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SUSTAINABLE DEVELOPMENT GOALS AND TODAY'S IOT AND AI WORLD: BIBLIOMETRIC APPROACH

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ABSTRACT:

Purpose: This article investigates the link between *"the Internet of Things (IoT), artificial intelligence (AI), and the Sustainable Development Goals (SDGs)"* by using a bibliometric analysis. More specifically, the article will focus on the years 2017–2024 in order to identify significant trends, prominent actors, and areas of research convergence.

Design/Methodology/Approach: Bibliometric methodology was used, using data taken from the Scopus database as the source of information. Through the use of software applications such as VOSviewer and R-studio, the research output was analysed, and visualisations of co-authorship networks, keyword co-occurrences, and research trends were brought into existence.

Findings: Indian institutions have made considerable contributions, with a particular emphasis on smart cities, agriculture, and financial markets as major areas where Internet of Things and artificial intelligence are furthering Sustainable Development Goals (SDGs), according to the report. The multidisciplinary character of this study topic is particularly highlighted by the presence of collaborative networks and theme clusters.

Originality/Value: Researchers, policymakers, and practitioners may all benefit from this article since it gives a thorough review of the present state of research at the convergence of the Internet of Things (IoT), artificial intelligence (AI), and sustainable development goals (SDGs). It also offers insights into emerging trends and prospective topics for further inquiry.

Keywords: IoT, AI, Sustainable Development Goals, Bibliometric Analysis, Smart Cities, Agriculture, Financial Markets

1. Introduction

Worldwide, innovation and efficiency have been propelled by the lightning-fast advancements in AI and the Internet of Things (IoT) (Alreshidi, 2019). Besides revolutionising whole sectors, these developments are very congruent with the SDGs, which are a set of global objectives put out by the UN to combat issues including poverty, inequality, climate change, and environmental degradation (Zulu et al., 2024). The capacity of these technologies to facilitate and accelerate the attainment of SDGs is becoming more obvious as they undergo continuous evolution. The Internet of Things (IoT) and artificial intelligence (AI) are altering established

businesses and paving the way for more egalitarian and sustainable global practices via their ability to link objects and systems and analyse and act upon massive volumes of data. A crucial area of research is the convergence of these technologies with SDGs, as it shows how we can use current tech to solve some of the biggest problems people are experiencing now.

According to Chakraborty et al. (2021), smart cities are metropolitan regions that integrate technology to improve the lives of its residents while minimising their environmental footprint. The Internet of Things (IoT) and artificial intelligence (AI) play a crucial role in these smart cities. The Internet of Things (IoT) allows smart cities to track a variety of metrics in real time, including energy use and traffic patterns, which are then analysed by artificial intelligence systems to improve municipal operations. Goal 11, which addresses sustainable cities and communities, may be directly advanced, for instance, by optimising traffic flow with the use of AI-driven analytics, thereby decreasing emissions and congestion (Zhaojie et al., 2020). Additionally, by optimising collection routes and monitoring garbage levels in real-time, smart waste management systems driven by AI and the Internet of Things may reduce fuel consumption and the environmental imprint of waste management operations. In line with the overarching goals of the SDGs, these advancements make cities more sustainable while simultaneously improving their liveability.

To achieve SDG 2: Zero Hunger, it is essential to modernise the agriculture industry, and the Internet of Things (IoT) and artificial intelligence (AI) are doing just that (Alreshidi, 2019). There is a lot of environmental damage and resource loss associated with traditional farming techniques. But with the help of AI and the Internet of Things, precision agriculture is possible, leading to far more effective use of water and fertilisers. The data provided by Internet of Things (IoT) sensors may help farmers make educated choices on the timing and amount of fertiliser and water applied to their crops by continuously tracking soil moisture levels, weather conditions, and crop health. By analysing this data, AI systems can forecast harvests, find the best times to sow seeds, and even spot impending insect outbreaks. By enhancing agricultural output and decreasing the environmental effect of farming, this contributes to the sustainable assurance of food security. It is crucial to address the global problem of feeding a rising population, and the Internet of Things (IoT) and artificial intelligence (AI) are playing a key role in making agriculture more resilient and sustainable by allowing more effective use of resources and decreasing waste.

2. Background of E-Sentiments and Stock Market Prediction

A multi-faceted phenomena, the meeting point of the Internet of Things (IoT), artificial intelligence (AI), and the Sustainable Development Goals (SDGs) affects many fields, including the social and economic ones, such stock market forecasting. In the past, basic research and historical data were the mainstays of stock market prediction. But e-sentiments, a new data source made possible by the rise of social media and the internet, has become an effective instrument for economic prediction. E-sentiments are the general feelings or opinions shared by people in online spaces such as social media, blogs, and news sites (Walshe et al., 2021). These feelings, which are indicative of the general public's and investors' attitudes, have the potential to greatly impact market fluctuations. An innovative method for forecasting market trends is made possible by the real-time analysis of e-sentiments by AI algorithms. This enables a more dynamic and up-to-the-minute comprehension of market behaviour. Goal 8 of the Sustainable Development Agenda is to establish stable and responsive financial markets in order to ensure sustained, inclusive, and sustainable economic development. This strategy is very pertinent to this goal.

E-sentiment analysis relies heavily on AI since it can handle and make sense of massive volumes of unstructured data that humans just cannot. In order to determine how the public feels about certain stocks, sectors, or economic events, AI systems, especially those that rely on natural language processing (NLP), can sift through millions of messages on social media and news articles (Johri et al., 2021). Artificial intelligence may detect trends and correlations in public opinion and stock market fluctuations by classifying these attitudes as positive, negative, or neutral. Take social media as an example. If people suddenly start feeling bad about a firm, it might be a sign that its stock price is about to fall. On the other side, optimistic attitude may indicate that stock value is about to rise. Traders and financial institutions may make better judgements with the help of this real-time analysis, which might result in markets that are more stable and predictable. Additionally, AI improves the precision of stock market forecasts by integrating e-sentiments into financial models; this is critical for preserving investor trust and economic stability.

By supplementing AI and e-sentiments with real-time data, the Internet of Things (IoT) integration in financial markets improves the accuracy of market forecasts. A plethora of monetary transactions and external variables impacting market circumstances may be tracked by Internet of Things (IoT) devices like sensors and smart systems. To illustrate the point, according to Pérez Henríquez (2019), commodities prices may be affected by the availability of items tracked in real-time via the Internet of Things (IoT), which also provides vital data on physical supply chain movements. The Internet of Things (IoT) may also track energy use, agricultural output, and even geopolitical developments, all of which have the potential to impact market patterns. Financial organisations may build more thorough models that take into consideration both quantitative data and qualitative e-sentiments by merging this real-time data with sentiment analysis powered by artificial intelligence. The Internet of Things (IoT) and artificial intelligence (AI) work together to make financial infrastructures more responsive and robust, which helps achieve SDG 8's goal of ensuring the long-term health of world economies.

Beyond simple financial forecasting, the wider ramifications of using e-sentiments and the Internet of Things in stock market prediction are substantial. Financial markets are becoming more open and accessible thanks in large part to these technology. More people, from small-scale investors to huge financial organisations, will be able to take part in the financial markets thanks to the democratisation of data and insights made possible by AI and the Internet of Things (Choudhari & Sasankar, 2021). More varied market participants may use the same data to make educated judgements, which can lead to more fair economic results if participation is expanded. In addition, ethical investing principles— which take into account not just financial returns but also social and environmental implications—are compatible with financial markets' usage of AI and IoT. These technologies aid in the attainment of SDG 8 and the maintenance of global financial stability over the long run by enabling more precise and rapid market forecasts, which in turn reduce risks and encourage more sustainable economic activities.

2.1 Rationale of the Study

This work is motivated by the need to get a bibliometric understanding of the increasing influence of AI and the Internet of Things on the attainment of SDGs (Monteiro et al., 2021). Although several studies have examined the effects of AI and the Internet of Things (IoT) on their own, very little is known about how these two technologies could work together to promote sustainable development (Dhanaraj et al., 2024). According to Savanna et al. (2024), this study intends to use bibliometric analysis to draw a picture of the research environment, spot important trends, and showcase the leading writers, institutions, and publications in this

field. In addition to shedding light on where things stand in terms of research, this all-encompassing method suggests avenues for additional investigation, such as how the Internet of Things and artificial intelligence might be better used to achieve worldwide sustainability goals (Pohjola et al., 2021).

Research Questions

1. How have IoT and AI technologies been utilized to support the achievement of SDGs from 2017 to 2024?
2. What are the key trends and research themes in the intersection of IoT, AI, and SDGs?
3. Which authors, institutions, and countries have made the most significant contributions to this field?

3. Methodology

This bibliometric study explores the intersection of Sustainable Development Goals (SDGs) with the advancements in Internet of Things (IoT) and Artificial Intelligence (AI) from a global perspective. The analysis encompasses research articles published between the years 2017 to 2024, offering a comprehensive overview of how these technologies are being leveraged to achieve various SDGs.

Data Collection

The bibliometric data was extracted from the Scopus database, one of the most comprehensive sources for peer-reviewed literature. The dataset includes a total of [insert total number] articles, focusing on the keywords "Sustainable Development Goals," "Internet of Things," and "Artificial Intelligence."

Keyword Selection

The keywords were chosen based on their relevance to the intersection of SDGs, IoT, and AI. These include but are not limited to:

- Internet of Things (IoT)
- Artificial Intelligence (AI)
- Sustainable Development Goals (SDGs)
- Smart Cities
- Machine Learning
- Big Data

Inclusion Criteria

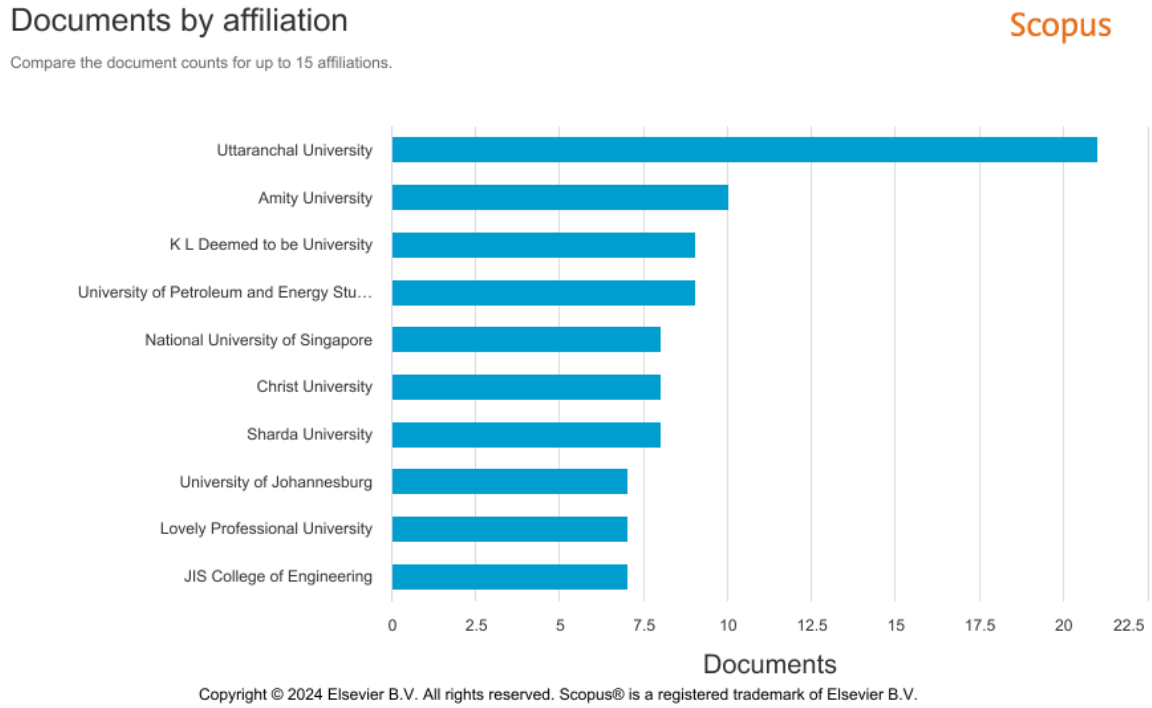
The study includes papers published from 2017 to 2024, ensuring a focus on the latest developments in the field. A specific emphasis was placed on articles published in 2024, with at least ten papers selected to highlight the most recent advancements.

Analysis

The selected articles were analyzed to identify trends, collaboration networks, and the most influential authors and institutions. Visualization tools, such as VOSviewer, were employed to create co-authorship networks, keyword co-occurrence maps, and other relevant visualizations. The bibliometric analysis was conducted using the biblioshiny (bibliometrix package) in R-studio and VOSviewer software.

4. Results

4.1 Documents by Affiliation

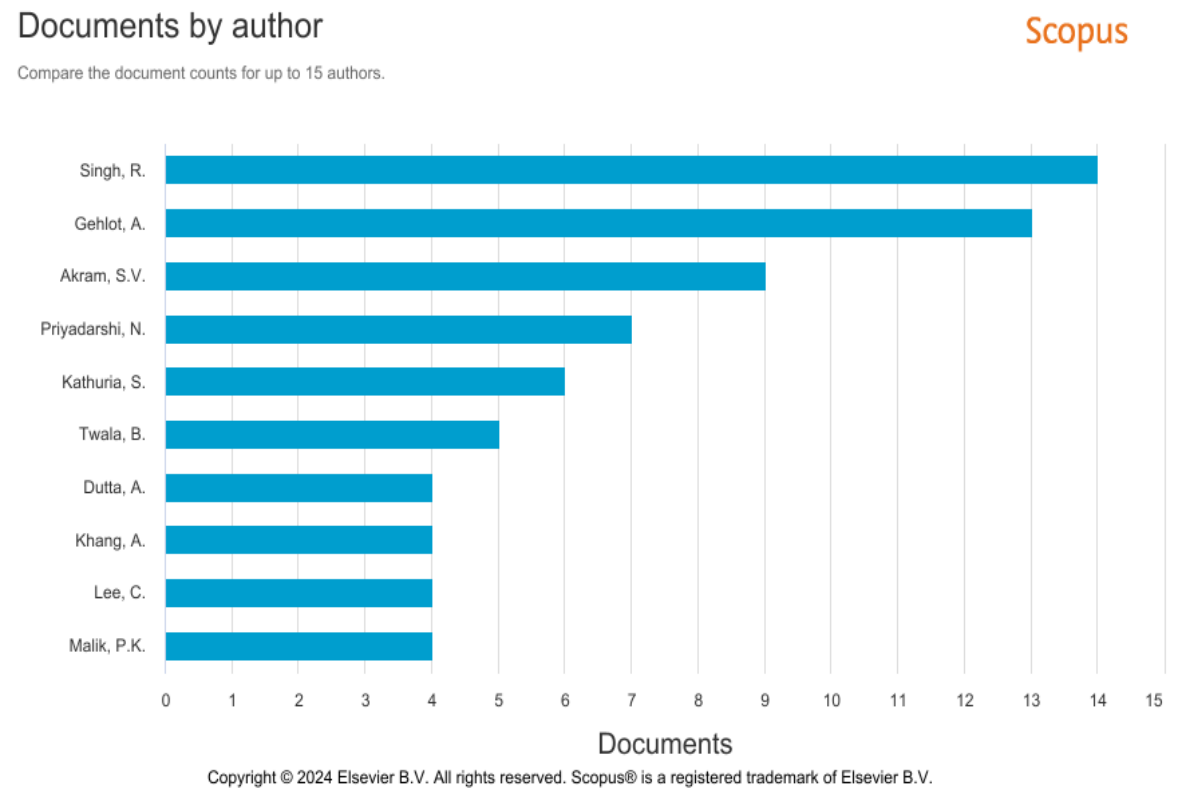


Graph 4.1 Documents by Affiliation

Various academic and research institutes' contributions to the field of IoT, AI, and SDGs may be seen in the "Documents by Affiliation" graph. As a result of its extensive research in these areas, Uttaranchal University has produced more papers than any other university. Next on the list are K L Deemed to be University and Amity University, which show that both schools place a lot of academic emphasis on using AI and the Internet of Things to achieve sustainable development objectives. With a significant number of studies coming out of top institutions in India, this data highlights the significance of institutional engagement in advancing sustainable technology research and innovation. The importance of academic research in developing technology solutions to global problems is emphasised by the prominence of these institutions.

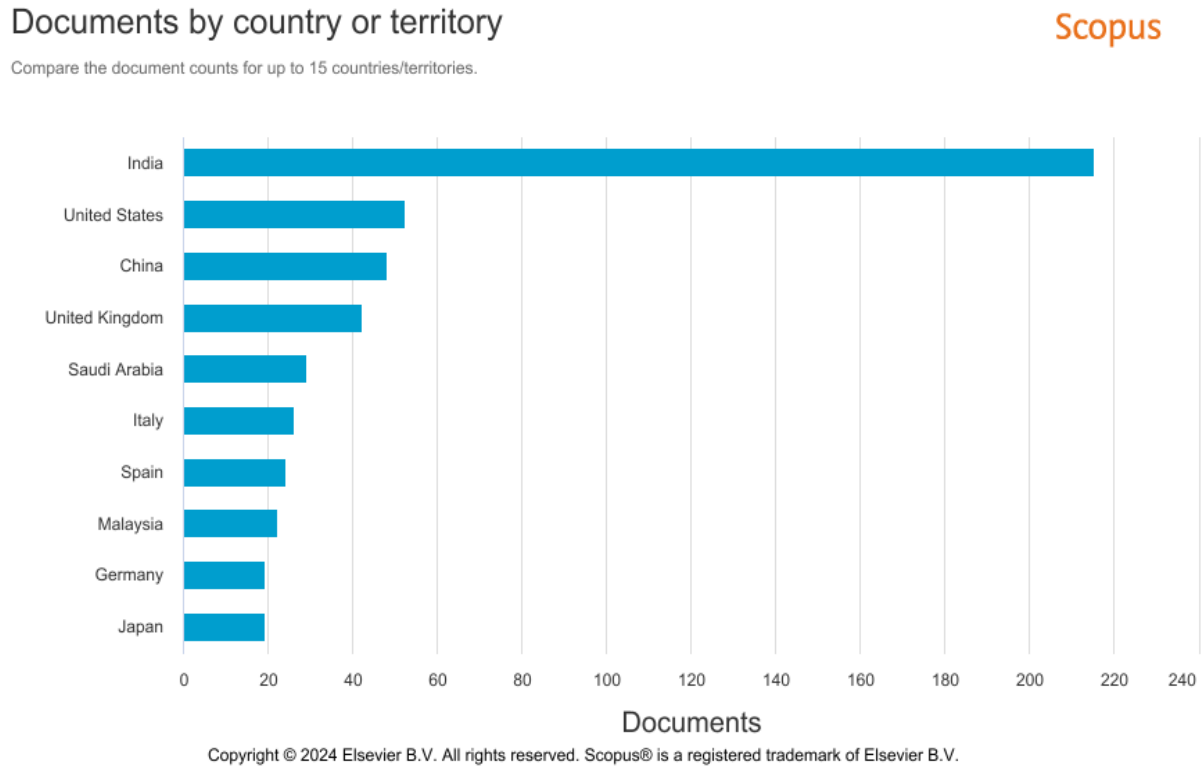
4.2 Documents by Author

Using the "Documents by Author" graph, we can see which top scholars have been working on the interplay between the SDGs, AI, and the Internet of Things. With the most papers, Singh, R. is at the top of the leaderboard, followed by Gehlot, A., and Akram, S. V. These writers have made a big splash in the industry, and their work will certainly help push the field forward in terms of using AI and the Internet of Things to accomplish sustainable development objectives. It is clear that there is a robust research community committed to investigating and broadening the uses of these technologies, since there are several authors with high document counts. Important figures whose contributions are moulding the trajectory of sustainability-focused IoT and AI may be located with the use of this data.



Graph 4.2 Documents by Author

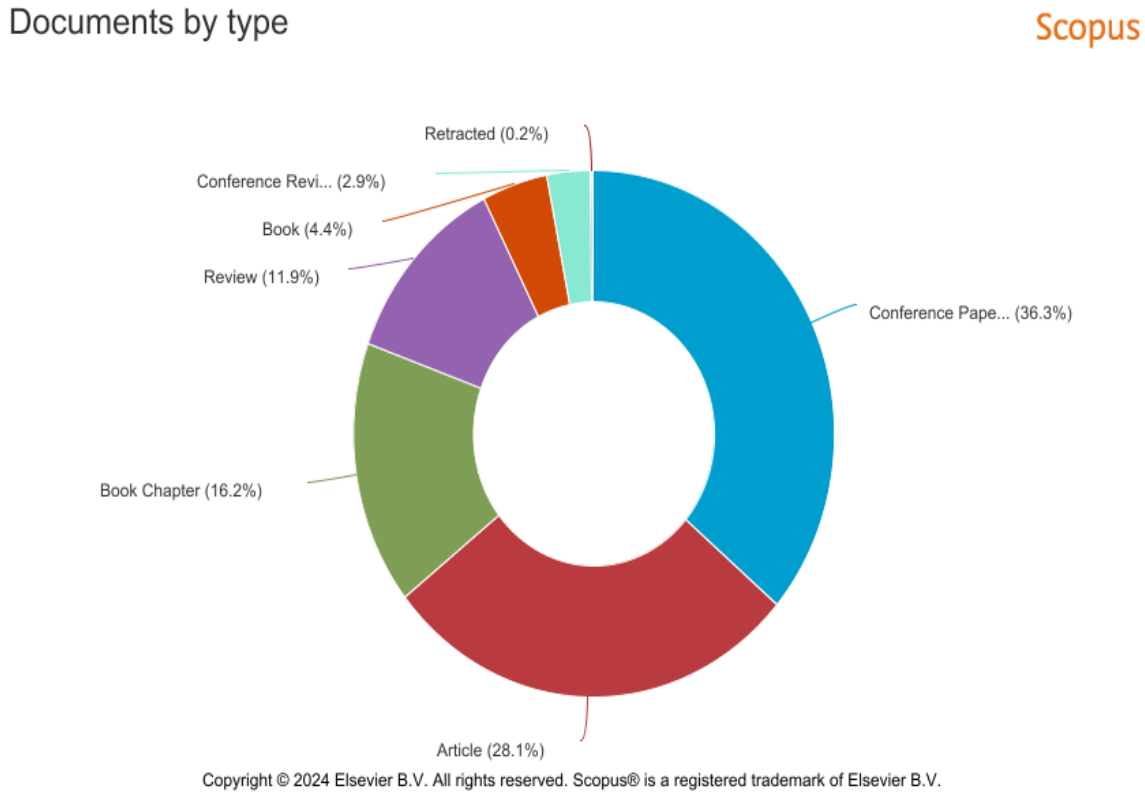
4.3 Documents by Country or territory



Graph 4.3 Documents by Country or territory

India has a significant lead over other nations, including the US and China, in terms of research output linked to the Internet of Things (IoT), artificial intelligence (AI), and sustainable development goals (SDGs), according to the "Documents by Country or Territory" graph. The rising importance of technology and sustainability in India is seen in this domination, which may be prompted by the need to tackle local issues including economic growth, environmental degradation, and urbanisation. Along with their respective contributions, the US and China highlight their position as world leaders in technical invention and implementation. The inclusion of Asian and European nations on this list emphasises the worldwide focus and joint efforts in using AI and the Internet of Things to accomplish sustainable development objectives, hence enhancing the transnational nature of this area of study.

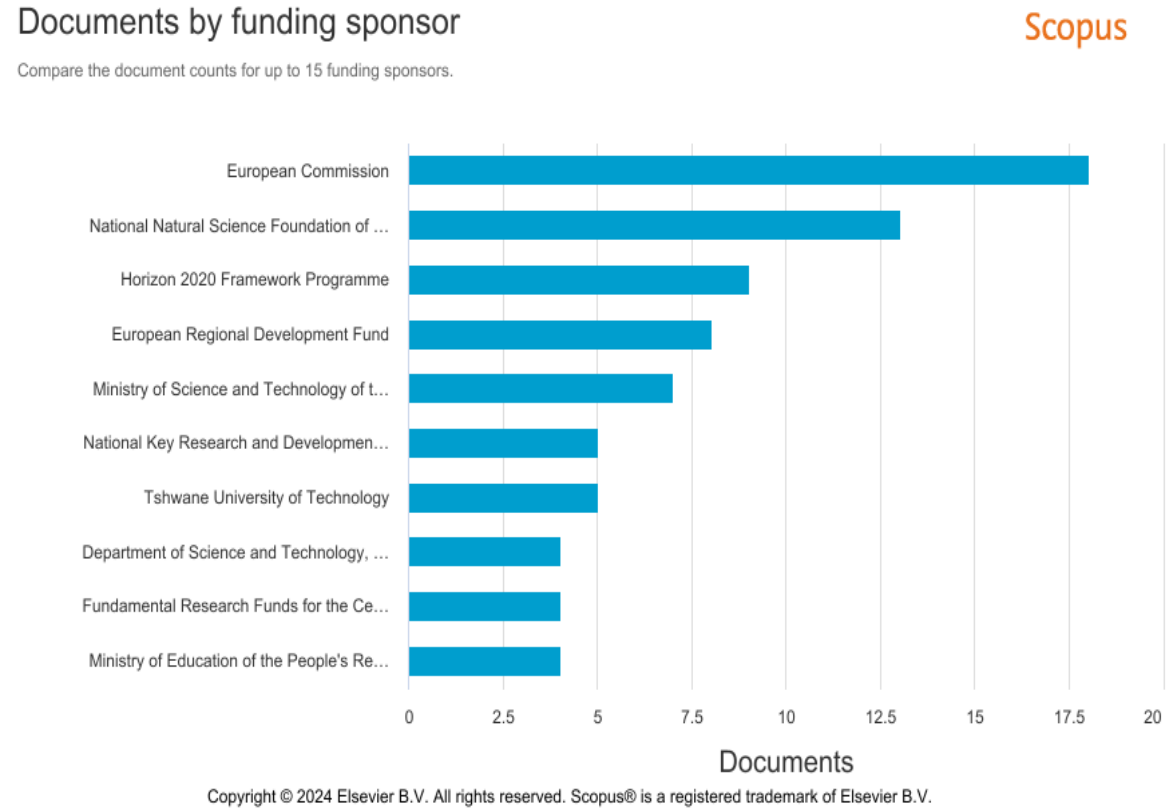
4.4 Documents by type



Graph 4.4 Documents by type

Conference papers, journal articles, and book chapters make up the bulk of the research outputs, according to the "Documents by Type" graph. Academic and professional conferences are great venues for the presentation and discussion of research results pertaining to the Internet of Things (IoT) and artificial intelligence (AI) as they pertain to the Sustainable Development Goals (SDGs). Conferences provide a venue for exchanging cutting-edge research and networking, and this distribution shows that academics are actively promoting their work via them. Since journal articles and book chapters are more commonly associated with in-depth studies and peer-reviewed publications, the large number of them suggests that the research is of a high enough quality to warrant inclusion in the academic literature on sustainable technology integration.

4.5 Documents by Funding Sponsor

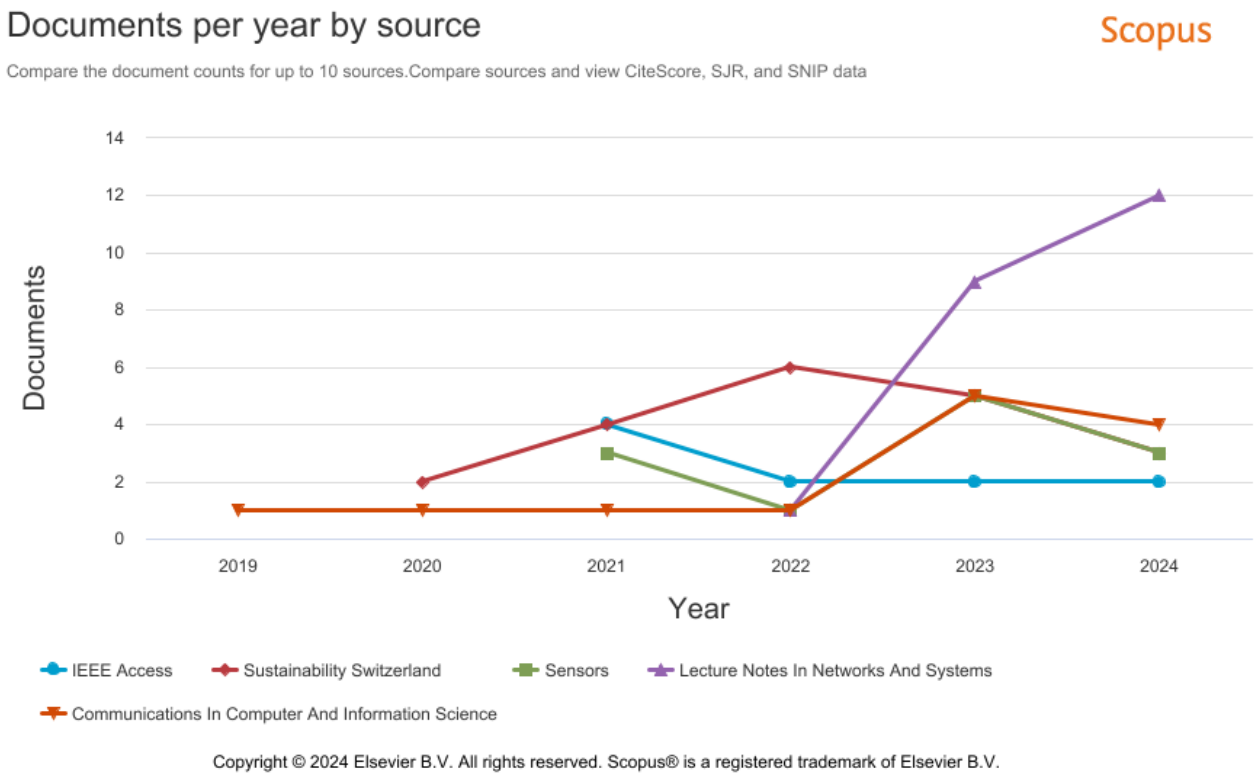


Graph 4.5 Documents by Funding Sponsor

Finding out who has been a major financial backer of studies related to the Internet of Things (IoT), artificial intelligence (AI), and sustainable development goals (SDGs) is made easy with the "Documents by Funding Sponsor" graph. As the primary funder, the European Commission exemplifies Europe's resolve to encourage and facilitate advancements in environmentally friendly technology. Close behind are two other major international research funding agencies, the National Natural Science Foundation of China and the Horizon 2020 Framework Programme. This allocation of funds exemplifies the organisations' long-term objectives in promoting technical solutions to attain sustainable development objectives. Furthermore, it highlights the importance of financing as a catalyst for innovation and research, allowing organisations and individuals to go into uncharted territories in the realms of AI and the Internet of Things.

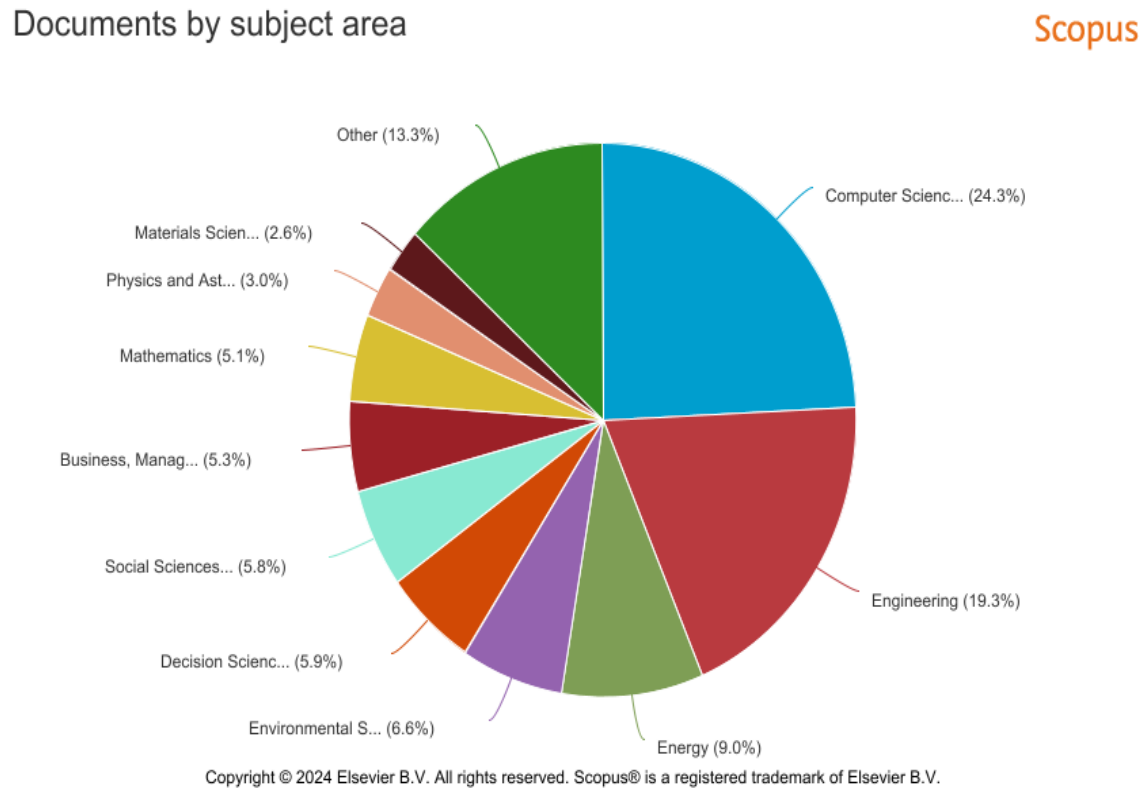
4.6 Documents per year by Source

An analysis of publishing patterns in prestigious journals and conference proceedings is shown in the "Documents per Year by Source" graph, which spans many years. Based on the data, it seems that there is a rising trend in publications, especially in "Lecture Notes in Networks And Systems," that highlight the importance of integrating AI and the Internet of Things in sustainable development. Academic production is rising in tandem with the development of these technologies, reflecting the ever-changing character of the area. This study subject is multidisciplinary since it combines technology and sustainability to solve global problems; sources like "IEEE Access" and "Sustainability Switzerland" consistently contribute to it.



Graph 4.6 Documents per year by Source

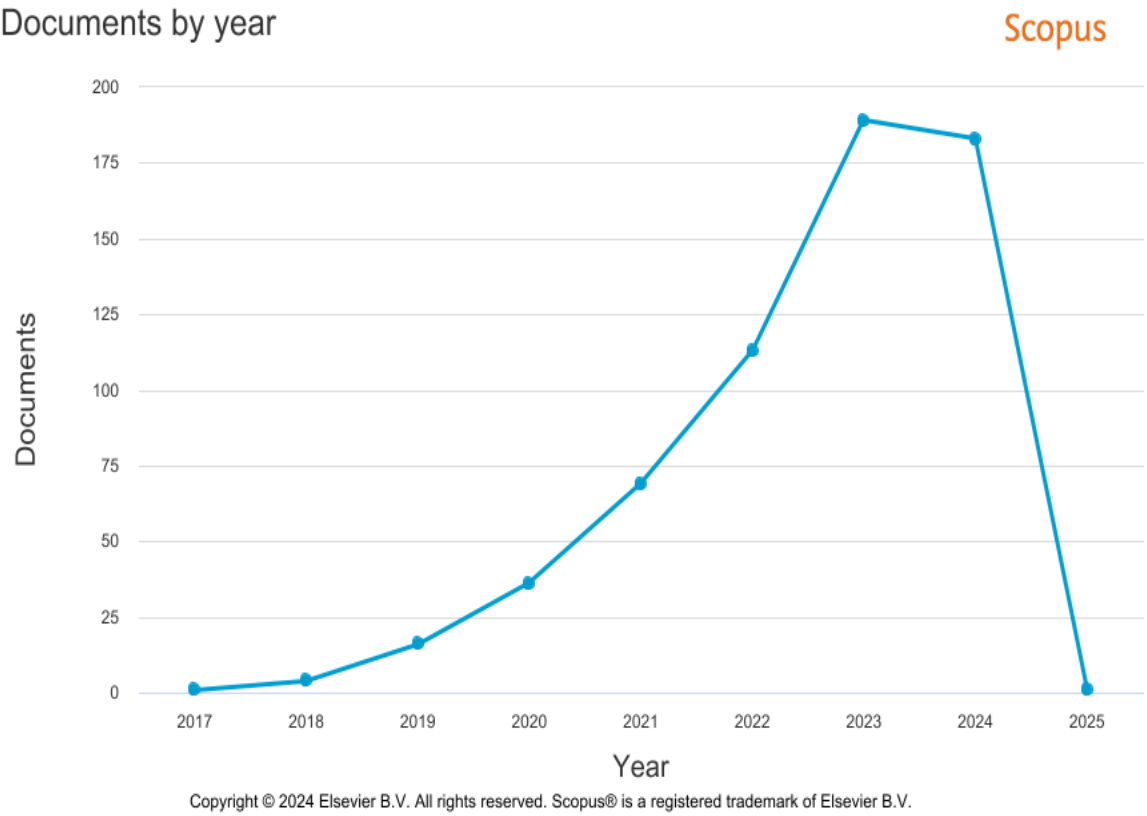
4.7 Documents by Subject Area



Graph 4.7 Documents by Subject Area

Intersectional research on the Internet of Things (IoT), artificial intelligence (AI), and sustainable development goals (SDGs) is multidisciplinary, as seen in the "Documents by Subject Area" graphical representation. With approximately half of the research output coming from computer science and engineering, these fields clearly dominate the topic areas. Since AI and the Internet of Things are mostly driven by technology, this is to be anticipated. These technologies have the potential to contribute to diverse elements of sustainable development, and the existence of other subjects like Energy, Environmental Science, and Business Management shows that they are applicable across sectors. Because it draws on a wide range of knowledge and experiences, this multidisciplinary approach is crucial for solving complicated global problems.

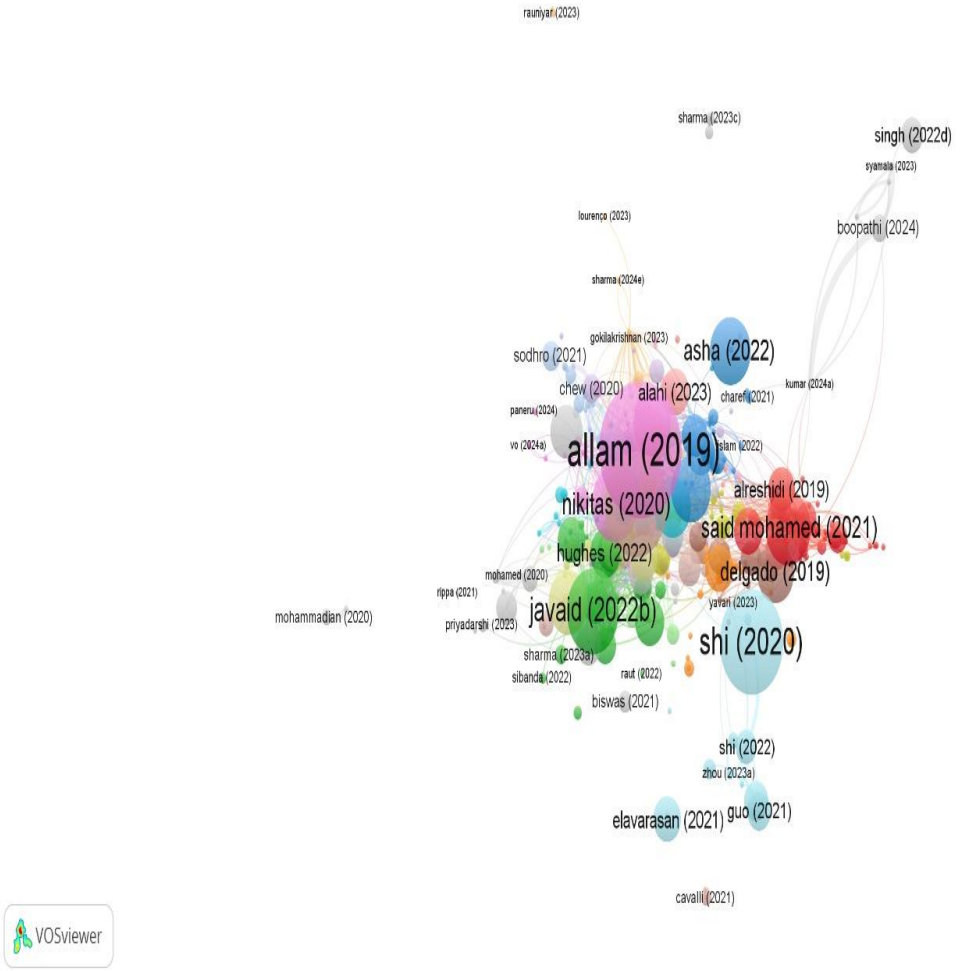
4.8 Documents by Year



Graph 4.8 Documents by Year

From 2017 through 2024, the number of documents increased significantly, reaching a high in 2023, according to the "Documents by Year" graph, which offers a time-series study of research output. Recognition of the potential of the Internet of Things (IoT), artificial intelligence (AI), and the Sustainable Development Goals (SDGs) to solve global difficulties is likely driving this dramatic increase in interest and funding for research in these areas. The little drop in 2024 may be due to the inevitable ups and downs of research production or a change in emphasis to other promising new fields. There is a large amount of research accessible to guide policy, industrial practices, and future academic investigation, indicating a persistent and rising interest in this topic.

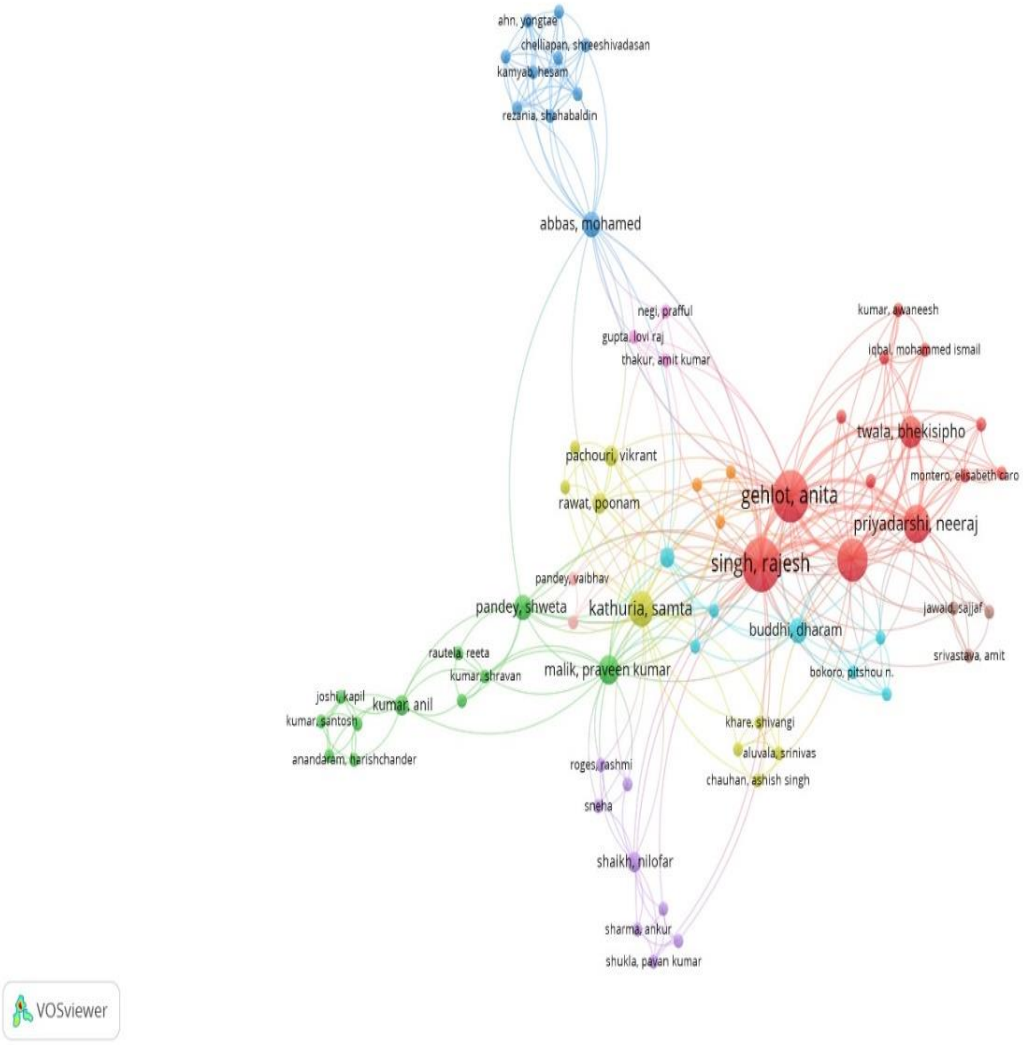
4.9 Service Mapping
Cluster I: Key Contributors in Emerging Research Networks



Graph 4.9: A visualization of prominent researchers and their interconnected influence from 2017 to 2024

From 2017 through 2024, Graph 4.9 displays a network visualisation of eminent scholars who made substantial contributions to the domains of IoT, AI, and Sustainable Development Goals (SDGs). Important people like Allam, Shi, and Javad stand out on the graph as hubs of this network, signifying the significant roles they play in the scientific community. Their high-impact works and regular collaborations with other prominent academics have solidified their positions as leaders in the field. The scholars in this network are likely not operating in a vacuum, but rather contributing to a larger intellectual conversation that cuts across fields and universities. Because it promotes the sharing of information and the joining of forces in research, this interconnection is vital for the advancement of novel concepts and approaches. As a result of the wide variety of uses and areas of interest in AI and the Internet of Things, the graph also shows the formation of many sub-networks or clusters. Future research in the field of Internet of Things (IoT) and artificial intelligence (AI) for sustainable development may be shaped by the foundational work of famous researchers, as shown by these clusters.

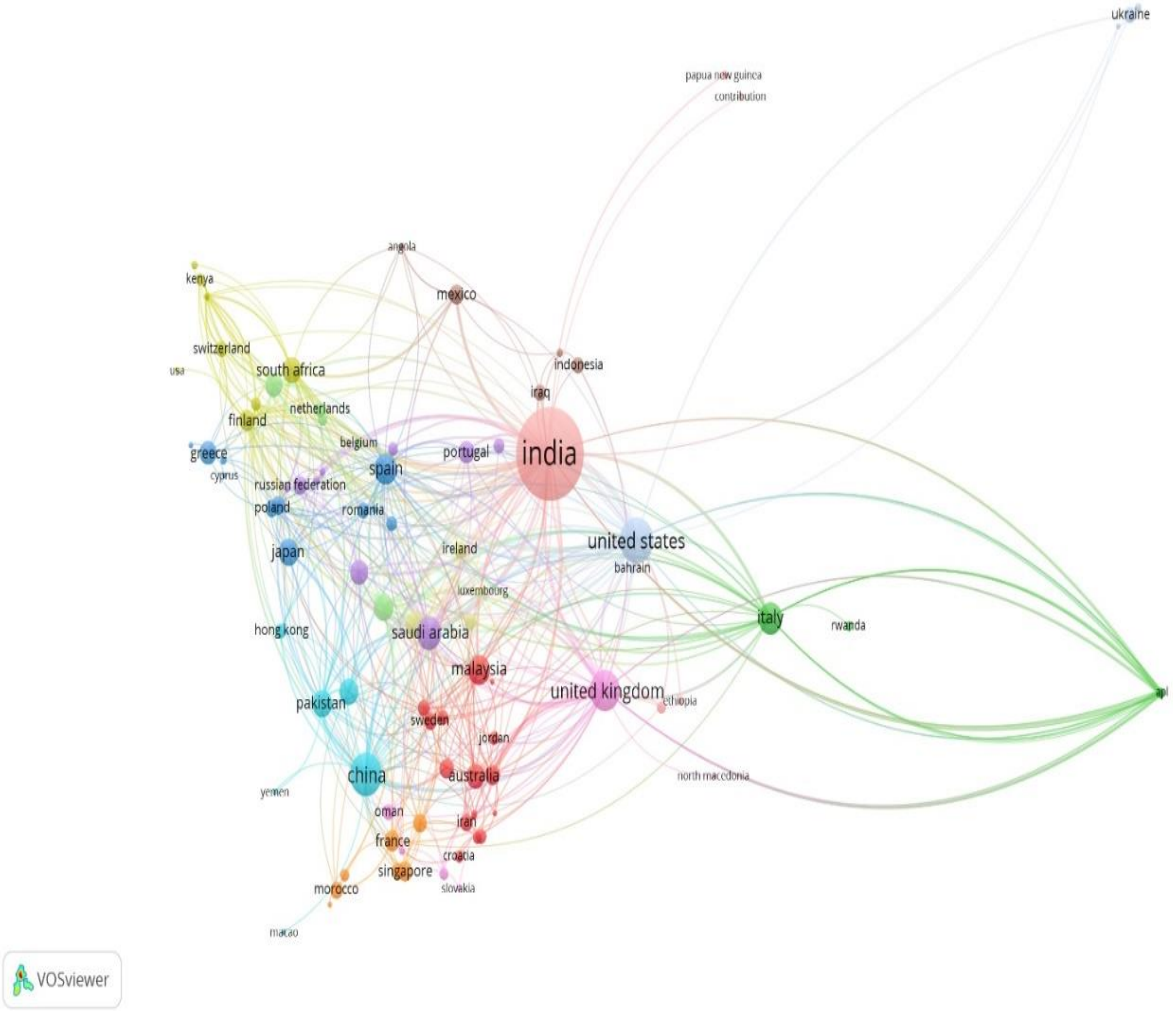
Cluster II: Collaboration Clusters in Global Research



Graph 4.10: A network analysis highlighting collaboration patterns among researchers

Graph 4.10 offers a comprehensive look at the ways in which academics in the domains of SDGs, AI, and the Internet of Things collaborate with one another. Multiple groups of researchers who work together on common topics are identified by the network analysis. It is clear that central people like Singh, Gehlot, and others play a crucial role in facilitating research cooperation, since they are found at the centre of the most active and prominent clusters. The graph emphasises how these networks of collaboration are helping to move research forward by facilitating the sharing of knowledge, tools, and data—all of which are essential for taking on the many problems that come with sustainable development. Although there is a robust core network, the existence of smaller, more specialised clusters indicates that there is also substantial activity in specialist areas of study, each making a distinct contribution to the field as a whole. The research landscape is enhanced as a whole when smaller clusters study particular uses of AI and the Internet of Things (IoT), for example, in smart cities, healthcare, or agriculture. In today's research, teamwork is key. This is especially true in complicated and quickly developing areas like AI and the Internet of Things (IoT), where multidisciplinary methods are frequently needed to find complete answers.

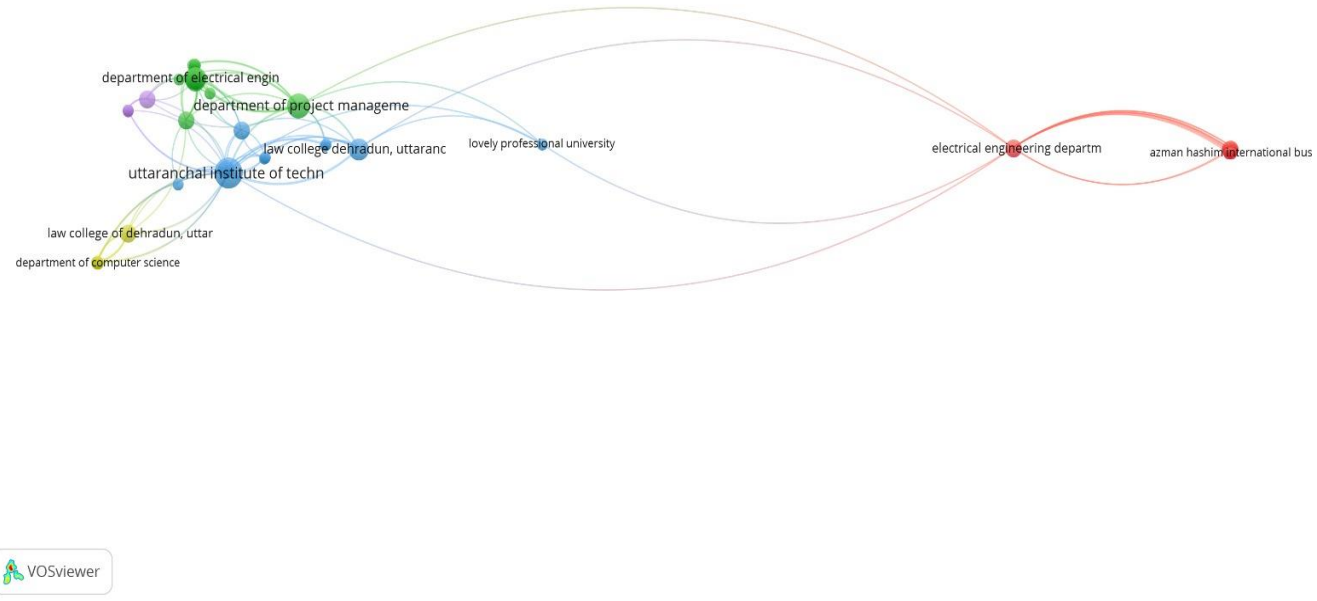
Cluster III: International Research Collaboration by Country



Graph 4.11: Mapping the global connections and research influence between leading nations

In Graph 4.11, we can see how many nations are working together on research related to the Internet of Things (IoT), artificial intelligence (AI), and sustainable development goals (SDGs). India is becoming the global centre of cooperation, with close relationships to other leading research countries including the US, UK, and China. India is becoming an increasingly important player in global research, especially in areas driven by technology, and its prominent position reflects that. High levels of international cooperation, as shown by the close cooperation between these nations, are necessary for addressing global issues like sustainable development. Another thing the network shows is how all these different nations are working together to build a common knowledge base via research. By working together across borders, researchers are able to share knowledge, learn from one another, and move forward more quickly. Regional clusters, where nations in close proximity to one another or sharing similar research interests, are also visible in the graph. In addition to being critical for the expansion of human understanding, this partnership will guarantee that research results are transferable to other settings and may be successfully used on a worldwide basis.

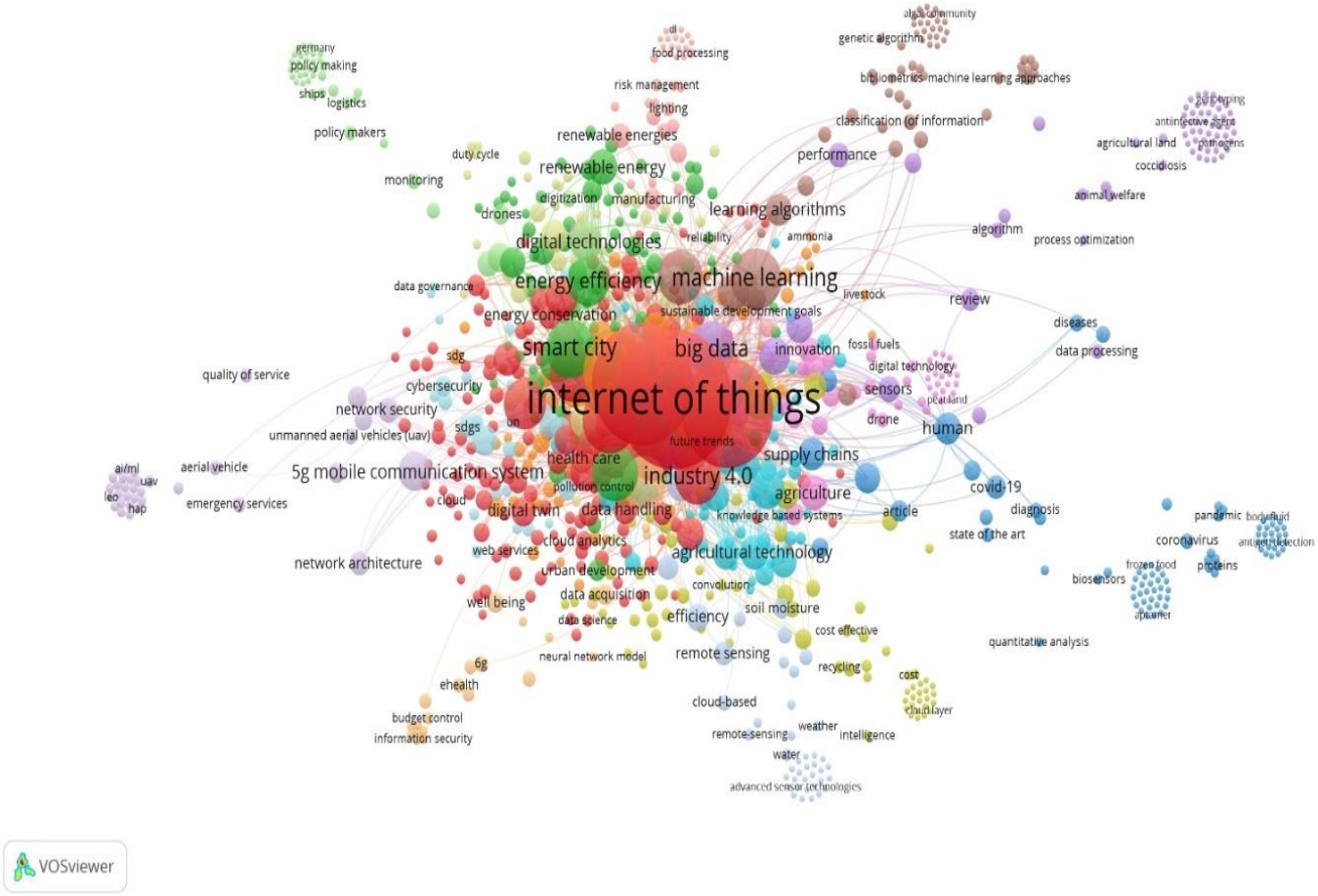
Cluster IV: Institutional Research Network



Graph 4.12: Analyzing the collaboration between key academic institutions in advancing global research

In the context of worldwide research on the Internet of Things (IoT), artificial intelligence (AI), and sustainable development goals (SDGs), Graph 4.12 examines the cooperation between important academic institutions. Uttaranchal University and Lovely Professional University are major nodes in the visualisation, which shows a complex network of institutional relationships. Because of their central role in bringing together faculty from different departments and external partners, these institutions play an important role in encouraging collaborative research. Some schools have a strong emphasis on electrical engineering, computer science, or environmental studies, as seen in the graph. By honing down on a particular area of expertise, institutions are able to better comprehend how the Internet of Things (IoT) and artificial intelligence (AI) might be used to accomplish sustainable development objectives. Thanks to the robust culture of cooperation, institutions are able to exploit each other's strengths to perform interdisciplinary research, as shown by the significant inter-institutional ties. To tackle the complex issues raised by the SDGs, this partnership is essential, since it allows for the incorporation of different viewpoints and methods. Innovative solutions and a wider effect of research results should be possible thanks to the visualization's indication of possible areas for further cooperation, especially amongst institutions with complementary skills.

Cluster V: Research Themes in Internet of Things (IoT)

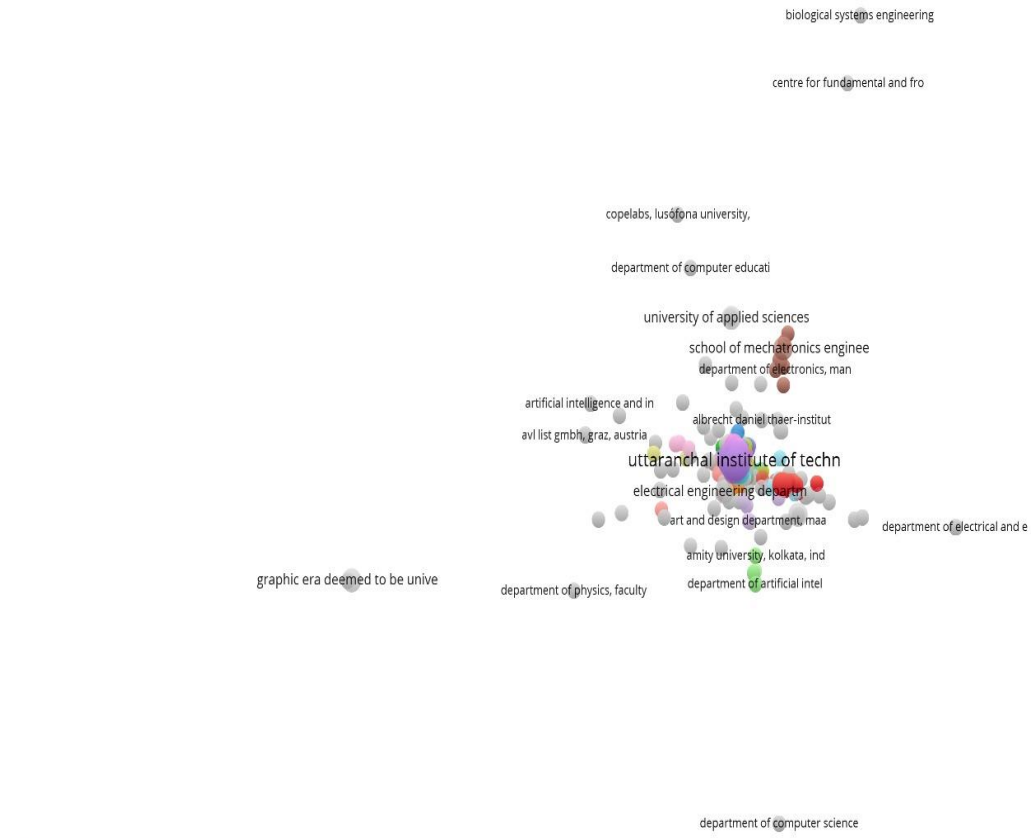


VOSviewer

Graph 4.13: A thematic analysis of key topics and emerging trends in IoT research

Graph 4.13 provides a topical overview of the IoT research environment, highlighting important subjects and new developments in this field. The Internet of Things (IoT) is the most central and interconnected node in the graph, with machine learning, smart cities, and big data all playing significant roles. This indicates that the Internet of Things (IoT) is a hot topic in the academic community right now, with many different industries investigating potential uses for it. It is clear from the close proximity of linked issues that academics are embracing multidisciplinary methods, combining IoT with other cutting-edge technologies to address intricate problems. For instance, there is a rising interest in using data-driven insights to improve the efficiency and efficacy of IoT systems, as seen by the confluence of IoT, machine learning, and big data. Reflecting the growing breadth of IoT research, the graph also displays developing research domains like environmental monitoring and healthcare that make use of IoT. If you want to know where the field is going and what areas are going to witness major advancements in the next years, this thematic map is a great tool to use for identifying research priorities and possible future paths.

Cluster VI: Institutional Collaboration and Research Focus



Graph 4.14: Mapping the concentration of research topics across various academic institutions

Graph 4.14 maps the concentration of research topics across various academic institutions, highlighting their areas of expertise and the nature of their collaborative efforts. The visualization shows that institutions tend to specialize in specific aspects of IoT and AI research, with some focusing on technical fields like computer science and electrical engineering, while others concentrate on applied areas such as environmental science and business management. This specialization allows institutions to develop a deep understanding and expertise in their chosen fields, contributing significantly to the broader research landscape. The graph also illustrates the collaborative nature of research in these domains, with institutions often partnering with others that have complementary strengths. These collaborations are crucial for addressing the complex, interdisciplinary challenges associated with sustainable development, as they enable the integration of diverse expertise and resources. The visualization also points to potential opportunities for expanding institutional collaborations, particularly in emerging research areas where new partnerships could lead to innovative solutions and significant advancements in the field. By mapping the research focus of different institutions, this graph provides a strategic overview of the research landscape, helping identify potential collaborators and areas for further exploration.

5. Conclusion and Future Directions

The integration of Internet of Things (IoT) and Artificial Intelligence (AI) with Sustainable Development Goals (SDGs) represents a significant and rapidly evolving area of research that has the potential to address some of the most pressing global challenges. This bibliometric analysis highlights the substantial contributions made by various institutions, countries, and researchers in advancing this field, with a notable concentration of work emerging from India, supported by global collaboration. The research reveals that IoT and AI are being increasingly applied across diverse sectors, including smart cities, agriculture, and financial markets, to enhance sustainability, optimize resource usage, and contribute to economic stability. As these technologies continue to develop, their role in achieving SDGs is likely to expand, offering new opportunities for innovation and impact. Future research should focus on deepening the interdisciplinary collaboration between technology and sustainability fields, exploring emerging applications of IoT and AI in new domains, and addressing the challenges of scalability and implementation in diverse global contexts. Additionally, there is a need to investigate the ethical implications of these technologies to ensure they contribute to inclusive and equitable development. Overall, the ongoing exploration of IoT and AI in the context of SDGs will be crucial in shaping a sustainable and resilient future for all.

5.1 Research Implications

This research emphasises the importance of AI and the Internet of Things (IoT) in achieving the Sustainable Development Goals (SDGs), demonstrating how these technologies are being used in many industries to tackle global problems. To maximise these technologies' influence on sustainability, the study stresses the significance of multidisciplinary cooperation and the need of ongoing investment in them. The study hints that the Internet of Things (IoT) and artificial intelligence (AI) will become more important in worldwide sustainability initiatives by detecting important patterns and contributors, which will be useful for future studies and policymaking.

5.2 Limitations

While comprehensive, this study is limited by its reliance on the Scopus database, which may not capture all relevant literature, particularly from non-English sources. The focus on recent years might overlook foundational research that is still influential today. Additionally, the study's quantitative approach does not account for the practical challenges of implementing IoT and AI in real-world scenarios, which could be addressed in future research by incorporating qualitative analyses.

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