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Advancing Particle Technology Research in Indonesia: Insights from Computational Bibliometric Analysis

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ABSTRACTS

This study explored the progress and trends in particle technology research in Indonesia using computational bibliometric analysis based on the Scopus database. Examining academic publications, collaboration networks, and citation patterns identified key areas of focus, influential contributors, and emerging topics within the field. Insights gained from this study provide a comprehensive overview of the research landscape, highlighting Indonesia's contributions to particle technology and offering guidance for future research priorities and collaborations. The findings aim to strengthen the country's scientific presence in this domain and foster innovation and global engagement

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1. INTRODUCTION

Particle technology is an interdisciplinary field that underpins numerous advancements in science, engineering, and technology. Its applications span diverse industries, including pharmaceuticals, materials science, environmental engineering, and energy systems. In recent years, particle technology research has gained significant momentum globally, driven by its potential to address critical challenges such as sustainable resource utilization, energy efficiency, and environmental preservation (Nandiyanto *et al.*, 2023).

In Indonesia, the development of research reflects a growing recognition of its importance for national innovation and industrial competitiveness. With increasing contributions from academic institutions, industries, and research organizations, the country has witnessed a notable rise in the volume and quality of research output. However, to better understand the trajectory and impact of particle technology research in Indonesia, a systematic analysis of the existing literature is essential (Nandiyanto *et al.*, 2020).

This paper presents a detailed analysis of the publication output, document types, and subject areas associated with particle technology research in Indonesia. The findings contribute to understanding how this field is evolving and offer strategic insights for researchers, policymakers, and industry stakeholders to foster future advancements.

2. METHOD

This study employed a computational bibliometric analysis approach to investigate the advancements in particle technology research in Indonesia. We used the scopus database for this matter. The method consisted of the following steps: Relevant scholarly publications were retrieved from major academic databases in the scopus database. Search terms were tailored to include "particle technology" and related keywords country with geographic filters set to Indonesia-based research (see Figure 1).

Fig. 1. Searching method in Scopus.

Several data were taken, including:

a. Publication Trends: The number of publications over time was analyzed to identify growth patterns.

b. Authorship and Collaboration Networks: Co-authorship networks were mapped to assess collaboration patterns among researchers and institutions.

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c. Keyword Co-occurrence Analysis: Keywords were analyzed to determine prevalent and emerging research topics.

d. Citation Analysis: Citation counts and influential works were analyzed to measure impact and identify leading contributors.

3. RESULTS AND DISCUSSION

3.1. Procedure

Bibliometric analysis provides a robust approach to examining the landscape of scientific research. By evaluating publication trends, citation patterns, and key thematic areas, bibliometric studies offer valuable insights into research progress, collaboration networks, and emerging opportunities. This study employs computational bibliometric analysis to investigate particle technology research in Indonesia over the past two decades. It aims to identify key trends, leading contributors, and potential growth areas, ultimately providing a comprehensive overview of the field's development within the Indonesian context. Several previous studies relating to bibliometric analysis are available (see Table 1).

Table 1. Previous studies relating to bibliometric analysis.

No	Title	Ref.
1	A bibliometric analysis of covid-19 research using VOSviewer	(Hamidah, *et al.*, 2020)
2	The latest report on the advantages and disadvantages of pure biodiesel (B100) on engine performance: Literature review and bibliometric analysis	(Setiyo, *et al.*, 2021)
3	A bibliometric analysis of management bioenergy research using vosviewer application	(Soegoto, *et al.*, 2022)
4	Research mapping in the use of technology for fake news detection: Bibliometric analysis from 2011 to 2021	(Gunawan, *et al.*, 2022)
5	Management information systems: bibliometric analysis and its effect on decision making	(Santoso, *et al.*, 2022)
6	Sustainable Production-inventory model with	(Utama, et al., 2023).

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	multi-material, quality degradation, and probabilistic demand: From bibliometric analysis to a robust model	
7	Phytochemical profile and biological activities of ethylacetate extract of peanut (Arachis hypogaea L.) stems: In-vitro and in-silico studies with bibliometric analysis	(Sahidin, *et al.*, 2023).
8	Biomass-based supercapacitors electrodes for electrical energy storage systems activated using chemical activation method: A literature review and bibliometric analysis	(Hamidah, *et al.*, 2023)
9	Antiangiogenesis activity of Indonesian local black garlic (Allium Sativum 'Solo): Experiments and bibliometric analysis	(Arianingrum, *et al.*, 2023)
10	Characteristics of tamarind seed biochar at different pyrolysis temperatures as waste management strategy: Experiments and bibliometric analysis	(Rahmat, *et al.*, 2023)

Figure 2 shows the publication growth of documents relating to a specific research field in particle technology published from 2000 to 2023. The results are in the following:

(i) Document Results: The total number of documents analyzed was 528, indicating significant research activity in this domain over the selected period.

(ii) Yearly Growth: The publication output was initially relatively low, with fewer than 20 documents published annually until around 2015. A significant increase in publications occurred after 2015, showing a steep upward trend, especially from 2018 onwards. By 2023, the publication count reached its peak at 83 documents, highlighting the rapid growth and

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increased research interest in recent years.

(iii) Insights: The steady growth from 2018 to 2023 suggests a rising focus and investment in this research area, possibly driven by advancements in technology, collaboration opportunities, or its relevance to societal and industrial needs. The gradual increase before 2015 may indicate a foundation-building phase with fewer contributors or resources.

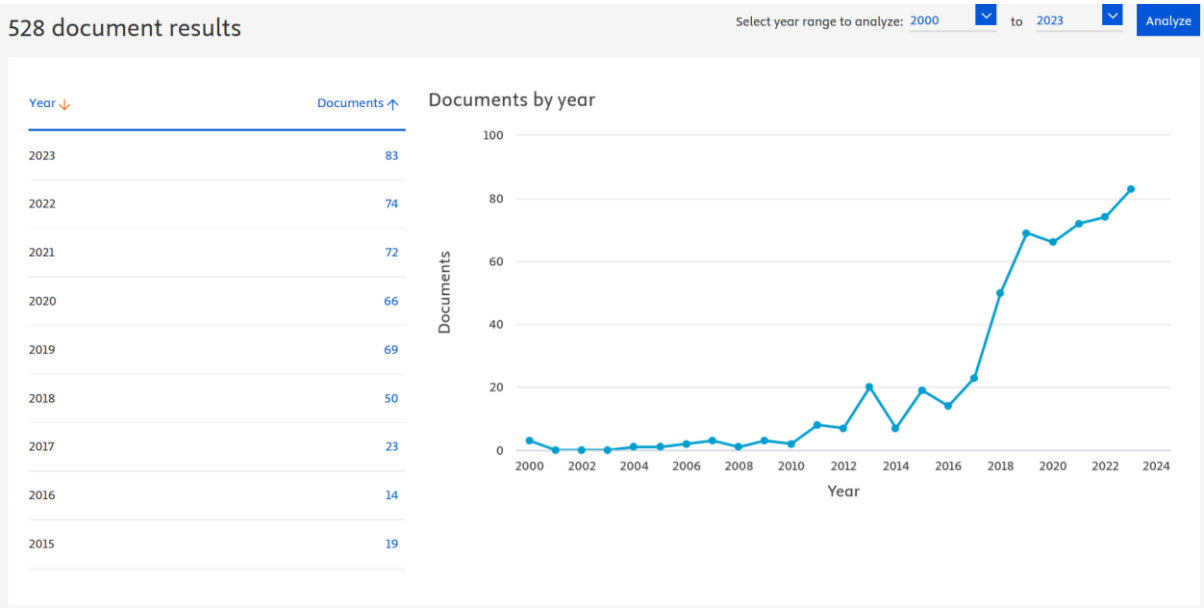

Fig. 2. Publication trend.

Figure 3 categorizes the 528 document results by their publication types and provides a visual breakdown using a pie chart. Several types of documents were obtained:

(i) Conference Papers (51.9%): It represents the largest portion, with 274 documents, indicating that a significant amount of research in this field is shared at academic conferences, which often focus on the latest advancements and emerging topics.

(ii) Articles (40.7%): The second-largest category is 215 documents, which are from peer-reviewed journal publications, typically representing comprehensive studies with high academic rigor.

(iii) Reviews (4.4%) are found in 23 documents. Review papers summarize existing research and trends, providing insights and identifying gaps for future studies.

(iv) Book Chapters (1.9%) comprise 10 documents, contributing to edited volumes, often synthesizing knowledge in a specific area.

(v) Other Types are also found, including Retracted papers (0.6% or 3 documents) (withdrawn post-publication, possibly due to errors or ethical concerns), Short Surveys (0.4% or 2 documents) (brief reports on targeted research questions or trends), and Editorials (0.2% or 1 document) (commentary pieces,

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discussing issues or perspectives in the field).

We get the insights, that include

(i) The dominance of conference papers, suggesting a strong culture of presenting research in academic and professional gatherings.

(ii) The significant share of journal articles, highlighting the field's commitment to rigorous scientific dissemination.

(iii) The smaller contributions of reviews and book chapters suggest limited emphasis on summarizing or consolidating knowledge compared to producing original research.

This distribution reflects an active and dynamic research community with a focus on both sharing new findings and contributing to academic literature.

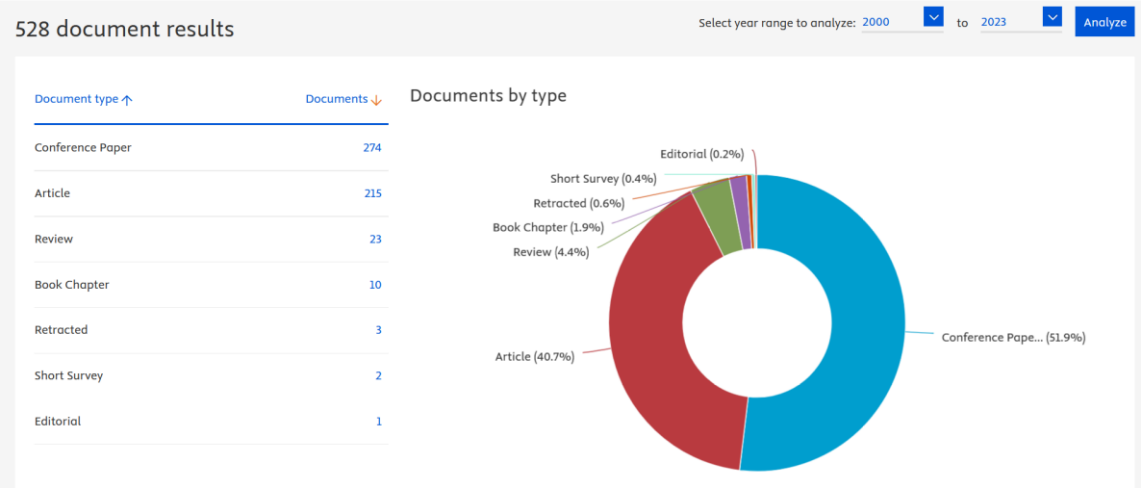

Fig. 3. Type of Publication.

Figure 4 shows the uploaded chart relating to the type of subject area, illustrating the distribution of 528 documents. The following is the breakdown:

(i) Engineering (dominating 194 documents (18.0%)).

(ii) Physics and Astronomy (130 documents (12.0%)).

(iii) Environmental Science (116 documents (10.8%)).

(iv) Materials Science (89 documents (8.2%)).

(v) Computer Science (85 documents (7.9%)).

(vi) Earth and Planetary Sciences (73 documents (6.8%)).

(vii) Energy (66 documents (6.1%)).

(viii) Chemical Engineering (50 documents (4.6%)).

(ix) Chemistry (47 documents (4.4%)).

(x) Agricultural and Biological Sciences (3.6%).

(xi) The "Other" category (17.6%).

Figure 5 shows an analysis of countries interfering with research. The most

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dominant collaborating country is Japan, followed by Malaysia. Some collaborations were found for Australia, India, the United States, and the United Kingdom.

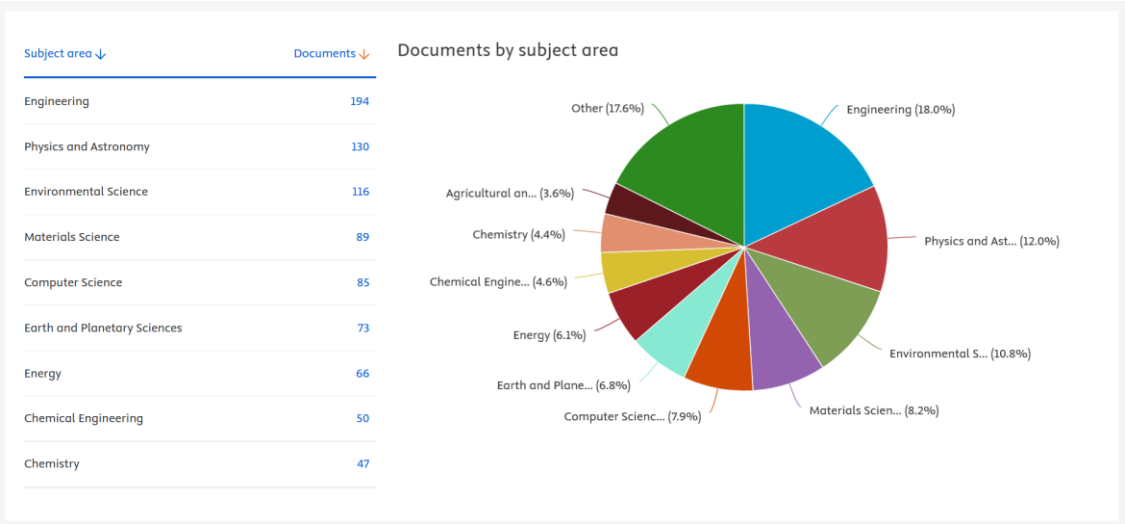

Fig. 4. Relating types of publication.

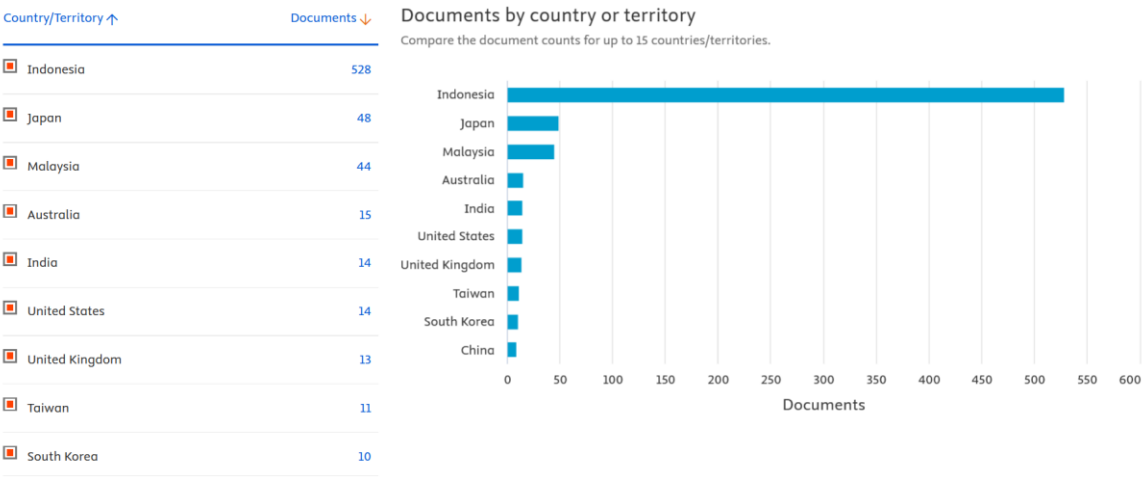

Fig. 5. Countries.

This study provides a comprehensive bibliometric analysis of particle technology research in Indonesia, highlighting the significant growth and interdisciplinary nature of this field over the past two decades. The analysis reveals a steady increase in research output, particularly in engineering, physics, and environmental science, indicating the field's expanding role in addressing critical technological and societal challenges. Key insights include the dominance of conference papers, which underscores the importance of knowledge exchange and collaboration within the research community, and the significant contributions of various subject areas, demonstrating the field's broad applicability across disciplines such as materials science, energy, and

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chemical engineering. Additionally, the rising focus on environmental and energy-related topics suggests that Indonesian researchers are aligning their work with global priorities for sustainability and renewable energy. The findings underscore the potential for further growth in particle technology research in Indonesia, particularly through increased collaboration among institutions, industries, and international partners. By fostering interdisciplinary approaches and focusing on emerging challenges, Indonesian researchers can continue to drive innovation and enhance the global impact of their work. Future research should focus on deeper qualitative analyses, including mapping collaboration networks and evaluating the practical outcomes of research efforts. These steps will provide more actionable insights for stakeholders and help guide strategic investments in this critical area of science and technology.

4. CONCLUSION

This study highlights the significant growth and interdisciplinary nature of particle technology research in Indonesia over the past two decades. The increasing research output, particularly in engineering, physics, and environmental science, reflects the field's expanding role in addressing global challenges like sustainability and renewable energy. The dominance of conference papers emphasizes the importance of collaboration and knowledge exchange, while the broad applicability across disciplines demonstrates the versatility of this research area. Indonesian researchers are well-positioned to advance innovation by fostering interdisciplinary approaches and enhancing collaborations with both domestic and international partners. Future efforts should focus on strengthening these collaborations and aligning research priorities with practical applications to maximize impact.

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