Vol. 6, No. 1, 2026, 1-16. DOI: 10.47909/ijsmc.260

pro-metrics

REVIEW ARTICLE

The evolution and future directions of altmetrics research in computer science: A scoping review and bibliometric analysis

Andri Yanto[1,2,*], Adian Fatchur Rochim[1], Anne Parlina[3], Heriyanto[4], Lis Setyowati[1]

[1] Doctoral Program of Information Systems, Universitas Diponegoro, Indonesia.
[2] Library and Information Science Study Program, Universitas Padjadjaran, Indonesia.
[3] Research Center for Data and Information Sciences, National Research and Innovation Agency, Indonesia.
[4] Department of Library and Information Science, Faculty of Humanities, Universitas Diponegoro, Indonesia.
* Corresponding author
Email: andri.yanto@unpad.ac.id **ORCID:** https://orcid.org/0000-0001-7041-0134

ABSTRACT

Objective. The primary objective of this study was to analyze research performance and identify potential future research related to altmetrics in the last decade.

Methodology. The dataset employed in this study was derived from the Scopus database. The PRISMA flow diagram was utilized during the data collection phase. The results of the bibliometric analysis were used to describe research performance and extract future work and directions. The method known as scoping review and bibliometric analysis (ScoRBA) was used to achieve these goals.

Results. The dataset under consideration encompassed a total of 478 titles, derived from a sample of 93 journals. The *Scientometrics* journal was the primary source of information disseminating various research results in the field of altmetrics, followed by the *Journal of Informetrics*. Wang X. was an active and consistent contributor to the field of altmetrics, publishing studies related to the subject between 2015 and 2024. The results of the co-occurrence analysis of author keywords yielded three cluster themes from the altmetrics research. A close examination of the extant literature revealed the emergence of three cluster themes related to altmetrics research: (1) measurement and social impact of research, (2) impact of research through traditional and alternative metrics, and (3) the role of artificial intelligence (AI) and social media in impact analysis and dissemination of research. It was evident that the subjects of social impact and machine learning were intricately intertwined, constituting a multifaceted and evolving research domain characterized by dynamic developments and ongoing advancements.

Conclusion. The study concluded that the altmetrics field had reached a stage of maturity, with a shift in focus from exploratory expansion to more in-depth, high-impact studies. In light of these findings, future research should concentrate on expanding data sources, refining tracking methods, and developing

Received: 20-06-2025. **Accepted:** 04-09-2025. **Published:** 06-11-2025.

How to cite: Yanto, A., Fatchur Rochim, A., Parlina, A., Heriyanto, & Setyowati, L. (2026). The evolution and future directions of altmetrics research in computer science: A scoping review and bibliometric analysis. *Iberoamerican Journal of Science Measurement and Communication; 6*(1), 1-16. DOI: 10.47909/ijsmc.260

more sophisticated AI-driven models that can integrate both traditional and alternative metrics to achieve a truly holistic understanding of research impact.

KEYWORDS: altmetrics; alternative metrics; scoping review; bibliometric analysis; research impact.

1. INTRODUCTION

Altmetrics are a recently developed form of metrics that have emerged with the growth of online scholarly tools (Priem *et al.,* 2012). The utilization of altmetrics enables the discernment of novel insights into the influence of research, a task that was previously arduous to accomplish. Furthermore, altmetrics empower researchers to assess the impact of their work with greater efficiency compared to traditional metrics (Williams, 2017). Altmetrics is a contemporary methodology for evaluating scientific impact that leverages the capabilities of the internet and social media to provide a more holistic perspective on the influence of research. The utilization of altmetrics has been shown to facilitate a more precise assessment of the social impact and outreach of scientific publications (Chaubey, 2017). Atmetrics have the potential to be widely adopted alongside traditional metrics in academia, becoming a complement to measuring research impact (Alhoori & Furuta, 2014; Biswas, 2019; Koçyiğit & Akyol, 2021; Melero, 2015; Serrano-Vicente *et al.,* 2018). The volume of research related to altmetrics has increased annually, with an increasing number of journals covering the topic (Amiri *et al.,* 2023). As a nascent field of study, altmetrics encompasses a multitude of research dimensions (Sinha *et al.,* 2020), with a preponderance of studies focusing on the applicability and usability of alternative indicators (Melicherová *et al.,* 2021). To comprehend the evolution of this field, it is imperative to map its current state and identify potential future research opportunities (Amiri *et al.,* 2023).

While earlier studies have utilized bibliometric analysis to map altmetrics research (Amiri *et al.,* 2023; Guechairi, 2024; Sinha *et al.,* 2020), these have generally been in a broad context. A significant gap in understanding exists regarding the specific trends and trajectories of altmetrics within the domain of computer science, where technological advancements and social media are most prominent. Moreover, previous investigations have predominantly centered on bibliometric analyses exclusively. This study addresses this gap by combining a bibliometric analysis with a systematic scoping review (scoping review and bibliometric analysis [ScoRBA]) to map the existing landscape and systematically identify future research directions within this specific field. The paucity of studies addressing this combined approach renders this contribution novel. The objective of this study is to analyze the research productivity and impact of altmetrics literature within computer science and to identify emerging themes and future research directions. To this end, the following research questions (RQs) were formulated: RQ1: What are the key characteristics of research productivity and impact related to altmetrics in the field of computer science over the last decade? This inquiry will be addressed through a bibliometric analysis of publication output, author productivity, and influential sources. RQ2: What are the emerging themes and potential future research directions related to altmetrics within computer science? This inquiry will be addressed through the following methodological approach: keyword co-occurrence analysis, overlay visualization, and a scoping review based on patterns, advances, gaps, evidence for practice, and research recommendations (PAGER).

2. MATERIAL AND METHODS

This study employed an integrated approach, the ScoRBA, to systematically map and analyze the current research landscape of altmetrics in computer science. The ScoRBA methodology combined the strengths of two distinct research methods: bibliometric analysis, which quantitatively measured publication trends, and a scoping review, which provided a qualitative overview to identify key concepts, research gaps, and future directions. This combined approach yielded a more comprehensive and robust framework for understanding a field of study in comparison to the utilization of a solitary method alone (Gupta *et al.,* 2025; Khaw *et al.,* 2024).

2.1. Data source and search strategy

The dataset for this study was exclusively retrieved from the Scopus database in November 2024. Scopus was selected as the primary data source due to its comprehensive coverage of international scientific literature, particularly reputable journals in the field of computer science. This extensive coverage enabled a global analysis of research trends (El Allaoui *et al.,* 2024) and furnished comprehensive bibliographic information, which is indispensable for bibliometric analysis (Pranckutė, 2021; Rajni *et al.,* 2025). A systematic search strategy was formulated to ensure the retrieval of all relevant publications. The search queries were meticulously crafted to capture the search term "altmetrics" within the title, abstract, or keywords of publications. The specific query design and keyword selection followed a structured approach adapted from established bibliometric studies, as detailed in Table 1. The search was constrained to a 10-year period, from 2015 to 2024, to ensure that the analysis reflected the most recent advancements and trends (Keathley-Herring *et al.,* 2016). Moreover, the search was constrained to a particular document type, namely journal articles, and documents that were published exclusively in English. The search strategy employed by Page *et al.* (2021) and Nurliati *et al.* (2024) is outlined in Table 1.

Identification	Description	Result
Topic	Altmetrics	
Search string	TITLE-ABS-KEY (altmetric* OR "alternative metric*") Date access: November 2024	2,045
Screening result	Subject area: Computer Science	982
	Document type: Articles	598
	Source type: Journal	594
	Language: English	560
	Timespan: 2015-2024	508
	Not secondary research: Bibliometric	478
Final amount	Only primary research (TITLE-ABS-KEY (altmetric* OR "alternative metric*") AND NOT TITLE (bibliometric*)) AND (LIMIT-TO (SUBJAREA , "COMP")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2023) OR LIMIT-TO (PUBYEAR , 2024))	478

Table 1. Keyword selection and advanced query string in the Scopus database.

In the field of computer science research, the debate concerning the relative merits of publishing in journals as opposed to conference proceedings has been a subject of ongoing discussion. While conference papers are prevalent in the field of computer science, this study focused exclusively on journal articles to ensure a baseline of rigorous peer review and to analyze the evolution of topics within a more established publication format. Journal articles have been shown to receive a greater number of citations, reflecting their established prestige in academic circles (Vrettas & Sanderson, 2015). A bibliometric study indicated that journals facilitate more in-depth methodological exploration and discussion of findings compared to conference papers (Sarjidan & Kasim, 2023). Additionally, the concise nature of conference papers frequently constrained their analytical profundity and the presentation of extensive data. The journal's more substantial position within the academic hierarchy also influenced researchers' perceptions of impactful research (Sandnes, 2021).

2.2. Data processing and analysis

The initial dataset of bibliographic data, consisting of 478 records, was first cleaned and prepared using the OpenRefine application to remove duplicates and inconsistencies. The cleaned dataset was subsequently processed using two widely recognized bibliometric tools: VOSviewer (van Eck & Waltman, 2023) and

Bibliometrix (Aria & Cuccurullo, 2017). These tools were utilized to perform a comprehensive bibliometric evaluation. Bibliometric analysis provides a rigorous framework for examining large scientific data collections (Donthu *et al.,* 2021; Tsilika, 2023), thereby offering a comprehensive understanding of a field's structure, dynamics, and emerging concepts (Ahmed & Hussainey, 2023; Hook & Börner, 2005). This phase of the research addressed RQ1 by analyzing publication output, author productivity, and influential sources within the dataset. The findings from the bibliometric analysis were then used as a foundation for a scoping review. The subsequent phase entailed a qualitative analysis of the most impactful papers, with the objective of describing and extracting future research directions. A scoping review is a research method that involves a systematic examination of the existing literature on a specific topic to provide a comprehensive overview of the research area. It is used to address exploratory RQs and to identify the extent, range, and nature of research activities (Ghanadinezhad & Ghane, 2024; Liu *et al.,* 2024; Verhage & Boels, 2017). According to Olechnicka *et al.* (2024), a scoping review with mapping of review elements could identify gaps in the literature that require further research. A synthesis of bibliometric analysis and scoping review yielded a more comprehensive understanding of the research field (Gupta *et al.,* 2025; Khaw *et al.,* 2024). The findings of the scoping review were systematically presented using the PAGER framework (Bradbury-Jones *et al.,* 2022; Wijaya *et al.,* 2023). This methodological framework ensured a clear, structured, and comprehensive presentation of the study's findings to address RQ2.

3. RESULT AND DISCUSSION

3.1. Main information of the dataset

As illustrated in Figure 1, the findings from the dataset on the topic under investigation demonstrate the following. The dataset under consideration encompasses a total of 478 titles, derived from a sample of 93 journals. The study sample consists of 478 articles authored by 939 individual contributors. A total of 17,150 references were cited, and 1,332 authors' keywords were identified within the specified time range of 2015 to 2024, constituting the research sample. The growth rate of articles is 4.74%, with an upward trend in publications with a citation rate of 19.63%. The proportion of authors who engage in international collaboration is approximately 27.82%.

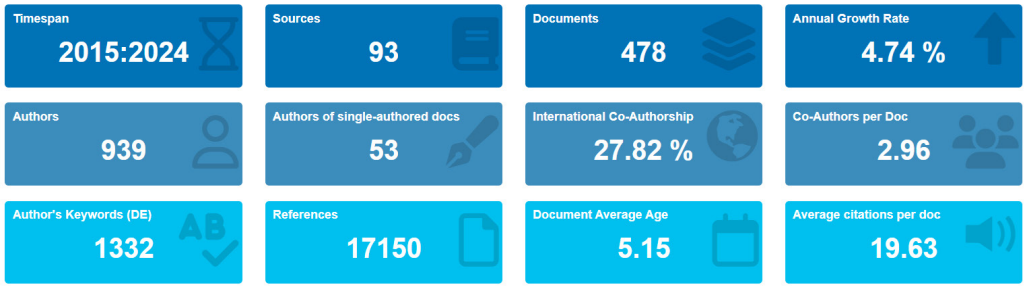

Figure 1. Main information from the dataset.

3.2. Research productivity and impact (RQ1)

The following information sources were identified as the primary disseminators of this subject matter. This finding indicates that the journal *Scientometrics* is the most pertinent source in the field of altmetrics (174), followed by *Journal of Informetrics* (48), *Journal of the Association for Information Science* (20), *Proceedings of the Association for Information Science* (20), *Online Information Review* (20), *Journal of Information Science* (13), *Aslib Journal of Information Management* (12), *Journal of Scientometric Research* (11), and *Sustainability* (8). The findings indicate that journals have become a prominent medium for publishing research results related to altmetrics. These journals have established themselves as valuable references for researchers and academics in the field of altmetrics. The preponderance of publications in journals dedicated to scientometrics and informetrics indicates that altmetrics research remains

predominantly a meta-science, emphasizing the study of research evaluation itself rather than its application in other disciplines. The prevalence of journals such as *Scientometrics* and the *Journal of Informetrics* indicates that the altmetrics field remains in its nascent stages. It is primarily functioning as a meta-science that focuses on the study of research evaluation itself, rather than its broad application across various computer science domains. This finding is consistent with previous research. The journal *Scientometrics* is the most prominent journal and a primary reference in this field. This assertion is strengthened by the study of Liu and He (2023), which specifically analyzed the bibliometrics of the scientometrics field itself. Their research demonstrated that *Scientometrics* is a highly influential journal and a foundational source for research in this domain, which encompasses altmetrics as one of its subfields.

This consolidation of publications in a limited number of core journals is a recurring phenomenon that is characteristic of the evolution of many emerging research domains. This pattern suggests that, despite its potential for broad application, the community of altmetrics researchers remains relatively tight-knit. This observation is further substantiated by the findings of Sinha *et al.* (2020), who conducted a bibliometric analysis of the altmetrics field. This analysis revealed the preeminence of a select group of journals and highly productive authors in shaping the research landscape. Since 2015, there has been a gradual increase in the number of published documents, from 29 in 2015 to a peak of 61 in 2021, followed by a decline to 44 in 2024, when these data were collected. Furthermore, the data demonstrate a direct correlation between the number of documents and the total number of citations, suggesting that as the number of documents increases, the total number of citations also tends to increase. The trend line with an exponential trend fitted to the data yields an R-squared value of 0.83, as illustrated in Figure 2. This exponential trend line ($R^2 = 0.83$) vividly exemplifies the considerable and persistent interest in a specific scientific topic (Wijaya *et al.,* 2023). This finding suggests that altmetrics have garnered significant attention and interest from the research community.

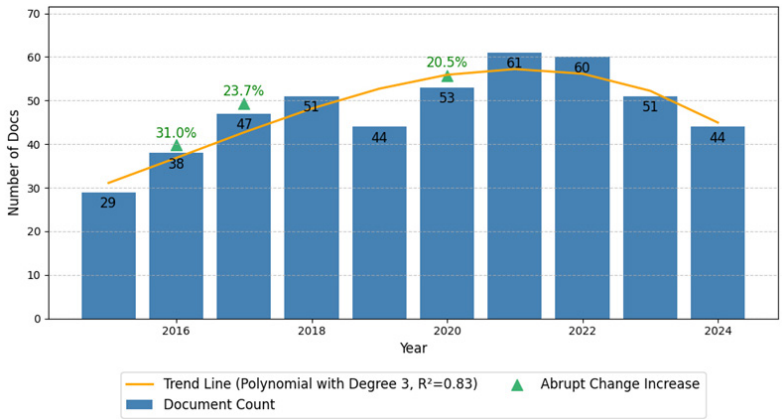

Figure 2. Publication trends and abrupt changes.

As illustrated in Figure 3, Wang X. demonstrated a consistent and active engagement in the field of altmetrics, evidenced by the publication of numerous studies between 2015 and 2024. Wang X. has also demonstrated a substantial research impact, as evidenced by the high number of citations received. An examination of the darker dot color reveals a total of 42 citations in 2024, further substantiating the researcher's significant contributions to the field. Additionally, Thelwall M. demonstrated a substantial research impact in 2016, and Costas R. exhibited a notable impact in 2015. In 2016, several authors demonstrated a notable increase in their productivity levels. For instance, Thelwall M. published eight article titles, while Bornmann L. and Haunschild R. published six article titles each. This finding also demonstrates that these works are well received by the academic community, thereby shaping the discourse in the field.

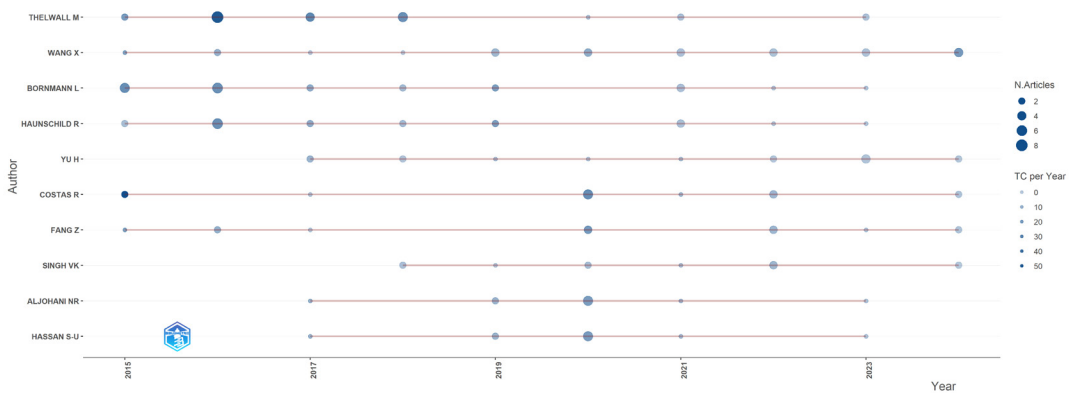

Figure 3. The authors' production over time.

The elevated productivity exhibited by prominent authors such as Wang X., Thelwall M., and Costas R. during this period serves as corroborating evidence for this trend, as these individuals frequently function as pivotal opinion leaders who exert a significant influence on the trajectory of a research field. Their sustained contribution and significant citation impact not only highlight their influence but also demonstrate that the field has a strong core of established researchers. The temporary decline in publications in 2024 could be indicative of a maturing field, wherein researchers are now prioritizing more in-depth, high-impact studies rather than a rapid expansion of exploratory works. This pattern is commonly observed as a research area transitions from a nascent to an established phase.

3.3. Research themes and future directions (RQ2)

This section addresses RQ2 by identifying thematic clusters, emerging topics, and directions for future research. The co-occurrence of authors' keywords functions as a mechanism to elucidate principal themes and topics (Shafin *et al.,* 2022). The results of the co-occurrence analysis of author keywords yielded three cluster themes from the altmetrics research. The grouping of each cluster is represented by the colors red, green, and blue, as illustrated in Figure 4.

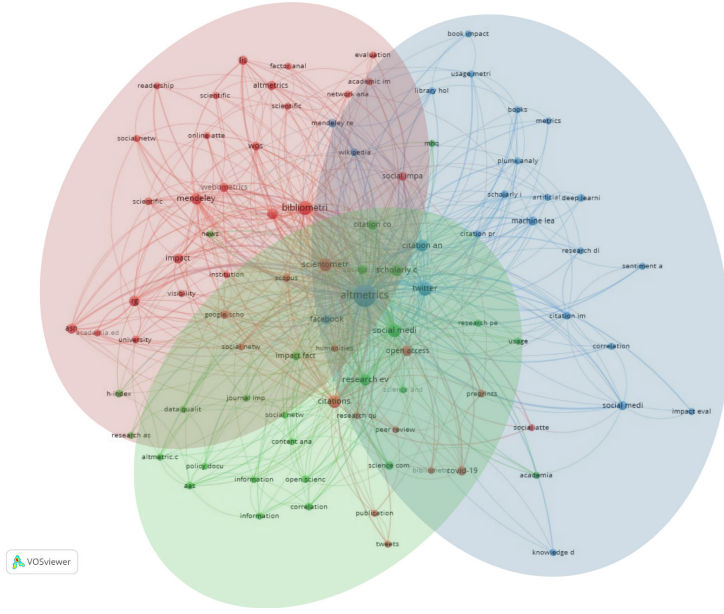

Figure 4. The main clusters of altmetrics research based on keyword co-occurrence analysis.

The research topics were subsequently organized into clusters and themes based on the predominant keywords in each cluster, as illustrated in Table 2. The primary clusters and themes identified were then employed to accentuate significant patterns within the PAGER framework.

Cluster	Theme	Description
Red	The measurement and social impact of research	The measurement and social impact of research highlight the transformative effects of the digital era on the methodologies used to evaluate scientific research impact within the digital landscape and assess scholarly influence.
Green	The impact of research through both traditional and alternative metrics	The impact of research broadens our understanding of how research performance assessments can incorporate a range of metrics that extend beyond mere citation counts to include other forms of digital interactions.
Blue	The role of artificial intelligence (AI) and social media in the analysis of research impact and dissemination	AI and social media play a crucial role in analyzing the impact and dissemination of research, taking into account how advanced technologies boost the visibility and engagement with research results.

Table 2. Clusters and themes in altmetrics research.

The mounting interest in altmetrics research necessitates a thorough literature review to assess the current state and emerging areas of the field. The enhanced strategic diagram (ESD) method is employed to analyze emerging research topics. ESD is obtained by comparing the total link strength (centrality), occurrence (density), and average year of publication (recency) of each keyword with its median value (Shafin *et al.,* 2022; Wijaya & Hermawan, 2025). As illustrated in Figure 5, the analysis indicates that the emerging or declining themes represented by quadrants 2 and 3 exhibit a state of underdevelopment, characterized by a paucity of density and centrality. Keywords such as altmetrics indicators, science communication, university ranking, Altmetric Attention Score (AAS), open science, and correlation analysis are present in this quadrant, suggesting that these are important yet underdeveloped topics that present opportunities for future research.

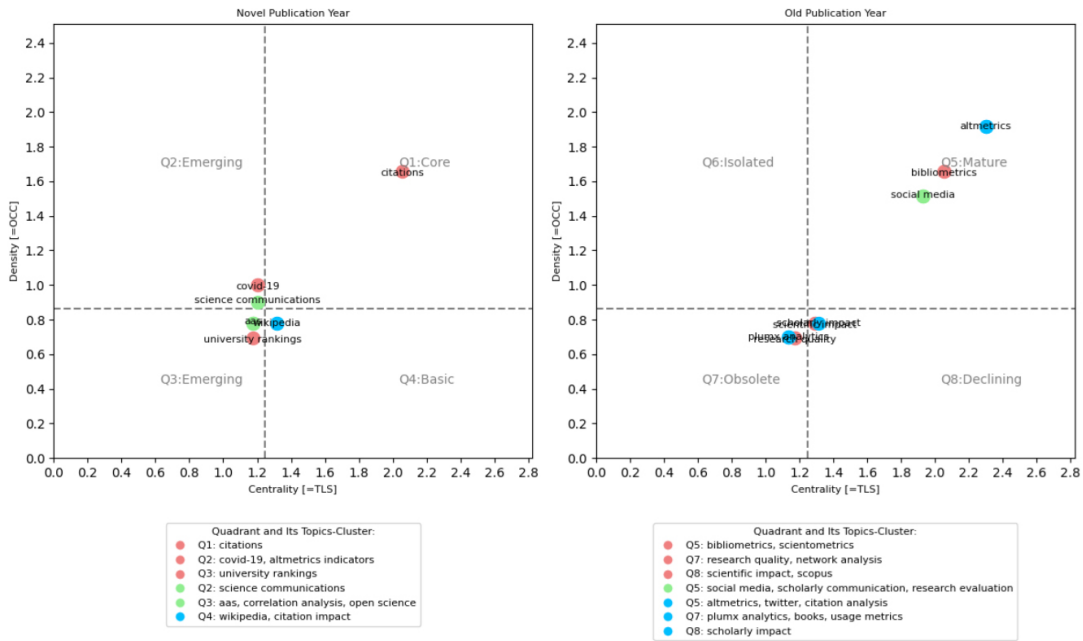

Figure 5. Topic analysis using ESDs.

According to Wijaya, Setiawan, and Shapiai (2023), thematic maps are not sufficiently comprehensive to ascertain whether existing keywords represent emerging or declining themes. Further confirmation is required by comparing the results of the co-occurrence analysis on the overlay visualization. As illustrated in Figure 6, the overlay demonstrated that social impact and machine learning were prominent emerging topics, as indicated by their brighter, yellower nodes.

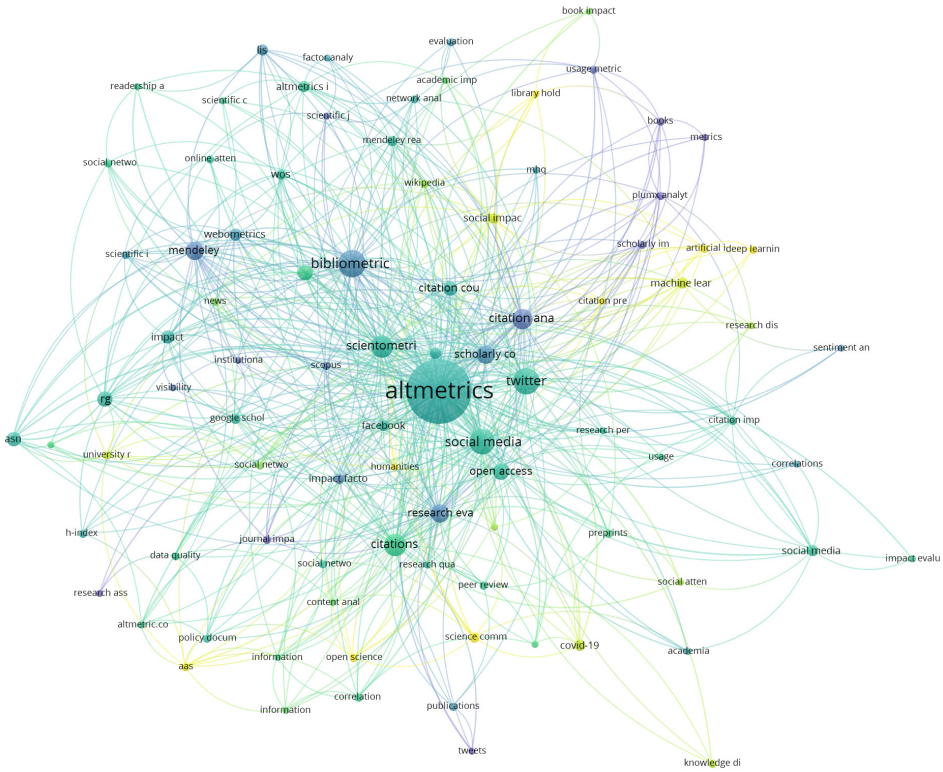

Figure 6. Overlay visualization of the co-occurrence analysis.

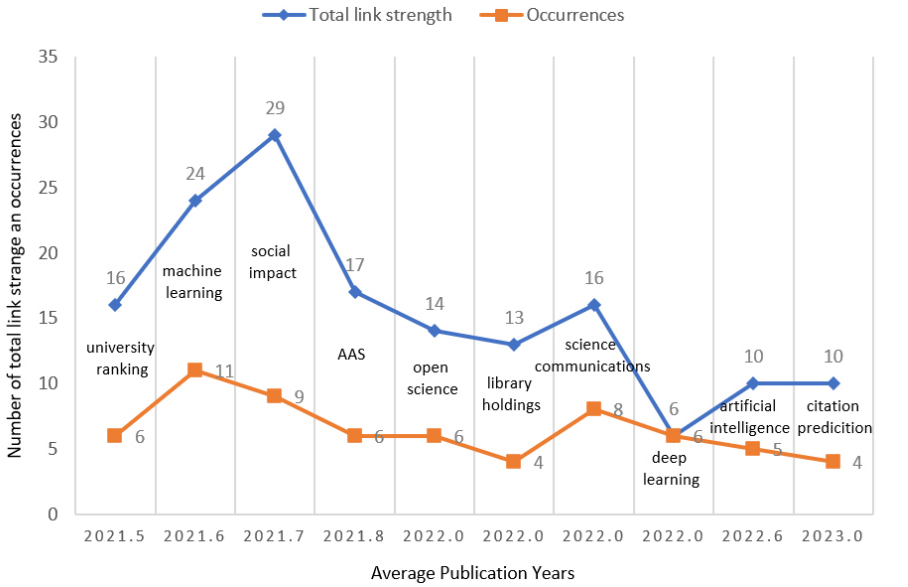

Figure 7. Resume of main topics based on bibliometric analysis.

This assertion is further substantiated by Figure 7, which demonstrates a high frequency and substantial link strength for these subjects, thereby validating their status as constituents of a progressive and evolving research domain. A bibliometric analysis, when combined with a scoping review approach, effectively establishes the foundation for identifying and advocating for future research directions. The overlay visualization technique, which is based on the publication time, is illustrated in Figure 6. Subsequently, the criteria for topics that fall into the category of emerging research topics were added. Based on the results of topic analysis using ESD, nine keywords were obtained, which were used as the basis for further analysis using PAGER. The nine keywords encompass a wide range of subjects, including social impact, university ranking, humanities, open science, science communications, AAS, citation prediction, AI, and library holdings. Research related to altmetrics is expanding rapidly and is of significant importance for the advancement of related studies.

3.4. Discussion

The findings from the bibliometric analysis and scoping review were synthesized to discuss the main patterns, advances, research gaps, evidence for practice, and future research recommendations, structured using the PAGER framework. This discussion establishes a connection between the results of this study and the extant literature, emphasizing the extent to which the results of this study align, contradict, or expand upon previous studies and their implications for the future of the field. Table 3 examines the following aspects in the altmetrics area: patterns, advances, gaps, evidence for practice, and research recommendations (PAGER).

3.4.1. The measurement and social impact of research

This study's finding that social impact constitutes a primary research theme (Cluster 1) is corroborated by recent literature advocating for the integration of bibliometrics and altmetrics, particularly in fields such as HSS (De Filippo *et al.,* 2023). Analysis of this study corroborates the notion that metrics from platforms such as Mendeley are regarded as valuable, a point also emphasized by Thelwall *et al.* (2023), who determined a correlation between these metrics and quality. However, this study underscores a persistent gap, as noted by De Filippo *et al.* (2023), concerning the absence of standardized metrics and the challenge of capturing non-DOI documents. Within the domain of university rankings, the results of this study are consistent with the research conducted by Wiechetek and Pastuszak (2022) and Ramezani *et al.* (2023), which demonstrated a correlation between ResearchGate metrics and social media engagement with established rankings. This study makes a contribution by demonstrating that within the field of computer science, this trend is particularly strong. A salient limitation articulated by Moshtagh *et al.* (2023) and substantiated in the analysis of this study pertains to the necessity for enhanced transparency in the methodology underlying platform score computations. Consequently, future research should prioritize the development of HSS-specific metrics (De Filippo *et al.,* 2023) and enhance the transparency of social media platform scores to ensure their reliability for institutional evaluation (Wiechetek & Pastuszak, 2022).

While the results of this study indicate a pronounced emphasis on social impact as a fundamental research theme, this constitutes a substantial departure from earlier sentiments in the field. Initial altmetrics research frequently encountered skepticism regarding its capacity to measure anything beyond basic attention or buzz. Critics contended that social media data were too noisy and lacked the qualitative depth to genuinely capture societal influence. The results of this study are consistent with the findings of more recent studies, such as that by Jonker *et al.* (2022), which examines the societal impact of university research in the written press. This study confirms a growing commitment to moving beyond simple correlations toward analyzing more tangible outcomes. This trend is also evident in the work of McGillivray *et al.* (2022) on the impact of data papers, suggesting a maturing of the field that is now tackling the more complex, and perhaps more meaningful, challenge of linking digital artifacts to tangible societal outcomes.

Patterns	Advances	Research gaps	Evidence for practice	Research recommendations
The measurement and social impact of research	The studies emphasize the mounting significance of integrating altmetrics, social media activity, and conventional metrics to enhance the assessment of research impact and social attention across diverse disciplines, including university rankings, data sharing, and the humanities and social sciences.	The research underscores significant discrepancies in dataset consistency, altmetric reliability, engagement evaluation, and long-term impact measurement, thereby emphasizing the necessity for more standardized and comprehensive approaches.	The studies recommend several strategies to enhance research impact through social media engagement, including the combination of RG metrics with traditional rankings, the publication of data papers, and the use of altmetrics alongside citations for more comprehensive evaluations.	Future research should concentrate on refining altmetric methods, incorporating time-series data, exploring social media impact, improving RG transparency, and conducting longitudinal studies across disciplines and networks.
The impact of research through both traditional and alternative metrics	The studies emphasize the manner in which both conventional and alternative metrics — including AAS, Twitter volatility, and social media engagement — influence the assessment of research impact across universities, journals, and disciplines.	The research underscores the limitations of both traditional and alternative metrics, including the shortcomings of AAS, the variability of altmetrics, and the biases inherent in media attention and non-academic communication.	The studies recommend several strategies for enhancing research impact, including increasing social media engagement, leveraging AI for social impact, enhancing altmetric tracking, adopting open peer review (OPR) for enhanced visibility, and cautioning against relying solely on media attention for research promotion.	Future research should explore the reasons why researchers prefer traditional methods, combine altmetrics with traditional metrics, improve tracking systems, investigate open science, and examine OPR's effects on impact measures and communication patterns.
The role of AI and social media in the analysis of research impact and dissemination	The studies emphasize the role of AI and social media in predicting and analyzing research impact, including book impact, scientific and social influence, and industry research outcomes.	The research underscores limitations in the application of AI and social media analysis to the evaluation of research impact. These limitations include biases in data sources, inadequate datasets, and the absence of quality metrics. Additional challenges such as the "cold start" problem and the lack of unified evaluation standards are also identified.	The studies recommend the utilization of a variety of review sources, the expansion of outreach initiatives, the cultivation of collaborative relationships between industry and academia, the integration of AI for abstracts, and the consideration of both intrinsic and extrinsic factors to enhance citations and impact evaluation.	Future research should concentrate on expanding review sources, exploring global data impacts, adding databases, testing cross-domain methods, improving AI evaluations, standardizing datasets, and using machine learning for citation prediction.

Table 3. Findings from the PAGER analysis.

3.4.2. The impact of research through both traditional and alternative metrics

The analysis of this study identified a second major theme (Cluster 2) focused on the interplay between traditional and alternative metrics. The findings of this study are consistent with the observations reported by Borgohain *et al.* (2024), who noted a positive correlation between social media engagement and citations, and by Moshtagh and Sotudeh (2023), who established a link between AAS and university performance. However, the study also revealed significant volatility and inconsistency, thereby corroborating the concerns raised by Arroyo-Machado and Torres-Salinas (2024) regarding the reliability of Twitter-based metrics. A salient finding from the thematic analysis of

this study is the mounting interest in open science, which stands in contrast to earlier, more general bibliometric studies. This finding is consistent with the recent research by Cheng *et al.* (2024), who determined that OPR enhances altmetrics but not necessarily citations. Additionally, De Filippo and Sastrón-Toledo (2023) underscored the significance of policy in fostering open science. This finding suggests a potential discrepancy between the immediate online attention and the long-term academic impact, a discrepancy that merits further investigation. Consequently, future research should prioritize the development of more stable altmetrics tracking methods (Arroyo-Machado & Torres-Salinas, 2024) and the exploration of the invisible aspects of open science. This exploration aims to facilitate a more profound understanding of the intricate relationship between novel dissemination practices and traditional impact measures (Cheng *et al.,* 2024; De Filippo & Sastrón-Toledo, 2023).

The relationship between traditional and alternative metrics, which the study identifies as a key theme, is not static but rather evolves over time. The results of this study that this relationship is both correlated and volatile is consistent with the observations of Taylor (2023), who noted that the trends of different altmetrics sources are subject to variation based on research age and the maturity of the attention source. Furthermore, the analysis of this study, which acknowledges this complexity, is supported by recent work that re-evaluates the applicability of altmetrics indicators based on the citation trajectory of papers (Li & Hou, 2024). This finding indicates that a rudimentary one-to-one comparison may prove inadequate. Hence, future research endeavors should take into account the temporal dynamics and lifecycle of a publication's impact across both traditional and alternative channels.

3.4.3. The role of AI and social media in the analysis of research impact and dissemination

The third theme identified in the study (Cluster 3), the role of AI and social media, is one of the most dynamic. The emergence of machine learning and citation prediction as pivotal subjects in the analysis of this study substantiates the field's progression toward more automated and predictive methodologies. This finding aligns with the findings of studies by de Winter (2024), who utilized ChatGPT-4 to predict citation counts from abstracts, and Xia *et al.* (2023), who developed a framework for scientific impact prediction. This study contributes to this body of knowledge by demonstrating that within the domain of computer science, these AI-driven approaches have emerged as a pivotal research subject. However, the analysis of this study also reflects the critical gaps identified in the extant literature, such as data biases and the lack of robust quality measures beyond citations (Färber & Tampakis, 2024; Roda-Segarra *et al.,* 2024). For instance, while Zhou (2024) and Maleki (2022a, 2022b) explored integrating diverse review sources for assessing book impact, the results of this study show that such multisource analysis is still an emerging, rather than established, practice. In the future, research should prioritize the standardization of datasets for training AI models (Xia *et al.,* 2023). Additionally, analyses should be expanded to include non-English sources and full-text articles (de Winter, 2024; Roda-Segarra *et al.,* 2024). Furthermore, more sophisticated machine learning models should be developed that can account for the complex, multifactorial nature of research impact (Khatoon *et al.,* 2024).

The advent of AI and social media as a pivotal component of the study's analytical framework signifies a novel domain for altmetrics. However, it is imperative to contextualize this assertion within the extensive history of research on scholarly communication. A critical distinction emerges when the results of this study are juxtaposed with those of preceding studies: the behavior and impact of social media exhibit substantial variations across scientific disciplines and geographical regions. For instance, as demonstrated by Torres-Salinas *et al.* (2024), disparate scientific disciplines employ varied communication channels, a circumstance that would demand field-specific AI models for precise prediction. Additionally, the role of social media in scholarly communication is not uniform. This assertion is indirectly corroborated by the findings of the study, as the extant literature on the subject did not extensively address international or regional perspectives on the impact of social media. A study by Singh

et al. (2024) in the Indian context underscores the necessity for a more localized approach to assess social media visibility, a gap that future research should address to provide a more holistic understanding.

4. CONCLUSION

This study furnished a comprehensive map of altmetrics research within computer science from 2015 to 2024, revealing consistent growth and significant academic interest. The analysis for RQ1 identified *Scientometrics* and the *Journal of Informetrics* as pivotal journals and Wang X. as a key influential author, indicating a strong foundation in meta-science. The response to RQ2 identified three core research themes: the measurement of social impact, the interplay of traditional and alternative metrics, and the rising role of AI and social media. The emergence of topics such as social impact, machine learning, university ranking, and open science indicates the future trajectory of the field. This study is not without its limitations. First, its emphasis was exclusively on the field of computer science within the Scopus database. This may have resulted in an incomplete capture of the full spectrum of altmetrics research across all disciplines or other databases, such as Web of Science. Second, the exclusion of conference proceedings and book chapters, despite their recognized importance in the field of computer science, may have introduced a bias toward research centered on journals.

In light of the findings of this study, future research should concentrate on addressing the identified gaps. There is a clear need for interdisciplinary studies to compare how altmetrics are used and perceived outside of computer science. Subsequent bibliometric analyses should encompass a more extensive array of document types, such as conference papers, to offer a more comprehensive representation of the field. From a methodological perspective, research should prioritize the refinement of altmetric tracking systems to enhance stability and the development of dynamic, AI-driven prediction models using more diverse and multilingual datasets. It is imperative to acknowledge that the integration of both traditional citation metrics and alternative metrics into a unified framework remains a critical objective to achieve a comprehensive understanding of research impact in both the academic and societal domains.

Funding

This work was supported by non-APBN DPA LPPM 2025, Universitas Diponegoro [222-068/UN7.D2/PP/IV/2025].

Conflict of interest

The authors declare that there is no conflict of interest.

Author contributions

Andri Yanto: Conceptualization, data curation, formal analysis, investigation, methodology, validation, visualization, writing – original draft, writing – review & editing.

Adian Fatchur Rochim: Formal analysis, investigation, supervision and validation, visualization, methodology, writing – review & editing, final approval.

Anne Parlina: Formal analysis, supervision and validation, writing – review & editing.

Heriyanto: Data curation, resources.

Lis Setyowati: Validation, data curation, resources.

Statement of data consent

Data generated during the research have been included in the article.

REFERENCES

Ahmed, F., & Hussainey, K. (2023). A bibliometric analysis of political connections literature. *Review of Accounting and Finance, 22*(2), 206-226. https://doi.org/10.1108/RAF-11-2022-0306

Alhoori, H., & Furuta, R. (2014). Do altmetrics follow the crowd or does the crowd follow altmetrics? In *IEEE/ACM Joint Conference on Digital Libraries* (pp. 375-378). IEEE. https://doi.org/10.1109/JCDL.2014.6970193

Amiri, M. R., Saberi, M. K., Ouchi, A., Mokhtari, H., & Barkhan, S. (2023). Publication performance and trends in altmetrics:

A bibliometric analysis and visualization. *International Journal of Information Science and Management, 21*(1), 95-115. https://doi.org/10.22034/ijism.2022.1977686.0

Aria, M., & Cuccurullo, C. (2017). *bibliometrix:* An R-tool for comprehensive science mapping analysis. *Journal of Informetrics, 11*(4), 959-975. https://doi.org/10.1016/j.joi.2017.08.007

Arroyo-Machado, W., & Torres-Salinas, D. (2024). Stranger things: The vanishing of the Altmetric Attention Score values in information and library science. *Scientometrics, 129*(10), 6287-6300. https://doi.org/10.1007/s11192-024-05011-5

Biswas, P. (2019). Altmetrics: Its trend and application in knowledge information centres. In A. Kaushik, A. Kumar, & P. Biswas (Eds.), *Handbook of research on emerging trends and technologies in library and information science* (pp. 119-131). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-5225-9825-1.ch009

Borgohain, D. J., Yuvaraj, M., & Verma, M. K. (2024). Analysing the relationship between altmetric attention score (AAS) and citation: A correlational study. *Information Discovery and Delivery, 52*(1), 11-22. https://doi.org/10.1108/IDD-05-2022-0035

Bradbury-Jones, C., Aveyard, H., Herber, O. R., Isham, L., Taylor, J., & O'Malley, L. (2022). Scoping reviews: The PAGER framework for improving the quality of reporting. *International Journal of Social Research Methodology, 25*(4), 457-470. https://doi.org/10.1080/13645579.2021.1899596

Chaubey, A. K. (2017). Bibliometrics to altmetrics: A changing trend. *International Journal of Library and Information Studies, 7*(4), 193-199.

Cheng, X., Wang, H., Tang, L., Jiang, W., Zhou, M., & Wang, G. (2024). Open peer review correlates with altmetrics but not with citations: Evidence from *Nature Communications* and *PLoS One*. *Journal of Informetrics, 18*(3), Article 101540. https://doi.org/10.1016/j.joi.2024.101540

De Filippo, D., Morillo, F., & González-Albo, B. (2023). Measuring the impact and influence of scientific activity in the humanities and social sciences. *Publications, 11*(2), 31. https://doi.org/10.3390/publications11020031

De Filippo, D., & Sastrón-Toledo, P. (2023). Influence of research on open science in the public policy sphere. *Scientometrics, 128*(3), 1995-2017. https://doi.org/10.1007/s11192-023-04645-1

de Winter, J. (2024). Can ChatGPT be used to predict citation counts, readership, and social media interaction? An exploration among 2222 scientific abstracts. *Scientometrics, 129*(4), 2469-2487. https://doi.org/10.1007/s11192-024-04939-y

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research, 133,* 285-296. https://doi.org/10.1016/j.jbusres.2021.04.070

El Allaoui, H., El Ahmadi, K., El Abdouni, A., Dira, I., El Bastrioui, M., Bouhrim, M., Eto, B., Shahat, A., Herqash, R., & Haboubi, K. (2024). Trends and insights in medicinal plant extract research: A ten-year bibliometric and visualization study. *Horticulturae, 10*(11), 1163. https://doi.org/10.3390/horticulturae10111163

Färber, M., & Tampakis, L. (2024). Analyzing the impact of companies on AI research based on publications. *Scientometrics, 129*(1), 31-63. https://doi.org/10.1007/s11192-023-04867-3

Ghanadinezhad, F., & Ghane, M. R. (2024). Analyzing review studies and bibliometrics of university-industry interaction using scoping review. *International Journal of Information Science and Management, 22*(3), 85-110. https://doi.org/10.22034/ijism.2024.2022906.1400

Guechairi, S. (2024). Mapping altmetrics: A bibliometric analysis using Scopus (2012-2024). *Journal of Science and Knowledge Horizons, 4*(01), 172-192. https://doi.org/10.34118/jskp.v4i01.3859

Gupta, A., Chaudhuri, R., Apoorva, A., Chaudhary, S., Thrassou, A., Sakka, G., & Grandhi, B. (2025). Vicenarian of workplace incivility: A bibliometric analysis and systematic review. *EuroMed Journal of Business, 20*(1), 52-74. https://doi.org/10.1108/EMJB-08-2022-0143

Hook, P. A., & Börner, K. (2005). Educational knowledge domain visualizations: Tools to navigate, understand, and internalize the

structure of scholarly knowledge and expertise. In A. Spink & C. Cole (Eds.), *New directions in cognitive information retrieval* (pp. 187-208). Springer Netherlands. https://doi.org/10.1007/1-4020-4014-8_10

Jonker, H., Vanlee, F., & Ysebaert, W. (2022). Societal impact of university research in the written press: Media attention in the context of SIUR and the open science agenda among social scientists in Flanders, Belgium. *Scientometrics, 127*(12), 7289-7306. https://doi.org/10.1007/s11192-022-04374-x

Keathley-Herring, H., Van Aken, E., Gonzalez-Aleu, F., Deschamps, F., Letens, G., & Orlandini, P. C. (2016). Assessing the maturity of a research area: Bibliometric review and proposed framework. *Scientometrics, 109*(2), 927-951. https://doi.org/10.1007/s11192-016-2096-x

Khatoon, A., Daud, A., & Amjad, T. (2024). Categorization and correlational analysis of quality factors influencing citation. *Artificial Intelligence Review, 57*(3). https://doi.org/10.1007/s10462-023-10657-3

Khaw, T. Y., Amran, A., & Teoh, A. P. (2024). Factors influencing ESG performance: A bibliometric analysis, systematic literature review, and future research directions. *Journal of Cleaner Production, 448,* Article 141430. https://doi.org/10.1016/j.jclepro.2024.141430

Koçyiğit, B. F., & Akyol, A. (2021). Altmetrics and citation metrics as complementary indicators for research management. *Central Asian Journal of Medical Hypotheses and Ethics, 2*(2), 79-84. https://doi.org/10.47316/cajmhe.2021.2.2.01

Li, H., & Hou, J. (2024). Revalidation of the applicability of Altmetrics indicators in article-level evaluation: An empirical analysis of papers of different types of citation trajectories. *Journal of Informetrics, 18*(4), Article 101573. https://doi.org/10.1016/j.joi.2024.101573

Liu, Y., & He, H. (2023). Scientometrics of scientometrics based on web of science core collection data between 1992 and 2020. *Information, 14*(12), 637. https://doi.org/10.3390/info14120637

Liu, Y., Wu, C., Wang, Z., Hu, K., Ding, F., Liu, C., Yi, S., Ruan, J., Luo, Y., Xie, G., & Ma, B. (2024). An introduction of the JBI scoping review execution process. *Chinese Journal of Evidence-Based Medicine, 24*(8), 986-992. https://doi.org/10.7507/1672-2531.202311060

Maleki, A. (2022a). OCLC library holdings: Assessing availability of academic books in libraries in print and electronic compared to citations and altmetrics. *Scientometrics, 127*(2), 991-1020. https://doi.org/10.1007/s11192-021-04220-6

Maleki, A. (2022b). Why does library holding format really matter for book impact assessment?: Modelling the relationship between citations and altmetrics with print and electronic holdings. *Scientometrics, 127*(2), 1129-1160. https://doi.org/10.1007/s11192-021-04239-9

McGillivray, B., Marongiu, P., Pedrazzini, N., Ribary, M., Wigdorowitz, M., & Zordan, E. (2022). Deep impact: A study on the impact of data papers and datasets in the humanities and social sciences. *Publications, 10*(4), 39. https://doi.org/10.3390/publications10040039

Melero, R. (2015). Altmetrics — A complement to conventional metrics. *Biochemia Medica, 25*(2), 152-160. https://doi.org/10.11613/BM.2015.016

Melicherová, M., Ondrišová, M., & Šušol, J. (2021). Bibliometrics versus altmetrics: Researchers' attitudes in Slovakia. *Iberoamerican Journal of Science Measurement and Communication, 1*(1), 002. https://doi.org/10.47909/ijsmc.11

Moshtagh, M., Jowkar, T., Yaghtin, M., & Sotudeh, H. (2023). The moderating effect of altmetrics on the correlations between single and multi-faceted university ranking systems: The case of THE and QS vs. Nature Index and Leiden. Scientometrics, 128(1), 761-781. https://doi.org/10.1007/s11192-022-04548-7

Moshtagh, M., & Sotudeh, H. (2023). Correlation between universities' Altmetric Attention Scores and their performance scores in Nature Index, Leiden, Times Higher Education and Quacquarelli Symonds ranking systems. *Journal of Information Science, 49*(4), 976-989. https://doi.org/10.1177/01655515211030868

Nurliati, G., Romli, M., Cecep Cepi Hikmat, M., Sriwahyuni, H., T.H, N. H., Suryantoro, S., Sulistio Wisnubroto, D., Hario

Putero, S., Iskandar, D., Syarbaini, S., Nirwani, L., Sumarbagiono, R., Setiawan, B., Adhi Pratama, H., Efri Ekaningrum, N., Mirawaty, M., Dwi Winarni, I., Muziawati, A., Setiawan, A., ... Yusuf, M. (2024). Literature survey and analysis of phytoremediation strategies for Cs-137 decontamination. *Nuclear Engineering and Design, 427,* Article 113414. https://doi.org/10.1016/j.nucengdes.2024.113414

Olechnicka, A., Ploszaj, A., & Zegler-Poleska, E. (2024). Virtual academic conferencing: A scoping review of 1984-2021 literature. Novel modalities vs. long standing challenges in scholarly communication. *Iberoamerican Journal of Science Measurement and Communication, 4*(1), 1-31. https://doi.org/10.47909/ijsmc.93

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372,* n71. https://doi.org/10.1136/bmj.n71

Pranckutė, R. (2021). Web of Science (WoS) and Scopus: The titans of bibliographic information in today's academic world. *Publications, 9*(1), 12. https://doi.org/10.3390/publications9010012

Priem, J., Groth, P., & Taraborelli, D. (2012). The altmetrics collection. *PLOS, 7*(11), Article e48753. https://doi.org/10.1371/journal.pone.0048753

Rajni, Garg, N., & Jalan, S. (2025). Spiritual leadership research: Past, present and future using bibliometric analysis. *Journal of Religion and Health, 64*(2), 999-1030. https://doi.org/10.1007/s10943-024-02178-2

Ramezani, A., Ghazimirsaeed, S. J., Ramezani-Pakpour-Langroudi, F., Siamian, H., YektaKooshali, M. H., Papi, A., & Aligolbandi, K. (2023). Ranking of Iranian medical universities based on altmetric indices. *Journal of Information Science, 49*(6), 1607-1614. https://doi.org/10.1177/01655515211072300

Roda-Segarra, J., Mengual-Andrés, S., & Rico, A. P. (2024). Analysis of social metrics on scientific production in the field of emotion-aware education through artificial intelligence. *Frontiers in Artificial Intelligence, 7.* https://doi.org/10.3389/frai.2024.1401162

Sandnes, F. E. (2021). A bibliometric study of human-computer interaction research activity in the nordic-baltic eight countries. *Scientometrics, 126*(6), 4733-4767. https://doi.org/10.1007/s11192-021-03940-z

Sarjidan, M. A., & Kasim, A. (2023). Trends of academic publications: A case study of malaysian research universities. *Journal of Research Management & Governance, 5*(1), 18-29. https://doi.org/10.22452/jrmg.vol5no1.2

Serrano-Vicente, R., Melero, R., & Abadal, E. (2018). Evaluation of Spanish institutional repositories based on criteria related to technology, procedures, content, marketing and personnel. *Data Technologies and Applications, 52*(3), 384-404. https://doi.org/10.1108/dta-10-2017-0074

Shafin, N., Ismail, C. A. N., Mustafa, M. Z., Ghani, N., Ahmad, A. H., Othman, Z., Wijaya, A., & Zakaria, R. (2022). Thematic analysis of multiple sclerosis research by enhanced strategic diagram. *Multiple Sclerosis Journal, 28*(14), 2160-2170. https://doi.org/10.1177/13524585221075542

Singh, V. K., Karmakar, M., Kanaujia, A., & Bhattacharya, S. (2024). Social media for science-science and science-society connects: Assessing the readiness in indian context through an analysis of social media visibility of research papers. *Journal of Scientometric Research, 13*(1), 239-244. https://doi.org/10.5530/jscires.13.1.20

Sinha, P. K., Sahoo, S. B., Gajbe, S. B., Chakrabory, K., & Mahato, S. S. (2020). Altmetrics research progress: A bibliometric analysis and visualization. *Journal of Scientometric Research, 9*(3), 300-309. https://doi.org/10.5530/jscires.9.3.37

Taylor, M. (2023). Slow, slow, quick, quick, slow: Five altmetric sources observed over a decade show evolving trends, by research age, attention source maturity and open access status. *Scientometrics, 128*(4), 2175-2200. https://doi.org/10.1007/s11192-023-04653-1

Thelwall, M., Kousha, K., Abdoli, M., Stuart, E., Makita, M., Wilson, P., & Levitt, J. (2023). Do altmetric scores reflect article

quality? Evidence from the UK Research Excellence Framework 2021. *Journal of the Association for Information Science and Technology, 74*(5), 582-593. https://doi.org/10.1002/asi.24751

Torres-Salinas, D., Docampo, D., Arroyo-Machado, W., & Robinson-Garcia, N. (2024). The many publics of science: Using altmetrics to identify common communication channels by scientific field. *Scientometrics, 129*(7), 3705-3723. https://doi.org/10.1007/s11192-024-05077-1

Tsilika, K. (2023). Exploring the contributions to mathematical economics: A bibliometric analysis using bibliometrix and VOSviewer. *Mathematics, 11*(22), 4703. https://doi.org/10.3390/math11224703

van Eck, N. J., & Waltman, L. (2023). *VOSviewer manual: Manual for VOSviewer version 1.6. 20*. Centre for Science and Technology Studies (CWTS) of Leiden University.

Verhage, A., & Boels, D. (2017). Critical appraisal of mixed methods research studies in a systematic scoping review on plural policing: Assessing the impact of excluding inadequately reported studies by means of a sensitivity analysis. *Quality & Quantity, 51*(4), 1449-1468. https://doi.org/10.1007/s11135-016-0345-y

Vrettas, G., & Sanderson, M. (2015). Conferences versus journals in computer science. *Journal of the Association for Information Science and Technology, 66*(12), 2674-2684. https://doi.org/10.1002/asi.23349

Wiechetek, Ł., & Pastuszak, Z. (2022). Academic social networks metrics: An effective indicator for university performance? *Scientometrics, 127*(3), 1381-1401. https://doi.org/10.1007/s11192-021-04258-6

Wijaya, A., & Hermawan, B. (2025). *BiblioPlot: Enhanced data visualization for bibliometric analysis* [Computer software]. https://biblioplot.metlit.net

Wijaya, A., Setiawan, N. A., Ahmad, A. H., Zakaria, R., & Othman, Z. (2023). Electroencephalography and mild cognitive impairment research: A scoping review and bibliometric analysis (ScoRBA). *AIMS Neuroscience, 10*(2), 154-171. https://doi.org/10.3934/Neuroscience.2023012

Wijaya, A., Setiawan, N. A., & Shapiai, M. I. (2023). Mapping research themes and future directions in learning style detection research: A Bibliometric and content analysis. *Electronic Journal of E-Learning, 21*(4), 274-285. https://doi.org/10.34190/ejel.21.4.3097

Williams, A. E. (2017). Altmetrics: An overview and evaluation. *Online Information Review, 41*(3), 311-317. https://doi.org/10.1108/OIR-10-2016-0294

Xia, W., Li, T., & Li, C. (2023). A review of scientific impact prediction: Tasks, features and methods. *Scientometrics, 128*(1), 543-585. https://doi.org/10.1007/s11192-022-04547-8

Zhou, Q. (2024). Evaluating book impacts via integrating multi-source reviews. *Scientometrics, 129*(11), 6931-6946. https://doi.org/10.1007/s11192-024-05174-1