating evidence-based strategies to promote the creation of green jobs using Artificial Intelligence technology.

2. Method

This study uses a bibliometric approach to examine how research on Artificial Intelligence (AI) and green jobs developed between 2015 and 2025. All data was retrieved from Scopus, which was chosen for its broad publication coverage and consistent use in bibliometric analysis. The search process was conducted using a simple Boolean query that combined the three main concepts of the study:
ALL ("Artificial Intelligence" "Green Jobs" "sustainable") AND PUBYEAR > 2014 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE, "English"))

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There were no additional restrictions on document type or subject area, as the aim of this study was to capture as broad an overview of the field as possible. Based on this search, 421 publications were found to meet the criteria.

After the data was extracted from Scopus, the next step was to clean and adjust the keywords before analyzing them using VOSviewer. At this stage, several important steps were taken to ensure that the keyword network was not biased or filled with duplicative terms. For example, words such as "human" and 'humans' were combined, retaining the term that appeared most frequently. Country names—such as "China," "United States," and others—were removed so that they would not dominate the cluster structure. In addition, words related to research methods such as "literature review," "survey," or "analysis" are also removed because they do not reflect substantive concepts in the topics of AI and green jobs. All keywords are then normalized to avoid variations in spelling that refer to the same concept.

Other bibliometric data such as publication trends per year, country contributions, document types, and subject areas were analyzed using the Analyze Results feature in Scopus. All data were then exported in CSV format for further analysis. VOSviewer was used to map keyword co-occurrence and identify research clusters emerging from publications over the past ten years. The results of the analysis are presented descriptively to illustrate the development of research and its relationship to the Sustainable Development Goals (SDGs) agenda.
To provide a comprehensive overview of the research process, the main steps of this study can be summarized as follows:

3. FINDING & DISCUSSIONS

3.1. Documents by Country

Table 1. Distribution of Documents by Country

Country	Document
China	80
Poland	42
United Kingdom	42
India	39
United States	36
Italy	39
Spain	25
France	16
Germany	16
Turkey	16

Source: Scopus Academic Database (2025)

Looking at the publication distribution data, China ranks first with 80 documents, followed by Poland with the United Kingdom with 42 documents, and the United States is in fifth place with only 36 documents. The apparent dominance of China in publications is certainly in line with the enthusiasm of the Chinese government towards technological progress in the field of AI, in 2017 China launched the New Generation Artificial Intelligence Development Goals which are targeted to become the largest global AI innovation center by 2030, (Roberts et al., 2020), the Chinese government has also provided support in the form of extensive funding for research in universities and AI laboratories through the NSFC and R & D programs (Rahkovsky et al., 2021) and in the Wall Street Journal coverage China is reported to have developed an independent AI ecosystem: funding more than 600 Artificial Intelligence Education, spare tire projects, and expanding power infrastructure and openness of AI open-source models, and it can be concluded that China has clearly increased expansion in academic publications. These factors collectively explain why China produces the highest number of AI-related academic publications, including those related to green jobs.

And what is interesting in this study is the discovery of America, which did not enter the top three nominations, even though according to (Ozkaya & Demirhan, 2023) the United States of America is the world leader in artificial intelligence research and development, while China is rapidly catching up This statement is in line with what actually happened, but due to differences in orientation, the United States of America does not make academic publications the main focus of the investment and focuses investment on industry, and many AI-related research in the US is published, but as white papers, arXiv preprints, or internal reports (Eastwood, 2023).

Then there is Poland, which ranks second, matching the UK and even surpassing the US in terms of the number of publications, demonstrating Poland's increasingly visible role in the European research ecosystem. The high number of publications can be interpreted as the impact of European Union policy support, particularly through the European Green Deal and Horizon Europe, which provide substantial funding for research, which Poland has subsequently utilized to increase its productivity in the academic field (Prandecki et al., 2021). Thus, Poland's strong presence in this dataset indicates how regional policy frameworks can significantly shape academic research productivity.

Implications of these findings extend beyond publication counts. China's dominance suggests that countries with strong centralized investment strategies may drive global discussions on how AI contributes to sustainability and green labor markets. Meanwhile, the U.S. pattern indicates that industry-driven innovation does not always translate into academic output, which can affect how knowledge is recorded and disseminated. Poland's unexpected rise underscores the influence of supranational policy (EU-level) in shaping research priorities. When viewed together, the distribution of countries in this study reflects not only different levels of technological capacity but also differences in policy orientation, research funding models, and regional sustainability agendas.

These results are consistent with prior studies showing that global AI research is shaped by geopolitical strategies, industrial ecosystems, and regulatory frameworks (Lu & Li, 2025);(Noman et al., 2022). However, the present findings extend the literature by demonstrating how these national differences also affect the development of AI-related green job research that earlier studies have not explored in detail.

3.2. Trend by Year

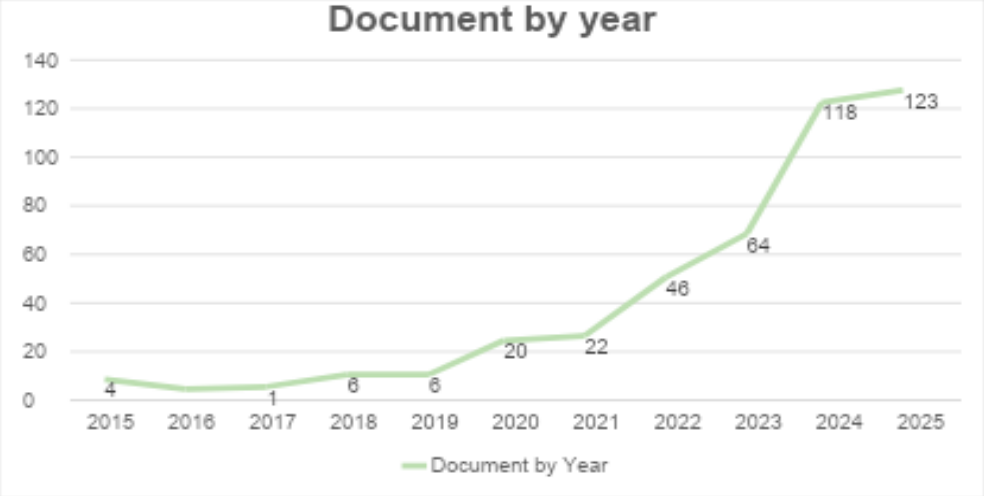

Figure 1. Publications Trend from 2015-2025
Source: Scopus Academic Database (2025)

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The data shows that from 2015 to 2019, publications related to Artificial Intelligence and Green Jobs remained low, with fewer than ten documents per year. This indicates that the topic had not yet attracted strong academic interest or was still seen as a niche field. A noticeable increase began in 2020 (20 publications) and continued in 2021 (22 publications). The growth then accelerated more significantly in 2022 (46 publications) and 2023 (64 publications), before reaching its peak in 2024 (118 publications) and 2025 (123 publications). Overall, the trend demonstrates a consistent year-to-year rise, with a pronounced spike after 2020.

One major factor behind the sharp increase after 2020 is the global impact of the COVID-19 pandemic. The pandemic accelerated digital transformation across sectors, prompting governments, industries, and research institutions to adopt AI technologies more rapidly (Grinin et al., 2021), forcing everyone, from governments to the public, to accelerate the adoption of artificial intelligence in the healthcare, education, and energy sectors. AI technology even played a significant role in diagnosis, prognosis evaluation, epidemic prediction, and even drug discovery for COVID-19 As these technologies expanded, interest in understanding how AI could support sustainable labor systems and green recovery policies also grew. This aligns with the increasing global awareness that AI can contribute to achieving the Sustainable Development Goals (SDGs), especially SDG 8 and SDG 9 (Fan et al., 2023). Since then, research has ceased to be separated from "AI" and "Green jobs," with an increasing number of publications attempting to bridge the two topics.

This upward trend has several implications. First, it suggests that the integration of AI and green jobs is becoming an emerging research priority, reflecting a global shift toward sustainable labor transformation. Second, the rapid increase in publications highlights growing policy interest in green economic recovery, digitalization, and energy transition. Third, the trend indicates that future labor markets will increasingly require AI-related green skills, making this field relevant not only for researchers but also for governments, educators, and industries preparing for long-term workforce adaptation.

Beyond the increase in numbers, this trend also reflects broader geopolitical and policy dynamics shaping the direction of AI–green jobs research. Countries such as China, which have made AI a national strategic priority through massive funding, infrastructure investment, and long-term innovate roadmaps, contribute significantly to the global increase in publications. This suggests that the post-2020 surge is not only a reaction to the pandemic, but also the result of sustained government efforts to integrate AI into environmental and industrial policy. Furthermore, this upward trend is in line with the adoption of green industry strategies and workforce transition agendas, particularly in economies implementing energy transition and green recovery programs. These developments show that research interests are increasingly aligned with policy needs, such as preparing the workforce for AI-related green skills and supporting industries in adopting low-carbon technological innovations. The

emergence of related keywords in subsequent years further highlights how AI is being framed as catalyst for future sustainable innovation, signaling a shift in global research priorities.

3.3. Document by Type

Table 2. Distribution of Documents by Type

Type	Total document	Percentage
Article	259	61,8%
Book Chapter	50	11,9%
Review	46	11,0%
Conference Paper	31	7,4%
Book	26	6,2%
Retracted	3	0,7%
Editorial	2	0,5%
Short Survey	2	0,5%

Source: Scopus Academic Database

Based on the findings, journal articles appear to dominate and are a popular primary medium for researching these topics, with 255 journal articles accounting for 61.9% of the total data. Furthermore, book chapters account for 49 (11.9%) and reviews for 44 (10.7%).

The large number of studies using journal articles suggest that the topics of AI and green jobs have become mainstream academic publications. Journal articles have become the standard for disseminating academic knowledge and have been the primary means of disseminating knowledge for 300 years (Riquelme et al., 2024).

The dominance of journal articles suggests that AI–green jobs research is primarily disseminated through peer-reviewed scholarly outlets rather than through conference forums. This pattern is common in interdisciplinary and policy-relevant fields, where researchers often choose journals to reach academic, governmental, and industry audiences simultaneously (Maran et al., 2022). The substantial presence of book chapters and review articles further reflects an effort to consolidate conceptual understanding and synthesize emerging findings, indicating that the field is still in the process of defining its theoretical boundaries. Meanwhile, the comparatively modest number of conference papers may suggest that discussions around AI-driven labor transformation are situated more within academic and policy discourse rather than within technical engineering communities (Amrullah et al., 2024). The appearance of retracted articles, although small, highlights the need for continued attention to research rigor as the field expands. Overall, the distribution of document types illustrates that AI–green jobs research is developing as an interdisciplinary domain where knowledge is shared through formats that support conceptual development, critical synthesis, and policy-oriented discussion.

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3.4. Co-occurrence Analysis

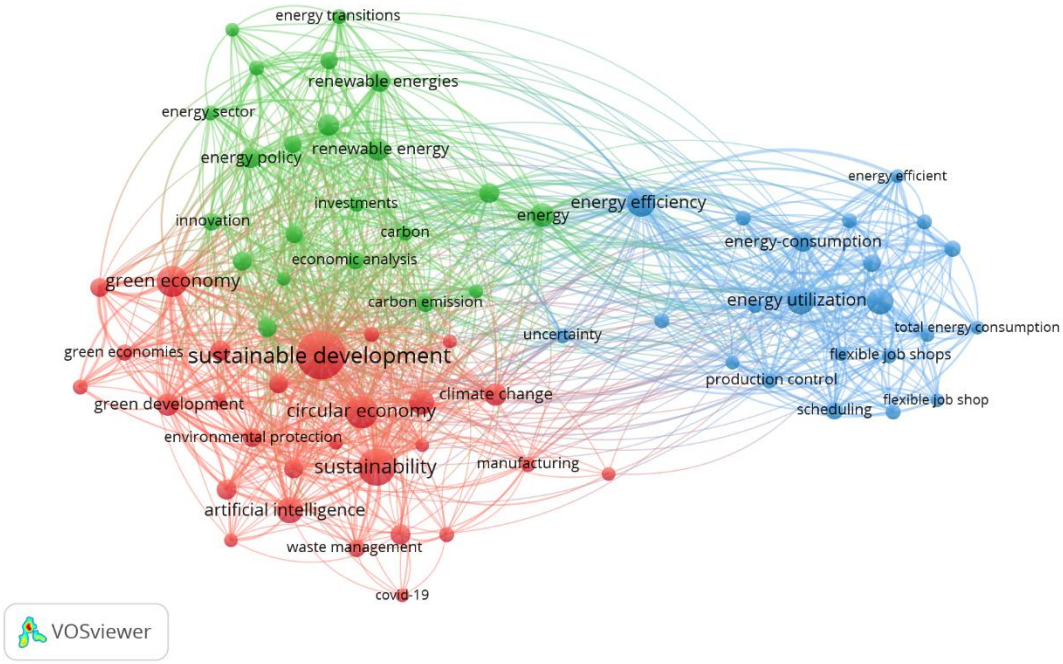

Figure 2. Co-occurrence analysis visualization
Source: Processed by author via VOSviewer

These findings are divided into three main clusters: (1) the red cluster, which focuses on sustainability and sustainable development, with keywords such as artificial intelligence, green economy, and circular economy. This cluster represents the conceptual and policy dimensions. (2) the green cluster, which focuses on keywords such as renewable energy, carbon, economic analysis, and energy policy. The green cluster highlights the dimensions of energy and macroeconomics. (3) The blue cluster, which is dominated by technical keywords such as workshop scheduling, energy efficiency, and energy utilization. This cluster represents the technical-operational dimension.

Interestingly, in these findings, the keyword artificial intelligence appears in the same cluster and relatively close to the keyword sustainability. This indicates that artificial intelligence is often mentioned alongside sustainability in the same document, and that research on artificial intelligence is no longer purely a field of technological research; instead, many academics are increasingly linking it to sustainability issues and the Sustainable Development Goals (SDGs). This finding corroborates recent studies that argue AI is increasingly viewed as a key enabler of the UN Sustainable Development Goals (Fan et al., 2023).

The existence of these dimensions in the findings also shows that research on Artificial Intelligence and Sustainability has become multidimensional: starting from the conceptual and policy dimensions, where AI is positioned as a tool to achieve the SDGs; continuing with the macroeconomic and energy dimensions, where AI supports the transition to renewable energy and green growth policies; and finally extending to the technical-operational dimension, where AI is applied practically to optimize energy production and efficiency. Such multidimensional applications of AI — spanning from policy support to technical optimization — have also been highlighted in the literature on digital technologies and sustainability transitions (Danish & Senjyu, 2023).

Although the focus of this study is the relationship between Artificial intelligence and green jobs, the results of the co-occurrence analysis indicate that the keyword "green jobs" does not appear predominantly in the bibliometric network. In contrast, the keyword "artificial intelligence" appears more prominently and is relatively easy to spot, indicating that discussions about artificial intelligence are often associated with sustainability, such as sustainable development, the green economy, the circular economy, and even climate change. This may reflect that research on artificial intelligence and green jobs still rarely uses the term "green jobs" explicitly, and is more often implied through sustainability issues, which also indicates a research gap regarding studies that directly discuss the benefits of AI for green jobs.

3.5. Document by Subject Area

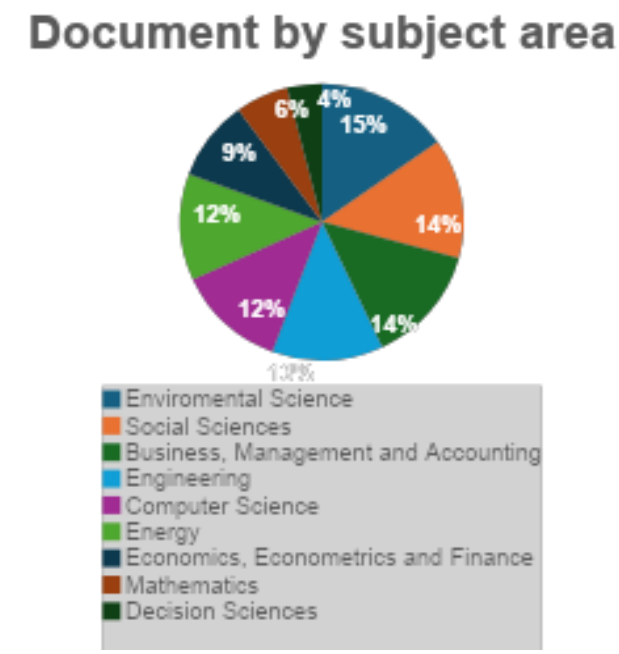

Figure 4. Document by Subject Area
Source: Scopus Academic Database, 2025

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In this data, no single topic dominates, and the variations appear fairly even. However, when ranked by percentage, environmental sciences, with 130 documents (13.7%), focus on environmental issues and examine how AI can directly support sustainability. Second, social sciences, with 121 documents (12.7%), focus on social issues, policy, and labor. Discussions in this field often address the impact of AI on the labor market, social justice, and the ethics of implementing technology in sustainable development. Next up are Business, Management, and Accounting with 118 documents (12.4%), Engineering with 109 documents (11.5%), Computer Science with 107 documents (11.3%), Energy with 107 documents (11.3%), and Economics, Econometrics, and Finance with 80 documents (8.4%).

The diverse presentations also emphasized that research related to artificial intelligence (AI) and green jobs is no longer limited to specific fields of study, but has been integrated into other fields, such as manufacturing and industry (Chen et al., 2024) education and human resources (Yigitcanlar et al., 2021), policy and governance (Zhang, 2024), and even construction and smart cities (Yigitcanlar et al., 2021) Going forward, it is not impossible to explore the relationship between these topics in fields that were previously unimaginable.

4. Conclusion

This bibliometric study maps research on Artificial Intelligence (AI) and green jobs from 2015 to 2025. The results show a steady upward trend, with a sharp spike after 2020—a pattern that reinforces how the COVID-19 pandemic has been a catalyst for accelerated technology adoption. Cluster analysis reveals three major dimensions that frame this research: conceptual and policy dimensions, macroeconomic and energy dimensions, and technical-operational dimensions. The proximity between the terms AI and sustainability indicates that the two topics no longer stand alone but are increasingly understood as a single ecosystem. However, although the relationship between AI and sustainability is widely discussed, the term "green jobs" rarely appears explicitly. This shows that the issue of employment in the context of sustainability is still often discussed indirectly through the concepts of green economy or circular economy.

This research offers two main contributions. Theoretically, this study positions AI–green jobs as an interdisciplinary field that is beginning to take shape and maps out an academic structure that explains how conceptual, economic, and technical dimensions are interconnected. By identifying clear research gaps, this study helps clarify the direction of literature development and provides a more structured basis for further research. Practically, findings on publication trends and differences in national orientation—such as China's academic dominance and the United States' industrial focus—provide strategic insights for policymakers in designing workforce readiness, green skill development, and AI-based industrial transformation. These findings are also relevant for the education sector and industry players to anticipate future competency needs.

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Given AI's dual role—as both a potential disruptor and a driver of green innovation, future research needs to move toward empirical studies. It is important to investigate how AI adoption creates green jobs in key sectors, such as renewable energy and manufacturing. Research also needs to explore the socio-economic impacts of AI-based green transitions, including inequality, skill gaps, and worker protection in an ever-changing job market. Overall, this study not only maps the existing knowledge structure but also highlights strategic opportunities for innovation, policy development, and sustainable employment transformation. Thus, this research provides a foundation for more systematic and evidence-based exploration of the role of AI in promoting sustainable job creation.

5. Recommendation

Seeing the surge in artificial intelligence research trends in the findings, policymakers should take advantage of this momentum as the right moment to integrate artificial intelligence into the structure of society to maximize opportunities for creating green jobs. Equal access to AI-related education and training is also very important, especially for technical workers and the wider community, to ensure that AI is seen not as a source of concern but as a companion in life and a driver of sustainability. Finally, future research should explicitly address the current gap by analyzing how AI directly contributes to the creation and transformation of green jobs, using empirical approaches across sectors and countries to provide actionable insights for both academics and policymakers.

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