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Research Trend on Data Mining Using Bibliometric Analysis with VOSviewer

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Abstract - This study aims to analyze global research trends in data mining using bibliometric analysis. The rapid development of information technology has transformed data mining into a crucial tool for various industrial sectors to extract knowledge from large databases. The research method used is a qualitative descriptive approach with a bibliometric approach, assisted by Publish or Perish (PoP) software for data collection from ScienceDirect and Google Scholar databases. Data visualization and mapping were performed using VOSviewer to identify topic clusters, temporal developments, and research density between January 2022 and December 2026. The analysis results indicate the existence of five main clusters: technical aspects of algorithms (red), technological and industrial infrastructure (green), geographic applications and environmental impacts (blue), causality analysis (yellow), and literature synthesis (purple). Overlay visualization reveals a shift in trends from mastery of basic algorithm infrastructure (such as random forests and big data) to a critical evaluation phase focused on risk mitigation, research gap identification, and practical application in the real world. This study provides a strategic overview for researchers to identify collaboration opportunities.
Keywords: Data Mining, Bibliometrics, VOSviewer, Research Trends, Visual Mapping.

1. INTRODUCTION

Recent decades have seen a sharp increase in the world's demand for minerals, which has led to an unparalleled growth in mineral extraction operations in a variety of geographical settings (Maia et al., 2026; Mo et al., 2026; Qiang et al., 2026). Numerous environmental and social effects, including as deforestation, biodiversity loss, community displacement, and resource-related conflicts, are directly associated with this mining boom (Liang et al., 2026). Complex worldwide supply chains that geographically separate resource use from the areas that incur the environmental and social consequences are the primary cause of these effects. Therefore, ecological degradation can be caused by a single product or economic sector in a number of geographically scattered locales, each of which has unique socio-ecological vulnerabilities (Z. Yang, Ling, et al., 2026). The necessity to research mining internationally while taking into consideration the local variability of its affects is becoming increasingly apparent as mining demands increase (Abdul-Kareem et al., 2026). There are now more chances to map, track, and evaluate the effects of mining on a global scale because to the growth of geospatial information, especially those based on remote sensing technology (Djerida, 2026). A variety of mining infrastructure elements, including pits, tailings, storage facilities, overburden heaps, waste rock dumps, and processing units, can be captured by datasets created from satellite photography. These characteristics are often represented as vector data, especially as polygons, even if they are generated from satellite photos (Guo et al., 2026).

Bibliometric analysis has several benefits. One of these is the ability to identify research topics that are constantly evolving (Manning et al., 2026). Despite this, researchers may identify businesses that have a lot of potential for growth. Bibliografi can also help prevent duplication of research (Li et al., 2026). This is very important for increasing research efficiency. In addition, the use of bibliometrics makes it possible to identify researchers or organisations with significant impact. This data can be used for collaborative research. As a result, bibliometric analysis becomes strategic (Bayus et al., 2026). This is especially true in industries like data mining that are seeing rapid growth. Bibliometric analysis analysis, a tool that can effectively analyse and visualise data is required (Botchwey et al., 2026). VOSviewer is a widely used program for creating and visualising bibliometric networks. This program may provide visual aids that illustrate the relationship between writing, language, and publication. This visualisation facilitates the interpretation of complex data (C. Zhang et al., 2026). Additionally, VOSviewer has the ability to group research topics. This makes it possible to identify the main topics in the current bidang. As a result, VOSviewer is an extremely useful tool for bibliometric research and graph mapping in data mining research.

2. RESEARCH METHOD

This research uses descriptive qualitative research with a bibliometric approach to convey the results of review of journal articles. The data search method was carried out using PoP software with the main Sciencedirect database and analyzed using the VOSviewer application (Yustiarini et al., 2025). A systematic literature review on was conducted in January 2022 - December 2026 using the keywords “Data Mining”. The process involved five key stages. First, keyword determination was carried out using Google Scholar, supported by PoP software, to search for journal articles published between Januari 2022 - December 2026, yielding 166,104 articles stored in RIS format, containing essential bibliographic information. Second, the initial search results were refined by filtering data based on study topics and ensuring only journal articles were included, which were then transferred to Mendeley for enhancement. Third, a thorough validation process was conducted to check the completeness and quality of the articles, ensuring the inclusion of relevant and high-quality literature, resulting in a final dataset of 60,348 articles. Fourth, statistical data compilation was performed in Mendeley to ensure all bibliographic details, such as publication year, volume, and page numbers, were complete and accurate. Finally, bibliometric network analysis and visualization were conducted using VOSviewer software, enabling the creation of network maps that revealed literature clusters, historical connections, and potential research opportunities within the field. This structured approach ensured a focused and reliable analysis of the topic (Y. Yang, Huang, et al., 2026). Data collection used a purposive method; the data were selected based on the special characteristics determined by the researcher (Hidajat, 2026) so that data relevant to the research topic was obtained. This research was adapted from (Utami & Astutik, 2025) through 5 stages. The process of data analysis for bibliometric analysis in research uses co-occurrence analysis as a description of the conceptual structure or knowledge from the literature and analysis based on keywords to see the development of research and the development of visualized data(Huang et al., 2026). Bibliometric data analysis techniques can be seen in the following flowchart in Figure 1.

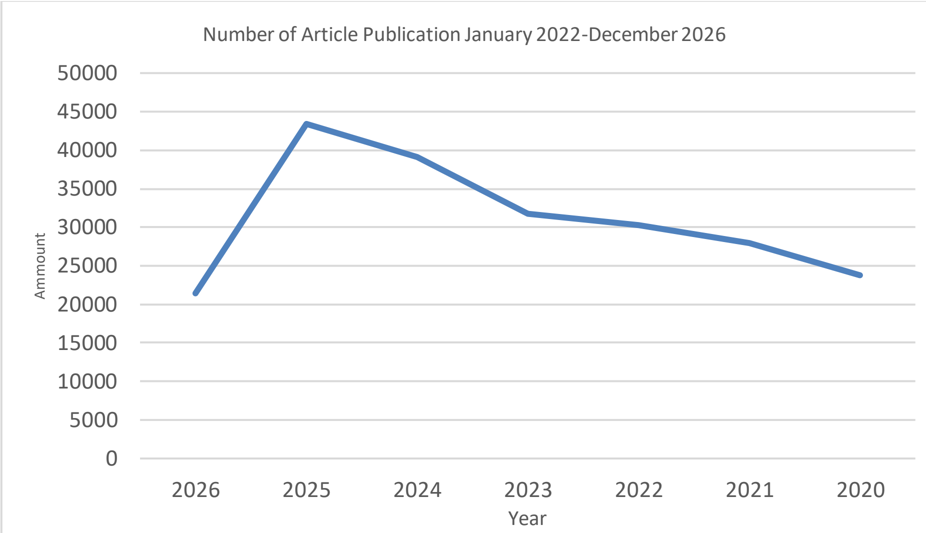

Figure 1. Article publication data Jan 2022-December 2026

3. RESULTS AND DISCUSSION

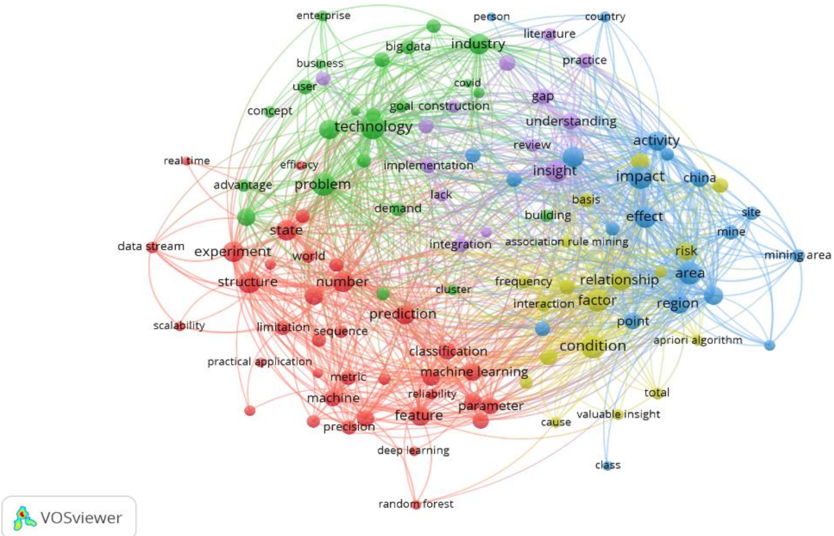

Figure 2. Visualization topic area using VOSviewer using network visualization

Figure 2 is a bibliometric network visualization generated using VOSviewer software (Hudec et al., 2026). This mapping aims to represent the relationships or co-occurrences between the most frequently occurring terms or keywords in a collection of literature or research documents related to data mining. In this visualization, each keyword is represented by a circle called a node (Burda, 2026). The size of each node indicates the frequency of occurrence of that term; the larger the circle and its text label (such as "technology," "insight," or "impact"), the more frequently the term is discussed in the analyzed literature dataset. The curved lines connecting the nodes represent the relationship or strength of association between two terms. The thicker and denser the line connecting two nodes, the more frequently the two keywords appear together in the same document, title, or abstract(Maus, 2026). Overall, VOSviewer has grouped these keywords into five main clusters marked with different colors: red, green, blue, yellow, and purple. Each of these cluster colors represents a specific sub-theme or research area that has a topical proximity to one another (Cho et al., 2026).

The red cluster, which dominates the bottom left of the visualization, focuses heavily on the technical aspects, methodology, and evaluation of data processing algorithms. This cluster represents the core of computational science and predictive modeling within the data mining domain (Reyes-Palacios et al., 2026; Rodríguez-Puello & Rickardsson, 2026). Within this red cluster, we can see the presence of nodes for advanced analytical methods such as machine learning, deep learning, and random forests. This demonstrates the trend toward using artificial intelligence and complex statistical modeling to solve data pattern extraction problems. Beyond the algorithms, the red cluster also places a strong emphasis on the types of tasks and model evaluation metrics(Heydari et al., 2026; Hu et al., 2026; Shen et al., 2026). Terms such as "prediction," "classification," "precision," "feature," and "metric" indicate the high volume of literature focused on testing the accuracy and robustness of mathematical models. The red cluster also highlights the specific types of data structures described by researchers. The keywords "data stream," "sequence," and "structure" indicate that these machine learning methods are applied to dynamic, continuous, and sequential data that require high scalability (Basile et al., 2026).

Moving to the Green Cluster in the upper left, the research theme shifts from pure algorithms to large-scale technological applications and infrastructure. This cluster bridges computing capabilities with real-world needs (Ahiaku & Kong, 2026). Key terms such as "technology," "industry," and "big data" dominate the green cluster. This illustrates the significant research volume devoted to how big data storage technologies can be adopted to transform the modern industrial sector. The green cluster also highlights the commercial and managerial context of data mining (Park et al., 2026). The presence of the terms "enterprise," "business," and "user" indicates that this technological innovation is intended to provide competitive advantages for companies and meet the needs of end users. Practical problem-solving aspects are prominent in the green cluster (Z. Yang, Tian, et al., 2026). The keywords "problem," "implementation," "goal," and "efficacy" demonstrate that the literature in this area focuses heavily on the challenges, efficacy, and processes of implementing technology into existing systems (Wang et al., 2026).

On the right side of the visualization, the Blue Cluster is unique because of its focus on a specific geographic location and industry sector, in this case, the physical mining sector or spatial geography. The proximity of nodes such as "mine," "mining area," "area," "region," "site," and "china" in the blue cluster highlights the large number of case studies focused on a specific geographic region (Y. Yang, Mei, et al., 2026). In particular, the high frequency of the word "china" indicates that the country is likely a major subject of study or producer of research in this topical area. The blue cluster also focuses heavily on the consequences of activities. This is evidenced by the relatively large number of nodes "impact" and "effect," which likely examine the environmental impacts, risks, or outcomes of activities in the mining area or regional industry (George & Bassey, 2026; Y. Zhang et al., 2026).

In the bottom right, the Yellow Cluster serves as an analytical bridge for identifying causal relationships or correlations within the data. This cluster focuses on interacting conditions and factors. A key characteristic of the yellow cluster is its use of pattern-finding algorithms. The keywords are "association rule mining" and "apriori algorithm" is particularly prominent here. This algorithm is a classic data mining technique that seeks to discover patterns of co-occurrence frequency or relationship rules between variables. Finally, the Purple Cluster, located in the top center, represents the conceptual foundations, literature review, and knowledge synthesis across the field. This cluster is where researchers reflect on existing knowledge.

Keywords in the purple cluster, such as "insight," "understanding," "literature," "review," and "gap," demonstrate the process of identifying research gaps. Researchers strive to build a comprehensive understanding and integrate practical findings from previous studies. Overall, this VOSviewer map depicts a highly interdisciplinary data mining research landscape.

Research flows from the development of technical foundations and machine learning (red), to infrastructure and industrial problem-solving (green), to the application of relational pattern finding (yellow), and to impact analysis in real geographic areas (blue), all united by a continually evolving literature review and insights (purple).

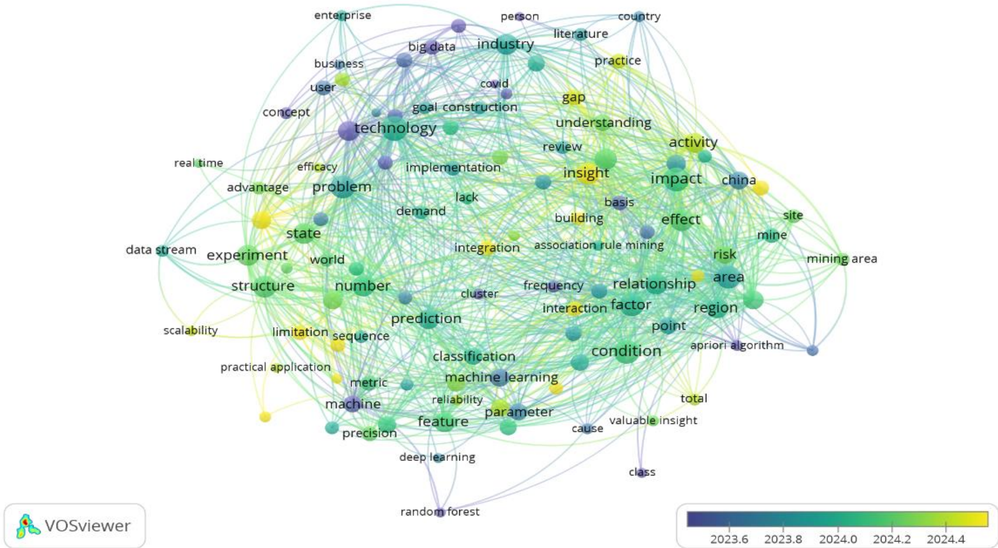

Figure 3. Visualization topic area using VOSviewer using overlay visualization

Figure 3 presents a different form of analysis than the previous visualization: an overlay visualization of the exact same keyword network. Unlike the first image, which groups keywords into static clusters based on shared themes, this image uses color gradations to show the temporal evolution and research trends of these topics. The key to reading this map lies in the legend in the lower right corner. The color scale moves continuously from dark blue to green to bright yellow, representing the publication timeframe (average year of publication of the documents).

Within the context of this legend, dark blue represents relatively older or earliest research topics in the dataset (around mid-2023), while bright yellow represents the most recent or trending topics (towards mid-2024). Through this temporal mapping, we can trace a historical narrative of how the focus of researchers in the field of data mining has shifted, matured, and evolved in just the past year or so. Let's begin our analysis from the initial phase (Dark Blue). If we look closely, at the bottom, top, and some outer corners of the network, we see nodes such as "random forest," "deep learning," "big data," "enterprise," and "apriori algorithm" colored dark blue. This indicates that around mid-2023, the literature focused heavily on the foundations of large-scale technology architectures and the establishment of initial infrastructure for advanced machine learning. The emergence of classic algorithms like the apriori algorithm and random forest in this early phase indicates that many researchers were solidifying basic data mining techniques before moving on to more complex explorations.

Moving into the middle phase (Blueish Green to Pure Green), representing the period from late 2023 to early 2024, a major transition occurs, with the majority of large nodes in the middle glowing green. Massive nodes like "technology," "machine learning," "prediction," "feature," and "parameter" indicate that during this period, exploration of specific algorithms began shifting toward maturation, feature optimization, and parameter calibration for better model predictions. In this green phase, we also see nodes such as "industry," "problem," "impact," "effect," and "implementation." This demonstrates that the literature is moving beyond purely theoretical realms and is busy measuring the impact, solving problems, and implementing these technologies in the real world. This middle phase marks a highly productive period in which the discipline's efficacy is tested; technologies are no longer simply developed in laboratories, but are being evaluated for their application in specific regions and industries. Next, we enter the cutting-edge topics area (Yellowish Green to Bright Yellow). These are bright spots that represent the hottest research trends approaching mid-2024.

It's interesting to note that bright yellow nodes such as "limitation," "gap," and "insight" are particularly prominent. This indicates that the most cutting-edge literature is currently in a phase of reflection and critical evaluation. Researchers are now devoting more attention to identifying shortcomings in the current analytics ecosystem, evaluating algorithm limitations, and identifying knowledge gaps for future research. Beyond evaluation, the push for concrete implementation is also a recent trend. Yellow nodes such as "practical application," "experiment," and "state" indicate a high urgency to translate findings into real-world, daily operations. Within the operational realm, yellowing of the "condition" and "risk" nodes indicates a growing awareness among researchers of the importance of managing risk and adapting algorithms to specific field conditions. The appearance of yellow nodes in "activity" also suggests that the current trend is shifting toward more dynamic, activity-based monitoring and analysis, rather than simply static data processing. Overall, this overlay visualization captures a classic but fast-paced technology maturity cycle: from mastering basic algorithm infrastructure (blue), to expanding to application and problem-solving in industry (green), and finally to the present (yellow), where the academic data mining community has reached a critical evaluation stage focused on gaining insights, addressing systemic limitations, mitigating risks, and pursuing valuable practical applications.

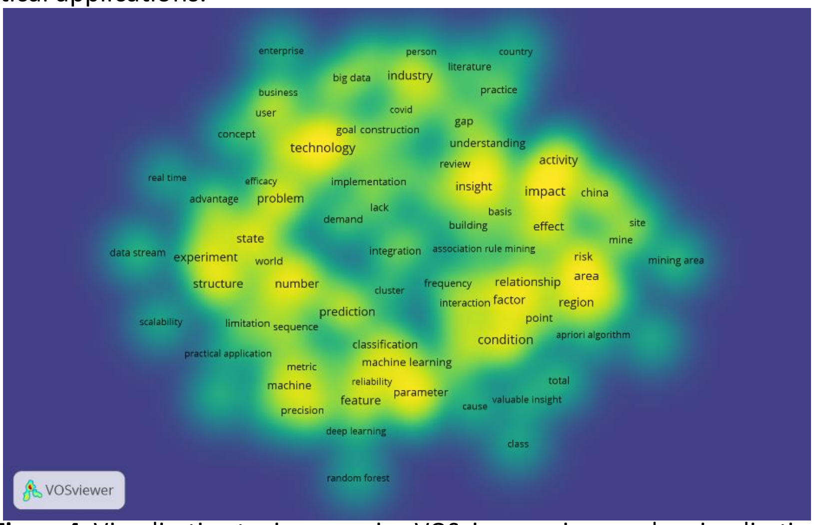

Figure 4. Visualization topic area using VOSviewer using overlay visualization

Figure 4 presents a form of analysis known as density visualization, or density mapping, using VOSviewer. While the previous visualization focused on connection networks and their temporal evolution, this map aims to highlight the most intensively researched areas, or "hotspots," in the field of data mining. The interpretation of this density map depends on the color spectrum used, which moves from dark blue to green, culminating in bright yellow. Dark blue represents areas with low literature density, while bright yellow indicates a very high concentration of research. The density at a point is calculated not only by the frequency of a keyword, but also by the weight of that node and the number of other relevant nodes around it. Therefore, the bright yellow area can be likened to the "center of gravity" in the academic landscape of that topic. Through this density map, we no longer see complex lines but can quickly identify which macro-themes constitute the main foundation or mainstream of the collection of publications being analyzed. A closer look at the map reveals that the data mining literature isn't concentrated in a single location, but rather has several overlapping main poles (bright yellow areas).

The First Density Pole can be found in the upper left quadrant, centered around the keyword "technology." This hotspot indicates that discussions of infrastructure and technology adoption are a significant pillar of this literature. The yellow area surrounding "technology" also includes terms like "problem." This indicates that a significant volume of publications is dedicated not only to the technology itself, but also to how it is used as a problem-solving tool. Slightly off-center from the technology area is the yellow distribution around "industry." While not as bright as the main hotspot, its density is significant, demonstrating that research in this data processing technology has a strong pull toward industrial applications. The Second Density Pole is at the bottom, representing the technical heart of the discipline. This hotspot is particularly bright around the keywords "machine learning," "feature," and "parameter." The high density of "machine learning" highlights that modern computational modeling is the lifeblood of data mining research today. This is the area where computer scientists devote the most time and resources. Interestingly, the brightest yellow color in this bottom area is concentrated around the terms "parameter," "feature," and "precision."

This suggests that researchers' primary technical focus is on feature engineering and hyperparameter tuning to achieve optimal model precision. Moving to the right quadrant, we find the Third Pole of Density, which is brightly lit around the keyword "insight" and extends to "impact." The yellow area around "insight" indicates that, despite the technical complexity of the algorithms, the ultimate goal most discussed in these publications is the extraction of new insights or knowledge from a large set of raw data. The high density of "impact" and "effect" indicates that the academic community is deeply concerned with the real-world consequences of their models, whether on business, the environment, or society at large. Just below the insight area, there are other bright spots centered on "relationship," "factor," "condition," and "area." These areas represent operational research methodologies in the field.

The high concentration of "relationship" and "factor" points demonstrates that searching for correlations between variables to understand a particular condition is the type of analysis that dominates the largest portion of data mining implementations. Between these densely packed yellow poles are yellowish-green "bridges," such as the words "prediction" and "state." These are the intersection points connecting the methodology area (machine learning) with its application area. Conversely, the dark blue or bluish-green areas at the edges (such as "data stream," "random forest," "enterprise," "covid") represent niche or isolated research topics.

4. CONCLUSION

Based on the results of bibliometric analysis and visualization using VOSviewer, it can be concluded that the current data mining research landscape is highly interdisciplinary and evolving dynamically. This research successfully mapped the knowledge structure divided into several main domains, ranging from the development of technical foundations such as machine learning and deep learning, to large-scale implementation in the industrial sector and impact analysis in specific geographic regions. Key findings indicate that the research focus has gone beyond simply developing algorithms in the laboratory; recent trends leading up to mid-2024 demonstrate a heightened urgency for critical reflection, such as identifying model limitations, managing risks, and implementing practical applications that deliver tangible value to users and companies. The identified research hotspots in the variables "technology," "machine learning," and "insight" emphasize that the ultimate goal of this research ecosystem is to transform raw data into impactful knowledge. Future research is expected to fill the identified knowledge gaps to further improve the efficiency and scalability of data mining technology across various fields.

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