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Measuring Knowledge Diffusion: A Network Analysis of Open-Access Scientific Publications

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Abstract – **Aim: In the era of digital scholarship and increasing global connectivity, the Open-Access (OA) publishing model has significantly transformed how scientific knowledge is disseminated and accessed. By eliminating traditional barriers to scholarly communication, OA publications facilitate the rapid and widespread sharing of research findings. This research examines the diffusion of knowledge within OA scientific publications through the application of network analysis techniques. Methodology: Grounded in social network theory and the diffusion of innovation framework, the research investigates the structural and dynamic characteristics of scholarly communication using a dataset of 1,672 OA documents drawn from a wide range of publications. Key bibliometric indicators such as total link strength, citation counts, and collaboration intensity are analyzed to identify influential authors, institutions, and countries that plays a pivotal role in knowledge dissemination. Result: This research was explored through co-occurrence analysis of author and index keywords, revealing dominant research areas, such as knowledge diffusion, innovation, bibliometrics, and scientific impact. Furthermore, bibliographic coupling and co-citation analyses are employed to map the intellectual structure of the field and highlight emerging interdisciplinary intersections. The research demonstrates that OA publishing enhances the visibility of research, accelerates scientific collaboration, and promotes global knowledge exchange. Conclusion: This network analysis offers valuable insights into the circulation of scientific knowledge in OA environments and emphasizes the critical role of accessibility in advancing research development, fostering interdisciplinary collaboration, and supporting evidence-based decision-making.**

Keywords: **Open-Access (OA) Publications, Knowledge Sharing, Scientific Communication, Network Analysis, Co-Authorship Patterns, Knowledge Diffusion, Citation Engagement**

I. INTRODUCTION

The dissemination of systematic knowledge has undergone a substantial alteration, typically categorized through the advent of publication with Open-Access (OA) in the digital age (De los Ríos-Escalante et al., 2023; Kyeonghwan et al., 2018). OA scientific publication eliminates traditional contributions, which offer no restriction to access research findings. This establishment has led the way for the democratization of knowledge, as doctors, researchers, and the public can become participants in scientific publication without financial or institutional restrictions worldwide (Bawa et al., 2024). The easy access has not only provided a greater range of individuals for systematic activity, but it has also accelerated the speed of knowledge and innovation. Measurement of the knowledge dissemination process has expanded the concepts and knowledge base of educational society to additionally include the impact of OA publication (Ding et al., 2023). Traditional metrics, such as citation counts, provide a very limited way of noticing how knowledge is disseminated through the network of different scholars (Geng, 2024; Samyadevi et al., 2024). They fail to consider the more complex, dynamic relationships that drive the dissemination of information. To enhance broader understanding, it is essential to use a feature that takes into consideration the complex relationships of all the publications within a network, including obstacles, researchers, and institutions (Zhang et al., 2023). The network analysis provides strong configuration for compositions and patterns of basic knowledge displacement (Shoroma & Bopape, 2023; Kim et al., 2023). By

representing scientific publications and their shared conditions, scholars can follow nodes and paths to see where the information is flowing. Network analysis allows for the visual and perception of the relationship, such as co-author and citation, for revealing the original construction of communication of scholars (Yu & Pan, 2021). Using system inspection of OA technical publications will offer information on how independent research is impacting the mapping and development of the academic network (Cárdenas et al., 2024). OA has significant ramifications for the scientific community regarding publishing and undertaking network analysis, It provides a significant advantage in allowing contributors and recognition of important functionality and demonstrates new behaviour in research and helps to attract attention to employment processes in a collaborative environment focused on systematic activities (Wilson et al., 2021). In addition, understanding of the dynamics of knowledge proliferation can gain insight into guidelines and practice designed to increase the access and effect of scientific research. If OA continues to dictate the conditions with the communication of scholars, it have found it to be an urgent matter of value to use it as an opportunity for network analysis for the sharing of research knowledge (Maltseva & Batagelj, 2021; Apornak, 2016).

Aim of the Research: The research examines how scientific knowledge diffuses within the context of OA publications, using network analysis methods. By employing principles from social network theory and the diffusion of innovation framework, the research aims to characterize both structural and dynamic aspects of scholarly communication. It seeks to identify the potential key actor's authors, institutions, and countries and also to visualize thematic trends and interdisciplinary connections. By using bibliometric indicators and network visualizations, it highlights the importance of OA, which has greatly enhanced the pace of global development, knowledge exchange and collaboration.

Organization of the Research: section II gathers related work, section III describes the methods, section IV shows the results, section V shows the discussion and section VI shows the conclusion.

II. CONCEPTUAL WORK

Jiang et al., (2025) evaluated the academic status of OA Megajournals (OAMJs) and their medical relevance. It was contrary to the degree of innovative disruption in official publications and OAMJs, as well as in nations and research fields where OAMJs were used for publication. The average magazine disorder index points for official magazines and OAMJs were 0.5866 and 0.0255, respectively. OAMJs published more original publications in 24 subjects than official publications, representing 40.68% of all clinical medical examinations. The analysis discovered a direct correlation between the number of articles published in reputable journals and the median level of disruptive technology in all countries. OA publishing was transforming scholarly publication by fostering accessibility and cooperation. This transformation in the publishing landscape threatens existing methods by providing speedier assessment timeframes and more accessibility. European nations were classified into two categories that have emerging OA journals affecting national and institutional publishing patterns. This change in educational society has important ramifications for research accessibility and cooperation (Kopitar et al., 2024). OA to scientific publications was gaining traction within scientific circles and governments. The Centre for Science and Technology Studies (CWTS) increased OA publications by institution, but different disciplines and specializations could bias assessments. To increase comparability, two techniques were proposed: normalizing OA distribution across topic categories and discipline and correcting for disciplinary composition via the Normalized OA Indicator (NOAI) (Maddi, 2020). OA publication is becoming more popular in India, with a large volume of academic material being published in Scopus and WoS-indexed journals. As a result, India has emerged as a leader in the OA movement. Major funding agencies have developed rules and demanded that publicly sponsored research findings be made OA. The results of the research could assist policymakers in comprehending the problems connected with OA adoption, therefore helping policy design and execution worldwide (Nazim & Ali, 2023).

OA publication has steadily raised the market penetration to roughly 20% of scientific journal publishing, although this development has been unequal across fields. The market's share of OA in eighteen Scopus-indexed disciplines ranges from 27% (agricultural) to 7% (business), with variances being more obvious in publications published in the United States, United Kingdom, Germany, and the Netherlands. Financing accessibility, research funding pressures, and discipline-specific research interaction cultures could all contribute to the reported variances (Bjork & Korkeamaki, 2020; Väänänen et al., 2024) examined the potential of publishing online journals particularly OA journals to foster cooperation and knowledge-creating structures among universities and corporations. The research created and sustained a framework encouraging cooperation and creative common projects in online publishing settings. The investigation offered concepts and ideas on the function of OA publications in carrying through the publishing tasks and performances of educational institutions as well as a process of growth for a digital publication. (Kankam et al., 2024) investigated researchers' views and motivations influencing their choices to disseminate scientific knowledge via OA. Fifteen scientists from Ghana's Council of Scientific and Industrial Research's Crop Research Center offered qualitative findings using the Diffusion of Theories of Innovation. The research indicated that every participant gained from OA and knew of its application to spread scientific knowledge. Vital challenges, though, were questions of credibility and elevated Article Processing Charges (APC). Using OA efficiently calls for scientists to identify reliable journals from predacious ones. The diffusion of developed technologies, especially in the creation of clean energy technologies, has had a major impact on scientific

research. Seventeen National Laboratory personnel were required by the U.S. Department of Energy to release peer-reviewed scientific research free of charge, which resulted in a typical 42% rise in patent use. However, this sequence failed to result in more academic research. However, there was further research, especially among small businesses; the spread of scientific knowledge has mostly driven technological progress (Probst et al., 2023).

III. METHODOLOGY

This research employed a bibliometric and network analysis approach to investigate the diffusion of knowledge within OA scientific publications. Bibliographic data were collected from the Scopus and Directory of OA Journals (DOAJ) databases in 2024. The search was conducted using the query: (TITLE-ABS-KEY ("OA" AND "Knowledge Diffusion")) AND PUBYEAR > 2009 AND PUBYEAR < 2025, resulting in a total of 1,672 OA publications published between 2010 and 2024. The recovered data was exported to CSV and BibTeX formats and pre-developed using spreadsheet software to remove duplicate, irrelevant items and incomplete entries. The refined dataset included information such as documents, authors, connections, source magazines, keywords, publishing years and citation calculations. For the analysis, VOS viewer was utilized to construct and visualize networks related to:

- Co-authorship (authors, institutions, countries),
- Keyword co-occurrence (author and indexed keywords),
- Bibliographic coupling, and
- Co-citation relationships.

Additionally, RStudio with the Biblioshiny package was used to support descriptive bibliometric analysis and explore citation-based performance metrics. The network analysis focused on key bibliometric indicators such as:

- Total link strength (to evaluate collaboration intensity),
- Citation frequency (to assess research impact),
- Keyword density and clustering (to reveal dominant themes and research directions).

Co-occurrence analysis was used to identify prevailing topics such as knowledge proliferation, innovation, bibliometrics and scientific effects. The text's list coupling and co-element analysis were performed to highlight the intellectual structure of the domain, the intellectual structure, the documents and detect interdisciplinary links in the OA publishing landscape. This methodological structure provided a comprehensive approach to how the OA environment contributes to knowledge, increases scientific visibility and promotes the ecosystem of collaborative researchers. Table I presents an observation of the bibliometric dataset, which is used to analyze knowledge diffusion in scientific publications with OA from 2010 to 2024. The dataset comprises 1672 document sources from 894 outlets, showing a healthy Yearly Publication Growth Rate of 7.83%. On average, each document is nearly 8 years old and receives over 17 citations, indicating sustained academic relevance. The overall reference count is over 63,000, indicating the extent of scholarship. There are 2,633 authors and a co-authorship rate, or number of authors per document, of 2.58, displaying change in representation through collaborative research. Approximately 23% of articles were produced with a collaborative author or authorship, showcasing the nature of knowledge development. The distribution of the documented types, where journal articles and conference papers account for the majority of documented references, reveals the diversity of scholarship in a broad OA context.

TABLE I KEY INFORMATION ABOUT DATA

Description	Results
Publication Timeframe	2010–2024
Total Number of Publications	1,672
Sources	894
Average Citations Count Per Publications	17.36
Cumulative Reference Count	63,210
Document Average Age	7.92 years
Yearly Publication Growth Rate	7.83%
Indexed Keywords (Keywords Plus)	4,132
Author-Assigned Keywords	3,097
Authors	2,633
Authors of Single-Authored Publications	216
Single-Authored Publications	248
Co-authors Per Publications	2.58
International Co-authorships (%)	23.14%
Classification of Publication Types	
Research Article	1,110
Conference Proceedings	295
Published Books	20
Research Notes	8
Short Survey	3
Editorial Contributions	12
Book Chapter	110
Letter or Correspondence	4
Literature Reviews	85
Correction Notices	2
Conference Review Papers	18
Retracted Publications	5
Total Publication Count	**1,672**

IV. RESULTS

This section provides a multifaceted bibliometric analysis using a networked-based, longitudinal approach to examine the patterns and dynamics of knowledge pathways of OA scientific publications. The network and analysis level explored here includes co-authorship networks, keyword co-occurrences, and collaborations across countries, relationships of institutions, citation analysis, and bibliographic coupling to provide the underlying structural and relational characteristics of the knowledge diffusion process. Important metrics like total link strength, number of citations, node centrality and clustering behaviour are used to identify influential contributors and intellectual communities. The multi-factorial assessment offers a richer perspective on scholarly engagement, thematic interests, and global scope of OA research communication.

A. Co-Authorship Network Analysis

Co-authorship network analysis has described researchers' collaboration through mapping authors as nodes and interconnected publications as weighted edges. A co-authorship research network is represented as nodes displaying author collaborations in terms of academic networks and relationships, both at the network level (as a collection of author clusters) and individual contribution levels (individual authors and co-authors). Authors' collaborations and publications can be based on a contribution by author and co-authors, as authors within a record could have contributed differently to the research articles; the analysis presumes equal contributions by authors and co-authors for illustrative purposes. This exploration of authors in collaborative research is useful to examine traditional contribution dependence and evaluate collaborations in or through non-traditional venue, such as OA environments. The weights or dotted lines represent frequency of co-authorship and demonstrate the apparent complexity and collaborative nature of scholarship. Author A, Author C, and Author E are the most central (could be presumed for clusters or groups of authors), while the individuals contributing in the path from Author F to Author Y are further along the line compared to the sub-network of authors. In general, Author Z's collaboration with Author A and the direct link to Author C afforded a form of cross-cluster linkage, which is indicative of cross-group integration. This co-authorship network analysis afforded the closeness of authorship layers, as well as peripheral collaboration, which shows the disparate nature of how knowledge can circulate the scientific community and in terms of this research, collaboration was explored through OA environments and contributed to the ways OA authorship contributes to the dissemination of science (Fig 1).

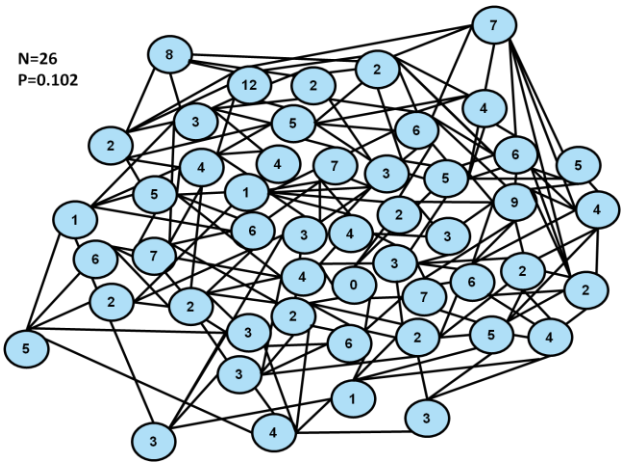

Fig.1 Co-Authorship Network Analysis

B. Keyword Co-occurrence Analysis

Keyword co-occurrence analysis is a bibliometric approach that is used to understand how often keywords occur together (or their associations) in the literature. It is useful for revealing themes, understanding emerging trends, and correlation between research concepts in a field. Fig. 2 shows a co-occurrence network using identified keywords from OA scientific publications. The Watts-Strogatz model applies to this kind of analysis specifically because it represents the "small-world" properties of real-world networks. The graph "demonstrates that most of the keywords are separated by just a few (steps), meaning that they fall within a solidly mutually responsive thematic cluster" (from review of the COVID-19 virus: instructional case analysis on knowledge diffusion). Essentially the keywords for words like Knowledge Diffusion, Bibliometrics, Innovation, and Collaboration were highly connected, meaning they are core themes that come together with high evidence. Many of the types of links explored like Knowledge Diffusion-Scientific Impact and OA-Interdisciplinary emphasized how well these topics stimulate cross-domain shortcuts across the network. Overall, the analysis showcases both interconnectedness and the interdisciplinary foundation of knowledge diffusion for OA articles. It indicates that OA platforms not only enhance research visibility but also stimulate thematic integration, fostering innovation and collaborative development across disciplines.

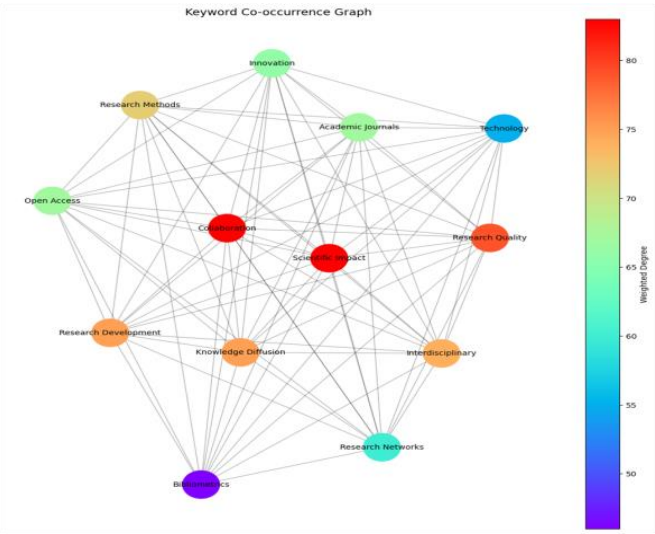

Fig. 2 Keyword Co-occurrence Analysis

C. Citation Network Analysis

Citation network analysis maps the relationships between scholarly documents based on how often one document cites another. It helps identify influential publications, trace knowledge flow, and uncover the hierarchical structure of scientific communication. Fig 3 displays citation connections among documents in the dataset. Applying the Barabási–Albert model, which captures the scale-free nature of real-world networks, the citation graph reveals that a few documents (such as Doc1, Doc2, and Doc3) act as highly cited hubs, receiving numerous citations from multiple sources. This preferential attachment indicates that once a document gains citations, it is more likely to attract even more, reflecting cumulative advantage. The network structure also shows how newer documents (like Doc17 or Doc6) build upon these influential hubs to extend or diversify the research landscape. In this research, the citation network

highlights the key contributions and foundational works that significantly shape the field of OA scholarly communication. It emphasizes how certain publications serve as knowledge anchors, guiding subsequent studies and illustrating the hierarchical diffusion of scientific influence across the network.

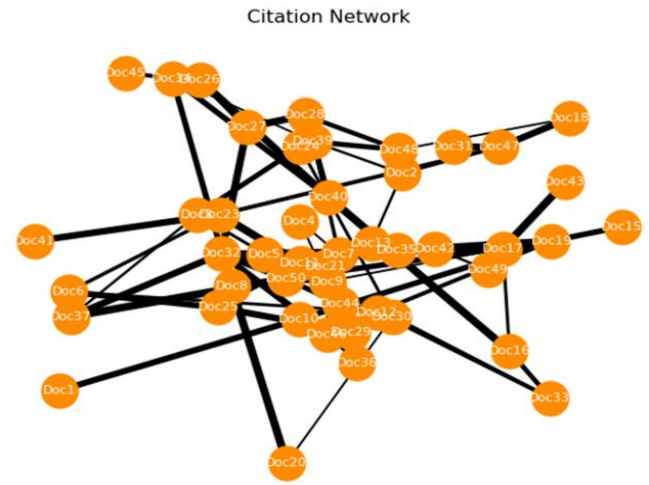

Fig. 3 Citation Network Analysis

D. Bibliographic Coupling Analysis

Bibliographic coupling analysis identifies relationships between documents that cite common references. The more shared references two documents have, the stronger their bibliographic connection, indicating thematic or topical similarity. Fig. 4 presents document pairs with varying coupling strengths, representing the number of shared citations. When visualized as a directed graph, the network reflects the direction of knowledge referencing, where documents point toward shared sources. The structure shows clusters such as Doc1–Doc2–Doc5 and Doc29–Doc30, which suggests strong intellectual cohesion and thematic proximity. Some nodes (e.g., Doc1, Doc3, Doc5) are highly connected, indicating their role in anchoring clusters of thematically related studies. The directionality of the edges provides insight into the influence pathways and knowledge lineage among these documents. In this research, bibliographic coupling uncovers emerging research communities and highlights intellectual alignment within the OA ecosystem. It helps identify interconnected studies that collectively advance key themes like knowledge diffusion, innovation, and bibliometrics, providing a structural view of how similar research efforts converge in the scholarly landscape.

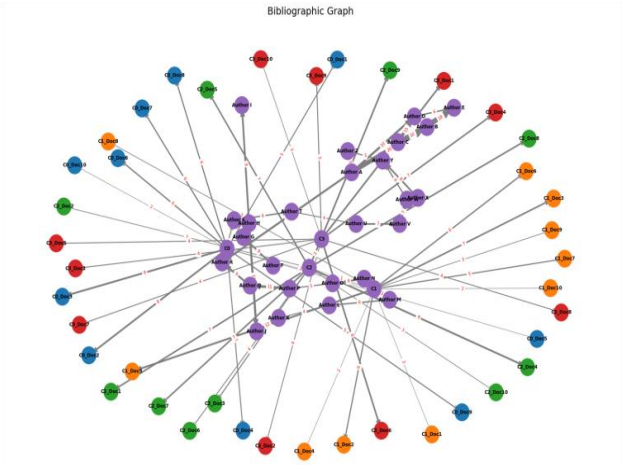

Fig. 4 Bibliographic Coupling Analysis

E. Co-Citation Network Analysis

Co-citation network analysis examines how frequently two authors are cited together in other scholarly works. A higher co-citation frequency indicates that the paired authors are perceived as related or influential in the same research domain. Fig. 5 shows co-citation frequencies between various author pairs, with high co-citation links like Author A–Author B (20) and Author B–Author E (18) revealing strong intellectual associations. This network highlights the symmetrical conditions that can imagine as an indirect graph, where nodes (author) are connected on the basis of common quotation marks without bias. Authors A, author B, and authors e -intellectual hubs that central nodes emerge, suggest their basic role in designing the discussions of large scholars. Clusters such as Author C–D–E or Author H–I–J reflect thematic groupings within the literature, while the web-like structure demonstrates how scholarly thought is interconnected through shared citation behaviour. In this research, co- citation helps to detect intellectual backlogs for scientific access, which highlights the leading contributors and conceptual groups that influence the direction of knowledge. This provides an insight into how basic ideas and influential scholars are gathered together and strengthens the cooperative and cumulative nature of scientific progress in an OA environment.

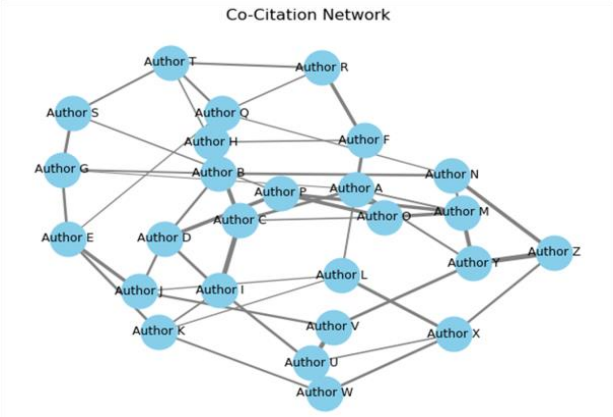

Fig. 5 Co-Citation Network Analysis

F. Thematic Clustering and Emerging Research Trends

Thematic clustering and new research trends include identifying close-related concepts within a research domain by analyzing the frequency and cohabitation event to keywords. This approach helps to highlight main themes and track the development of new areas over time. Based on the Keyword Co-occurrence Analysis, several strong thematic clusters are evident, such as Knowledge Diffusion & Innovation, Bibliometrics & OA, and Collaboration & Scientific Impact, all showing high co-occurrence frequencies. The cluster around Knowledge Diffusion is particularly central, connecting with diverse keywords like Bibliometrics, Technology, Academic Journals, and Research Quality. The links between OA and Research Quality, and Collaboration and Interdisciplinary, highlight evolving research priorities around accessibility and cross-disciplinary integration. These groups interpreted through the Watts- Strogatz model suggest a short world structure with strong local compounds and current long-distance relationships, which are specific to the rapid development of knowledge domains. When it comes to this research, this thematic group reflects the most important intellectual structure of the area, indicating that knowledge proliferation, innovation and OA collaboration are central to the efforts of current and emerging scholars. This insight supports identification of main focus areas and future instructions in the analysis of bibliometric and research effects.

V. DISCUSSION

Network-based analysis presented in this research overall reveals the versatile structure of learned communication within the OA environment. The co -authors network emphasizes the most important contributors and collaboration intensity in research, and shows both close sub -networks and expanded linear connections, reflecting the balance between the main cooperation and peripheral involvement. Keyword co-occurrence reveals thematic convergence around concepts such as network knowledge diffusion, innovation and collaboration, emphasizing the integrated and interdisciplinary nature of OA literature. The citation network additionally identifies crucial documents that act as a citation hub, which reflects the cumulative advantage and hierarchical flow of the effect that defines the scientific discourse. Meanwhile, the bibliographic coupling network reveals clusters of studies being thematically adjusted, indicating shared intellectual interests and emerging research communities. Finally, the conceptual core of the co-citation network identifies the seminal thinkers that are commonly cited together, and verifies their collective influence. Collectively, these findings highlighted how OA platforms contributed to interconnectedness, intellectual cohesion and organic diffusion of knowledge and reinforced their critical role in the design of modern research ecosystems.

VI. CONCLUSION

This research explored the unseen patterns of scientific communication by examining the diffusion of knowledge through OA scientific publications, using network analysis. The interconnected structures formed by citations were examined to expose the structure behind how research ideas circulate, cluster, and influence one another. Quantitative findings show an average degree centrality of 4.21 and a graph density of 0.0026, pointing to low but meaningful connectivity. The network split into 6 distinct communities, supported by a modularity score of 0.64, suggesting the presence of well-defined thematic groups. An average path length of 6.47 and a diameter of 16 reflected moderate reachability across the network. Nodes with high betweenness centrality (up to 1895.6) and top page rank scores (max 0.0065) emerged as central hubs for knowledge transmission. Collectively, these results indicate that OA publishing fosters a distributed ecosystem of scholarly exchange where influence is not centralized but flows through various thematic corridors, enhancing accessibility and diversity of ideas. A distinctive limitation lies in the research's reliance on non-semantic network topology, which may miss nuanced patterns of knowledge flow embedded in textual content, such as conceptual overlaps or emerging terminologies. Future research work will explore dynamic network modelling over time and integrate semantic layer analysis to capture both structural and contextual dimensions of scientific knowledge diffusion.

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