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Mapping Research on Carbon Emissions in Sustainable Development Goals: A Bibliometric Analysis in Scopus Database

Elza Fatika Nur Haliza[1], Aldous Billezra Bang[2], Hendra Gunawan[3], Enos Paselle[4]
[1]Mulawarman, East Kalimantan, Indonesia, Elzafatika14@gmail.com
[2]Mulawarman, East Kalimantan, Indonesia, Aldousbillezra@gmail.com
[3]Mulawarman, East Kalimantan, Indonesia, Ethamilan88@gmail.com
[4]Mulawarman, East Kalimantan, Indonesia, Enos.paselle@fisip.unmul.ac.id

Corresponding Author: Elzafatika14@gmail.com[1]

Abstract: The intensifying global climate change has made carbon emissions a strategic issue in the sustainable development agenda. Carbon emissions, which mostly come from fossil fuel combustion, urbanization, and industrial activities, are a major contributor to global warming. In the context of the Sustainable Development Goals (SDGs), particularly SDG 13 on climate action, controlling carbon emissions is crucial. This study aims to map research trends on carbon emissions in relation to the SDGs through a bibliometric approach. Data were collected from the Scopus database for the 2014–2024 period using the keywords 'carbon emissions' and 'sustainable development goals,' then analyzed using VOSviewer software. The results show a significant increase in the number of publications each year, with a sharp spike from 2019 to 2024. Bibliometric visualization shows that themes such as "sustainable development," "carbon emissions," and "renewable energy" are the main focus of attention in the literature. Institutions such as King Saud University and the Chinese Academy of Sciences demonstrate significant contributions to publications, while China, India, and Turkey are the countries with the highest number of publications. Network visualizations, topic development (overlay), and research density demonstrate strong relationships between topics and a shift in research focus from economic issues to sustainability solutions and climate change mitigation. This study makes a significant contribution to understanding the direction and dynamics of research related to carbon emissions within the SDGs framework, and helps academics and policymakers identify research gaps and potential cross-disciplinary collaborations to promote more sustainable development.

Keywords: Carbon Emissions, SDGs, Bibliometrics, Climate Change, VOSviewer, Sustainable Development.

INTRODUCTION

Climate change is a major global challenge, and carbon dioxide (CO_2), the primary greenhouse gas, has been identified as a key contributor to global warming. (Galuh et al., 2024). Human activities such as burning fossil fuels, urbanization, and industrial activities accelerate the increase in carbon emissions (Zubaydah et al., 2024). Therefore, controlling carbon

emissions is crucial to achieving environmental sustainability. Sustainable development is a strategic approach taken by the government to improve public welfare by ensuring equitable distribution of resources across all regions, while simultaneously preserving the environment to prevent damage (Hanafi et al., 2024). The Sustainable Development Goals (SDGs) are a form of shared commitment globally and nationally, consisting of 17 main goals and accompanying targets (Husnaini et al., 2018). The delivery of information related to the SDGs reflects the company's efforts to uphold transparency and accountability, particularly in demonstrating their role in minimizing adverse environmental impacts and promoting sustainable social development (Tenriwaru & Serang, 2025).

Carbon emission reporting is an effective way to integrate sustainability goals into corporate strategies and ensure active participation in achieving sustainable development (Fandira et al., 2022). Carbon emissions have a significant impact on achieving the Sustainable Development Goals (SDGs), particularly regarding action on climate change (SDG 13) (Fatimah, 2025). This is emphasized by Anshari & Isnalita (2020) who stated that disclosure of Indonesia's carbon emissions is still voluntary because the Indonesian government has not yet issued a policy requiring every company to disclose its carbon emissions, especially for public companies.

According to data from the World Result Institute in 2014, Indonesia was the sixth largest contributor of carbon emissions in the world, producing 2.05 billion tons of carbon emissions (Chang, 1983). In the research of Yang et al., (2023) it was revealed that carbon emissions have a double effect: on the one hand they can encourage coordination between SDGs in low-income countries, but on the other hand they actually hinder it in high-income countries, thus reflecting regional disparities in development achievements. Carbon emissions are greenhouse gases that are primarily produced from the combustion of fossil fuels, urban development, and industrial production (Hariswan et al., 2022). Since they contribute significantly to global warming and climate change, efficient reduction methods are needed through cooperation, innovation and policy interventions for sustainable development (Cheng, 2024). Carbon emissions refer to the release of carbon dioxide (CO2) and other greenhouse gases (GHGs) into the atmosphere, which generally originate from industrial activities, energy generation, and the transportation sector (Saptomo et al., 2019). These emissions are one of the main factors triggering global warming and climate change, so appropriate and effective management strategies and reduction efforts are needed (Zaky & Sari, 2024).

Several previous studies have demonstrated the importance of contributing to climate change issues within the context of the Sustainable Development Goals (SDG 13). The following paragraphs illustrate how a program was designed to be concise yet significantly impactful on the environment, and serve as the basis for this study (Z et al., 2024). Other previous research has revealed that disclosure of carbon emissions contributes significantly to understanding the factors influencing corporate disclosure of carbon emissions. These findings serve as a starting point for strengthening the theoretical and analytical foundations of our study, particularly in the context of carbon emissions and their relationship to sustainable development goals (Saptiwi, 2019). Scientific studies on carbon emissions in the context of the Sustainable Development Goals (SDGs) continue to experience rapid development (Galuh et al., 2024). However, research directions and trends in this field have not been fully systematically mapped. Therefore, bibliometric analysis is a relevant and important approach to identifying publication trends, collaboration patterns among researchers, dominant keywords, and emerging themes. Using the Scopus database, one of the largest and most trusted scientific literature indexes, this mapping can be conducted comprehensively and based on high-quality data (Anastasya & Putri, 2024). This study aims to provide a comprehensive overview of the direction and focus of research related to carbon emissions within the SDGs framework. Through the resulting mapping, it is hoped that this research can serve as a strategic reference for academics, policymakers, and practitioners to identify research gaps, identify potential cross-disciplinary

collaborations, and develop a more focused, targeted, and impactful research agenda for sustainable development. Based on the above description, it is important to understand how research trends on carbon emissions are evolving in the context of the Sustainable Development Goals (SDGs), and to identify the contributions of institutions and countries that dominate this field. Furthermore, an analysis of the network of topical linkages, the development of themes over time, and the density of research is necessary to provide a comprehensive picture of the direction and focus of existing scientific studies. Therefore, this study was formulated to answer three main questions: (1) what are the trends in carbon emissions research in the context of the SDGs? (2) which affiliates and countries have the highest contributions to this research? and (3) what is the network structure, time span, and the density of themes in the carbon emissions literature related to the SDGs?

METHOD

This research method uses bibliometric analysis to map the literature on carbon emissions in the context of the Sustainable Development Goals (SDGs). The research data was obtained by searching the Scopus database, known as a trusted source for providing comprehensive academic metadata. The search was conducted using a query targeting articles that included the keywords "carbon emissions" and "sustainable development goals" in the title, abstract, or keywords. Using this query, only relevant articles on carbon emissions and the Sustainable Development Goals were included in the analysis.

The search was limited to publications published between 2014 and 2024, to ensure that only the most recent literature was included. Furthermore, filters were used to include only specific publication types, such as scientific articles (ar), conference proceedings (cp), and scientific book chapters (ch), all of which must be written in English. With this approach, this study focuses on the most relevant and recent scientific publications in the field of carbon emissions and the SDGs, providing a clear overview of existing research trends.

After data collection, further analysis was conducted using VOSviewer software, which allows for visualization and analysis of bibliometric data. VOSviewer will be used to map the relationships between key themes, authors, institutions, and countries contributing to the research. This analysis aims to identify development trends, international collaborations, and the contributions of key authors and institutions in the field of carbon emissions and the Sustainable Development Goals. Using VOSviewer, this study will provide deeper insights into the research dynamics in this field and future research directions (Perdana & Haliza, 2024).

RESULTS AND DISCUSSION

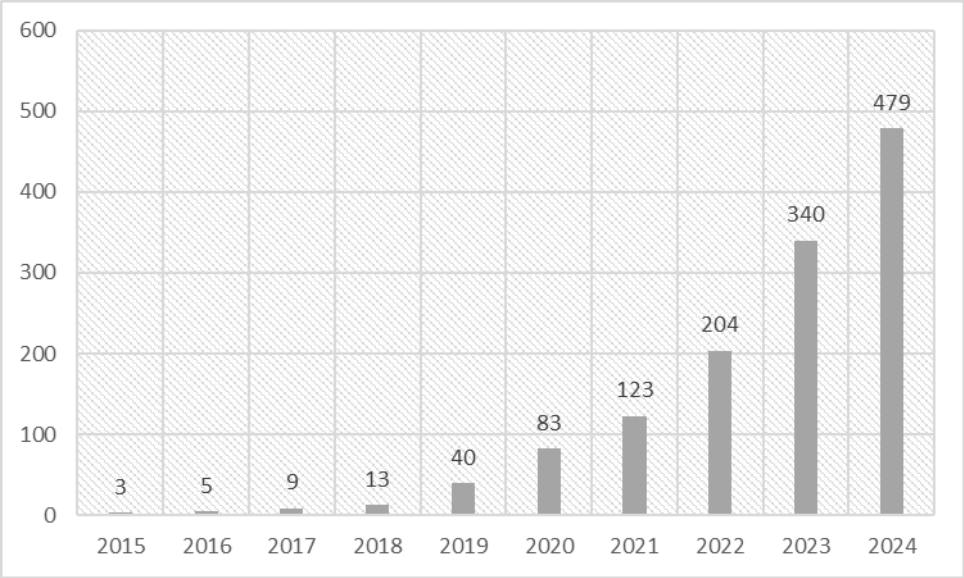
Research Trends on Carbon Emissions in the Sustainable Development Goals

Research trends on carbon emissions in the context of the Sustainable Development Goals (SDGs) show a significant increase in the number of publications from year to year. In 2015, there were only three publications covering this topic, reflecting the initially limited attention to carbon emissions in the context of the SDGs. However, the number of publications began to increase moderately in 2016 with five articles, and continued to grow to nine publications in 2017. This increase reflects the beginning of greater attention to the relationship between carbon emissions and the achievement of sustainable development goals.

Over time, the number of publications has increased sharply. In 2018, there were 13 publications discussing carbon emissions within the SDGs, and in 2019, the number jumped significantly to 40. This surge indicates that the issue of carbon emissions is receiving greater attention as global awareness of climate change and its impact on sustainable development grows. A further increase occurred in 2020, with 83 publications, reflecting the growing importance of this topic on the global agenda, particularly amidst the COVID-19 pandemic, which has heightened discussions about environmental sustainability.

Research trends continue to show rapid growth, with 123 publications in 2021, 204 in 2022, and an estimated 340 publications in 2023. By 2024, the number of publications is expected to reach 479, indicating that carbon emissions in the context of the SDGs are increasingly becoming a key focus of global research. This increase in the number of publications reflects the importance of this topic on the international research agenda, where carbon emissions and mitigation measures are increasingly seen as integral to achieving the Sustainable Development Goals. The sharp increase in recent years indicates that this issue is gaining depth and receiving significant attention in global efforts to mitigate the impacts of climate change.

Table 1. Research Trends Carbon Emissions in Sustainable Development Goals



Source: Database Scopus

Top Affiliations and Countries in Carbon Emissions Research in Sustainable Development Goals

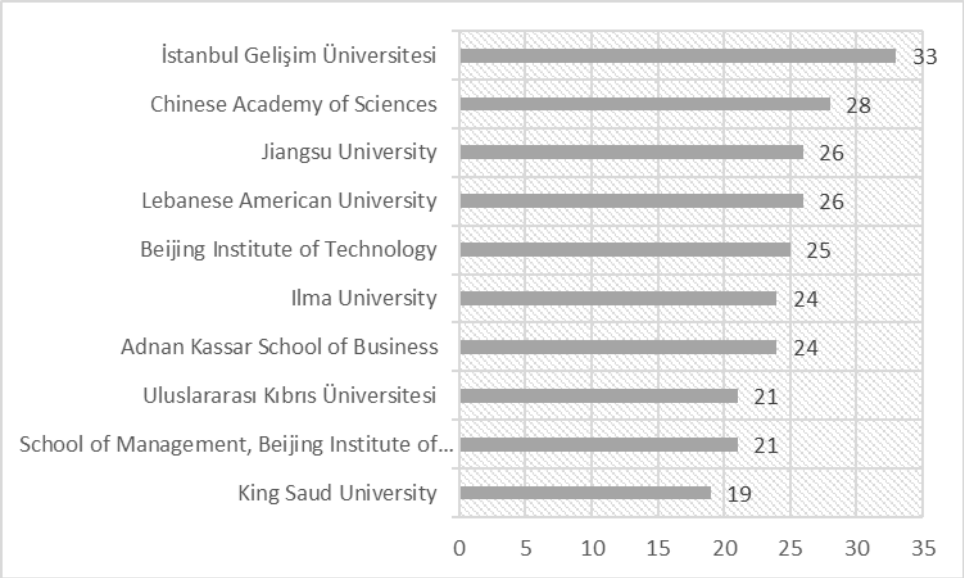
In research on carbon emissions in the context of the Sustainable Development Goals (SDGs), several leading institutions have made significant contributions. King Saud University in Saudi Arabia is one of the largest contributors, with a total of 19 publications. Furthermore, the Beijing Institute of Technology, which comprises two entities contributing to this research, has recorded a total of 25 publications, underscoring its important role in research related to carbon emissions and sustainability in the Asian region.

Furthermore, Uluslararası Kıbrıs Üniversitesi and Adnan Kassar School of Business have recorded 21 and 24 publications, respectively, demonstrating significant contributions from institutions in Turkey and Lebanon. Ilma University and the Lebanese American University have contributed 24 and 26 publications, respectively, indicating that these institutions also play a significant role in enriching the literature on carbon emissions and the SDGs, particularly in the Arab world and the Middle East.

Substantial contributions also came from Jiangsu University (26 publications) and the Chinese Academy of Sciences (28 publications), reflecting China's dominance in research related to carbon emissions and sustainable development. Furthermore, İstanbul Gelişim University stands out as one of the leading institutions active in this research in Turkey, with 33 publications. Overall, this data demonstrates that institutions from various countries, particularly those in Asia and the Middle East, are playing a significant role in advancing research on carbon emissions and the SDGs. This contribution reflects the growing global

attention to climate change and the need for international collaboration to achieve sustainable development goals.

Table 2. Top Affiliation On Carbon Emissions In Sustainable Development Goals Reseach



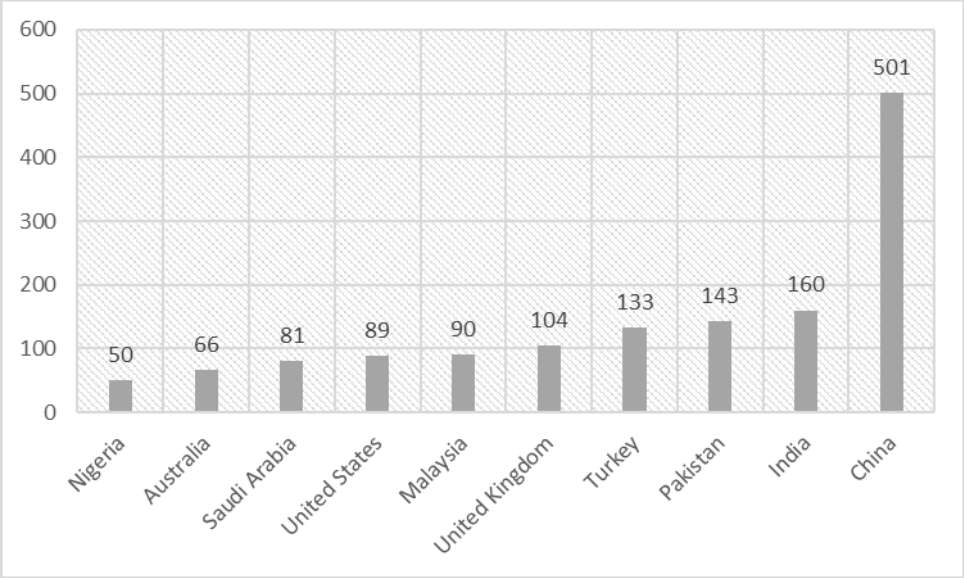
Source: Database Scopus

Next, in research on carbon emissions in the context of the Sustainable Development Goals (SDGs), several countries have made significant contributions to the existing literature. China leads the way with the highest number of publications, reaching 501, indicating its leading role in research related to carbon emissions and sustainability. This significant contribution from China reflects the country's significant efforts to address the challenges of climate change and strengthen the global sustainable development agenda.

Other major countries, such as India with 160 publications, Pakistan with 143, and Turkey with 133, also demonstrate significant attention to carbon emissions. The increase in publications from these countries reflects their growing awareness and commitment to carbon emission reduction efforts and achieving the SDGs. The United Kingdom (104 publications) and the United States (89 publications) also play significant roles in this literature, reflecting the contributions of developed countries to enriching research in this area.

Malaysia and Saudi Arabia recorded 90 and 81 publications, respectively, indicating that countries in Asia and the Middle East are also increasingly active in research on carbon emissions and sustainability. Australia, with 66 publications, and Nigeria, with 50, demonstrate significant contributions from countries in other regions, further reinforcing the importance of international collaboration in addressing the challenges of climate change. Overall, this data demonstrates that research on carbon emissions in the context of the SDGs has gained global attention, with significant contributions coming from countries across the globe.

Table 3. Top Countries On Carbon Emissions In Sustainable Development Goals Reseach

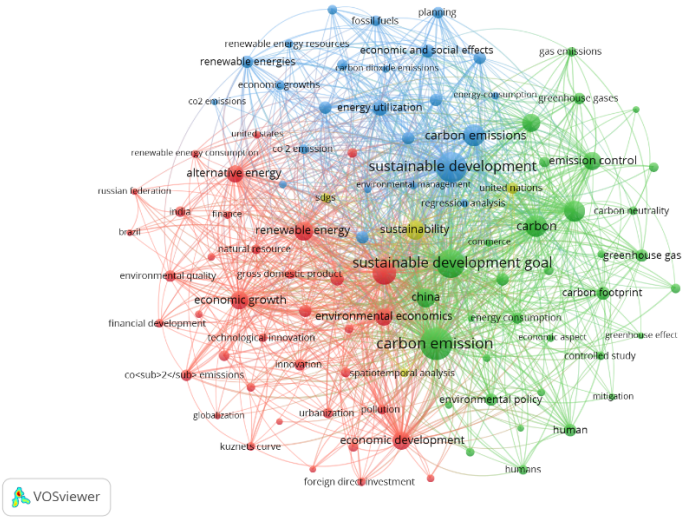


Source: Database Scopus

Network, Overlay and Density Research on Carbon Emissions in Sustainable Development Goals

Research related to carbon emissions and the Sustainable Development Goals (SDGs) is growing along with increasing global awareness of the importance of environmental sustainability and controlling the impacts of climate change (Rahayu, 2025). In this context, bibliometric analysis is used to map the relationships between various concepts in the literature related to carbon emissions and efforts to achieve the SDGs. The data visualizations generated through this analysis provide deeper insights into research trends, interrelationships between topics, and shifts in research focus over time. The following discussion will examine three types of data visualizations that illustrate the network of relationships between topics, the temporal evolution of research, and the density of research across various themes.

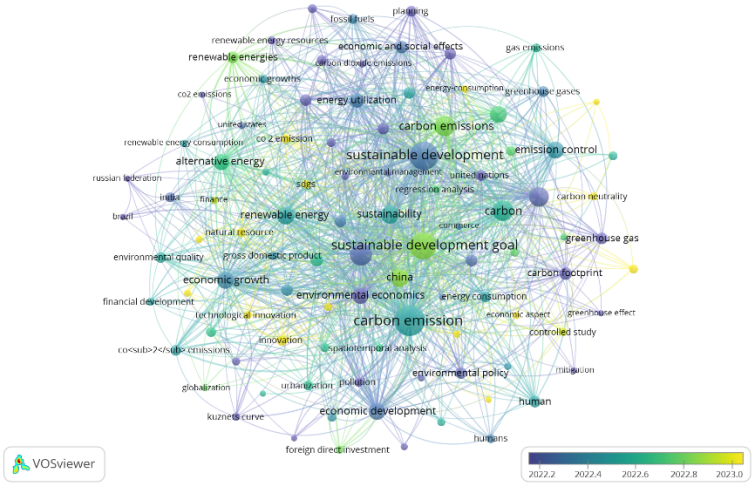
The first visualization is a Network Visualization that shows the relationship between various keywords in the literature related to carbon emissions and the SDGs (Mahfuza et al., 2025). In this figure, we can see that larger nodes, such as "sustainable development," "carbon emissions," and "carbon," are the most dominant and frequently occurring themes in the research literature. This indicates that these topics are a major focus in the field. Furthermore, terms like "energy consumption," "greenhouse gases," and "carbon footprint" are connected to these larger themes, indicating that they are interconnected within the broader discussion. Each keyword connection illustrates the interconnectedness of ideas and concepts explored in the scientific literature, with different colors indicating topic clusters that focus on specific aspects. For example, the red cluster focuses more on economic aspects, the green cluster on controlling carbon emissions, and the blue cluster on renewable energy. This visualization provides a clear picture of how various research topics related to carbon emissions and the SDGs interact.



Source: Scopus database processed with VOSviewer, 2025

Figure 1. Network Visualization

The second visualization is the Overlay Visualization, which uses color gradients to show the evolution of these topics over time. The blue and green colors in the center and around keywords like "sustainable development" and "carbon emissions" indicate that these studies appeared more frequently in 2022 and 2023, indicating their growing presence in the scientific literature. Topics like "carbon neutrality," "emission control," and "renewable energy" are also widely discussed in recent research, reflected in the blue and green colors in these areas. Conversely, the yellow and orange colors located more toward the outside of the visualization indicate that topics like "economic growth," "environmental economics," and "globalization" appear more frequently in older research. This indicates that these topics have been the focus of research for a long time, but there is now a shift in focus to more sustainable solutions related to carbon emission reduction and renewable energy use.



Source: Scopus database processed with VOSviewer, 2025

Figure 2. Overlay Visualization

The third visualization is the Density Visualization, which provides an overview of research concentration based on intensity. Darker areas indicate a higher concentration of research related to a particular keyword. The darker centers of the visualization, with keywords such as "sustainable development" and "carbon emissions," indicate that these topics are the most widely discussed in the literature. This finding confirms that studies on carbon emission

management and sustainable development are highly dominant. Furthermore, darker areas also indicate a significant concentration of research on keywords such as "renewable energy," "carbon footprint," and "energy consumption." This confirms that topics related to carbon emission reduction and sustainable energy use are receiving significant attention in current research. This visualization also helps us understand where researchers are focusing, with lighter areas indicating topics that have received relatively less research attention.

Source: Scopus database processed with VOSviewer, 2025

Figure 3. Density Visualization

Taken together, these three visualizations provide an in-depth look at trends in carbon emissions and Sustainable Development Goals research. The network visualization illustrates how different topics are interconnected, the overlay visualization shows the temporal shift in research focus, and the density visualization highlights the most discussed areas in the literature. By understanding these visualizations, we can see how the discussion on carbon emissions and sustainable development has evolved over time, as well as the key areas of focus that are of concern in current research. In line with legitimacy theory, companies that consistently disclose carbon emissions will improve their standing in society, ultimately improving corporate performance and promoting corporate sustainability. (Husnaini et al., 2018).

CONCLUSION

This study aims to map trends and developments in scientific literature related to carbon emissions in the context of the Sustainable Development Goals (SDGs) through a bibliometric approach using data from the Scopus database from 2014 to 2024. The number of publications on the topic of carbon emissions in relation to the SDGs has increased significantly over the past decade. The sharp increase began in 2019 and continues to rise, reaching an estimated 479 publications by 2024. This reflects the growing awareness and attention of the global scientific community towards carbon emissions as an integral part of the sustainable development agenda. Several institutions have made significant contributions to the development of related literature, including King Saud University, the Chinese Academy of Sciences, and the Beijing Institute of Technology. In terms of countries, China is the largest contributor with 501 publications, followed by India, Pakistan, and Turkey. This dominance of institutions and countries underscores the important role of Asia and the Middle East in advancing research on climate change and carbon emissions. Visualization using VOSviewer shows that the most frequently appearing keywords are "sustainable development," "carbon emissions," and "renewable energy."

These topics center on the issue of emission control, clean energy use, and their impacts on the environment and the economy. Topic clusters are categorized into areas such as

renewable energy, energy consumption, carbon footprint, and greenhouse gas emissions, all of which are interconnected in the scientific discourse. Through overlay and density visualization, it is known that topics such as "carbon neutrality" and "renewable energy" have begun to receive greater attention in recent years, while the initial focus of research was more focused on economic aspects and globalization. This indicates a shift in focus from macroeconomic analysis to more environmentally friendly and sustainable practical solutions. This study provides a comprehensive overview of the carbon emissions research landscape in the context of the SDGs, which can be used as a basis for determining the direction of further research. Furthermore, the results of this study are also important for policymakers in developing more measurable, evidence-based carbon emission reduction strategies that support the achievement of SDG 13 (Climate Action).

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