The Utilization of Big Data in University Libraries: A Bibliometric Analysis

Pemanfaatan Big Data di Perpustakaan Perguruan Tinggi: Sebuah Analisa Bibliometrik

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Abstract

Background: *The utilization of Big Data is a tangible benefit of technology and interest in analyzing the field has significantly increased in recent years. However, there are limited investigations on the application of the field in university libraries.* **Objective***: This research aimed to identify and describe the characteristics of publications related to Big Data in university libraries using bibliometric analysis to explore and understand the trends.* **Method***: Bibliometric visualization methods were used in the investigation.* **Results***: The results showed that there were 80 publications on Big Data in university libraries from 2014 to 2023. The College of Economics and Management, as well as publications by Ahmad (2019) and Fox Edward, had the most significant influence on the field.* **Conclusion***: The mapping showed the validity of the relationship between theory and the opportunities presented in the field.*

Keywords: *Academic Library, Bibliometric Analysis, Big Data, College Library, University Libraries.*

Abstrak

Latar Belakang: Salah satu peran teknologi yang dapat dirasakan secara nyata manfaatnya adalah adanya pemanfaatan Big Data. Dalam beberapa tahun terakhir, minat penelitian terkait Big Data meningkat secara signifikan. Namun, masih jarang penelitian Big Data yang secara spesifik memfokuskan pada pemanfaatannya di perpustakaan perguruan tinggi. **Tujuan**: Penelitian ini bertujuan mengidentifikasi dan mendeskripsikan karakteristik publikasi tentang Big Data di perpustakaan perguruan tinggi dengan menggunakan analisis bibliometrik untuk menjelajahi dan memahami tren penelitian di bidang tersebut. **Metode**: Peneliti menggunakan metode visualisasi bibliometrik pada penelitian ini. **Hasil**: Temuan penelitian menunjukkan bahwa selama tahun 2014 hingga tahun 2023 terdapat 80 publikasi yang membahas tentang Big Data di Perpustakaan Perguruan Tinggi. Negara China, College of Economics and Management, serta publikasi Ahmad (2019) dan Fox, Edward a menjadi yang paling memiliki pengaruh pada bidang Big Data di Perpustakaan Perguruan Tinggi. **Kesimpulan**: Kesimpulannya, pemetaan dari hasil analisis bibliometrik terkait Big Data di Perpustakaan Perguruan Tinggi menunjukkan validitas hubungan antara teori dan bukti peluang tersebut.

Kata kunci: Academic Library, Analisis Bibliometrik, Big Data, Perpustakaan Perguruan Tinggi, University Library.
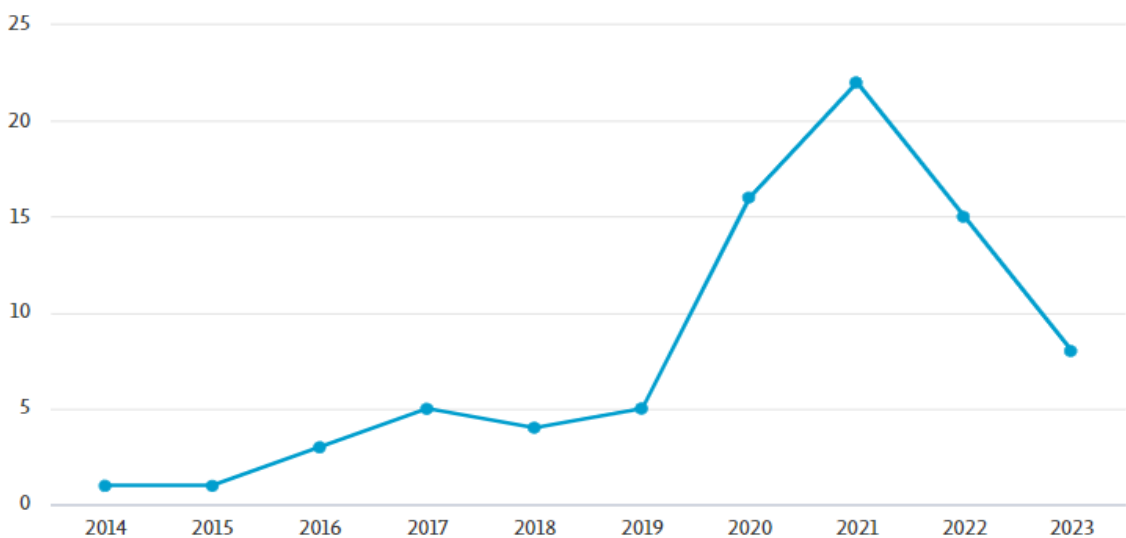
I.   INTRODUCTION

Research Background. The era of Industry 4.0 and Society 5.0 opens up limitless opportunities for achieving a digital and sustainable future. In this context, the utilization of *Big Data* is crucial for addressing challenges and using the technological innovations of the industrial revolution (Wali et al., 2023). According to the *Worldwide Semiannual Big Data* and *Analytics Software Tracker from the International Data Corporation (IDC),* the analytics software market experienced a growth of 14.7% in the first half of 2022, exceeding the 12.5% growth of 2021 (Hidayat, 2023). The utilization has become a trend across various fields, including the operation of library functions. Sanap (2023) stated that the capabilities of *Big Data* gained the attention of the library world, where professional librarians could play a significant role in the domain with skills, knowledge, and service-oriented mentality. The digital era demands libraries to continuously adapt and evolve with the times. To support this, libraries provide collections of printed information sources stored in a room or building and offer digital services to users.

The utilization of technology is a crucial key to achieving library objectives for university libraries functioning as providers of accurate information. To support the achievement of providing valuable insights, *Big Data* serves as a facilitator and an accelerator.

University libraries play an important role in disseminating knowledge (Yao, 2022). Meanwhile, *Big Data* enables libraries to collect, protect, and analyze data on a large and complex scale. For instance, libraries can be assisted in making better decisions regarding collection development, space management, material search, and maintaining the quality of functions (Azam & Ahmad, 2023). Efficient, innovative, and user-oriented services can be offered under the influence of the analytic software (Azam & Ahmad, 2023). Sanap (2023) reinforced that the utilization could enhance the quality of library services by creating innovations to meet user needs.

Problem. The utilization of *Big Data* faces different complex challenges and this is driven by increased digitalization in scale and quality (Abdelrahman, 2022). Some of the challenges include significant barriers such as insufficient financial resources, inadequate infrastructure, and subpar software for effective data management (Dunmade & Hamzat, 2022). Additionally, Ye (2018; Zhao (2020) stated that effective use required the management of diverse data sources and the implementation of distributed storage and computing models. Manaseer et al. (2019) emphasized that investing in the technology improved the optimal utilization in university libraries. Meanwhile, Xiaodan & Wei (2017), stated that reforming service and management models was necessary. Despite growing interest, there are two main obstacles in processing *Big Data* in university libraries, namely the technical and algorithmic complexities, as well as the large volume, velocity, and variety of data (Al-Barashdi & Al-Karousi, 2019).

In recent years, research interest has increased significantly. Regarding the application in university libraries, publications about *Big Data* in the Scopus database commenced in 2014 with a publication. Referring to a search in the *Scopus database*, this increase is reported in the following figure.

Figure 1.
Big Data Publication Trends in University Libraries

Source: Research Data, 2024

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Research related to *Big Data* in university libraries did not experience significant growth from 2014 to 2019. However, in 2020, there was an increase in publications, reaching 16. The following year witnessed an increase to 22 publications, making 2021 the peak year for publications. In 2022 and 2023, the number of publications declined. A 2021 research by Gao (2021) showed that the era of *Big Data* could be used to analyze students' information literacy. Similarly, Yi (2021) explained that in the context of implementing the technology, digital resources could be shared with cloud computing services. The development of *Big Data* also motivates libraries to become intelligent knowledge service-providing organizations (Li et al., 2022). Therefore, the benefits have a real impact on the development of university libraries.

Review of Previous Research. Several related research have been recorded in the Scopus database on *Big Data*. Cai et al. (2024) focused on the use of the technology in the hospitality and tourism sectors using scientometric analysis. Another research by Samsul et al. (2023) presented an analysis in the field of education and learning, using bibliometric analysis with the aid of PRISMA application. Meanwhile, Sharma (2023) examined *Big Data* in the finance sector using Systematic Literature Review analysis. In the same year, research on *Big Data* was reported in human resource management (Fauzi et al., 2023), the insurance industry (Ellili et al., 2023), as well as *deep* learning and *Big Data* (Vicente-Ramos & Durán-Carhuamaca, 2023), using bibliometric analysis. Bibliometric research in the library field has been conducted using the keywords "*Big Data AND libraries*" (Chigwada, 2021), focusing on knowledge production (Ajibade & Mutula, 2020).
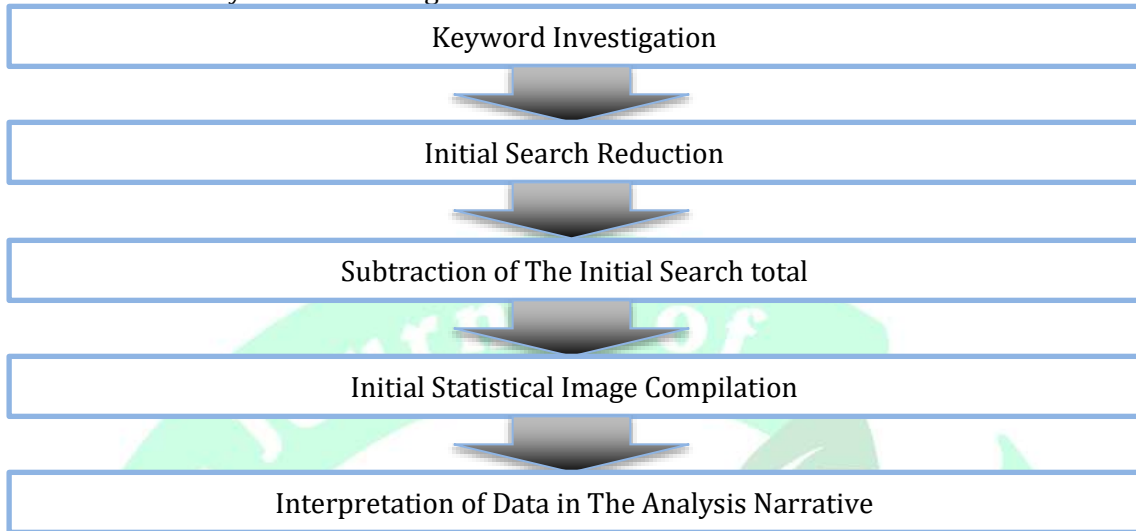
State of the Art. Anna & Mannan (2020) publications related to *Big Data* in libraries were not fully reported. The novelty of this research lies in the keywords used. The keywords were accepted even though previous results used bibliometric analysis. Additionally, bibliometric research using *Big Data* and university libraries has not been conducted. In this context, this research focuses on the utilization of *Big Data* in university libraries.

Objective. This research aims to identify and describe the characteristics of publications related to *Big Data* using bibliometric analysis to explore and understand trends. According to Phoong et al. (2022); Wang et al. (2021); Zhang et al. (2019), bibliometric is a statistical method used to analyze publications. The concept forms the basis for identifying the most popular and significant publications in a particular field (Zyoud et al., 2015). Therefore, the method analyzes and identifies the most significant and popular publications in a research field. According to Anna & Mannan (2020), the application of *Big Data* in libraries is in the early stages, marked by the limited practical implementation.

II.   METHODS

Bibliometric visualization methods were used and the sample consisted of 80 publication documents obtained from Scopus database based on the keywords. Data collection was conducted on January 27, 2024, and the resulting search with the keywords *Big Data* AND University Library was 119 documents. Subsequently, a specific threshold was set with the criteria (TITLE-ABS-KEY ("BIG DATA") AND TITLE-ABS-KEY ("UNIVERSITY LIBRARY")) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SRCTYPE, "j") OR LIMIT-TO (SRCTYPE, "p")), yielding 80 publication documents. This research used the VosViewer application, presenting three types of visualizations, namely *network, overlay, and density.*

Figure 2.
Bibliometric Analysis Method Stages

Keyword Investigation

⬇

Initial Search Reduction

⬇

Subtraction of The Initial Search total

⬇

Initial Statistical Image Compilation

⬇

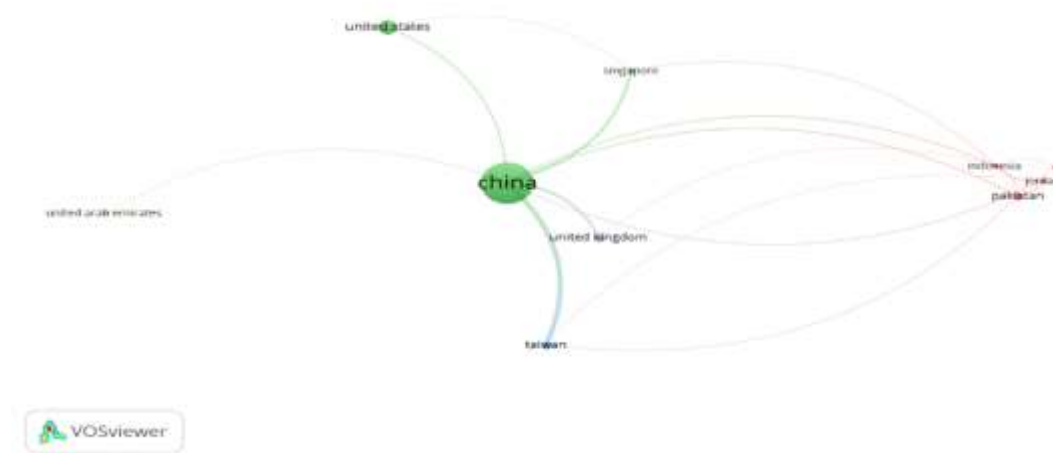| Interpretation of Data in The Analysis Narrative |
|---|

Source: Muhammad et al. (2022)

According to Dewi, Widodo, Rochintaniawati, & Prima through Muhammad et al. (2022), there were five stages in bibliometric analysis. In the first stage, the keywords were determined, namely *Big Data* in University Libraries. The second stage classified searches based on the keywords through Scopus database. The third stage was shown through the use of specific thresholds for each visualization presented using the VosViewer application. In the fourth stage, publication trends were presented through visualizations of country, institution, journal, publication, and author bibliography pairs, as well as co-occurrence of keywords. In the fifth stage, the data related to the visualizations were interpreted.

III.   RESULTS AND DISCUSSION

The development of publication trends through bibliometric analysis includes various aspects such as country, institution, journal, publication, and author bibliography pairs, as well as co-occurrence of keywords.

Country Bibliography Pair. In the visualization of bibliographic network among countries, a threshold of 1 publication and 1 citation was used. From the 16 countries analyzed, 13 met the criteria, with Indonesia ranking sixth based on a total of 15 link strengths, 9 citations, and 1 publication. Meanwhile, China occupied the first position with a total link strength of 154, 152 citations, and 58 publications.

Figure 3.
Network Visualization of Country Bibliography Pair

Source: Research Data, 2024

The remaining countries were arranged based on the number of publications, citations, and total link strength in a specific order. These included Taiwan (2, 14, 84), United Kingdom (2, 6, 27), Singapore (1, 8, 25), Pakistan (2, 28, 17), Indonesia (1, 9, 15), Jordan (1, 17, 14), United States (7, 12, 10), Thailand (1, 2, 2), United Arab Emirates (1, 2, 2), India (1, 1, 0), Saudi Arabia (1, 4, 0), and South Korea (2, 4, 0). Figure 2 shows different colors as a representation of clusters based on the intensity of relations between countries, with the main cluster consisting of China, Singapore, and the United States. The second cluster is Taiwan, while the third includes Indonesia, Jordan, Pakistan, and Thailand. The fourth and fifth clusters are the United Kingdom and United Arab Emirates, respectively.

Institutional Bibliography Pair. Bibliographic relationships between institutions are shown in Figure 4 through Overlay Visualization. A threshold was set for each institution to have at least 1 publication cited a minimum of 5 times. Only 27 out of 117 institutions met these criteria and were ranked based on total link strength. In this context, the *College of Economics and Management (China)* occupied the first position with a total link strength of 240, 13 citations, and 1 publication.

Figure 4.
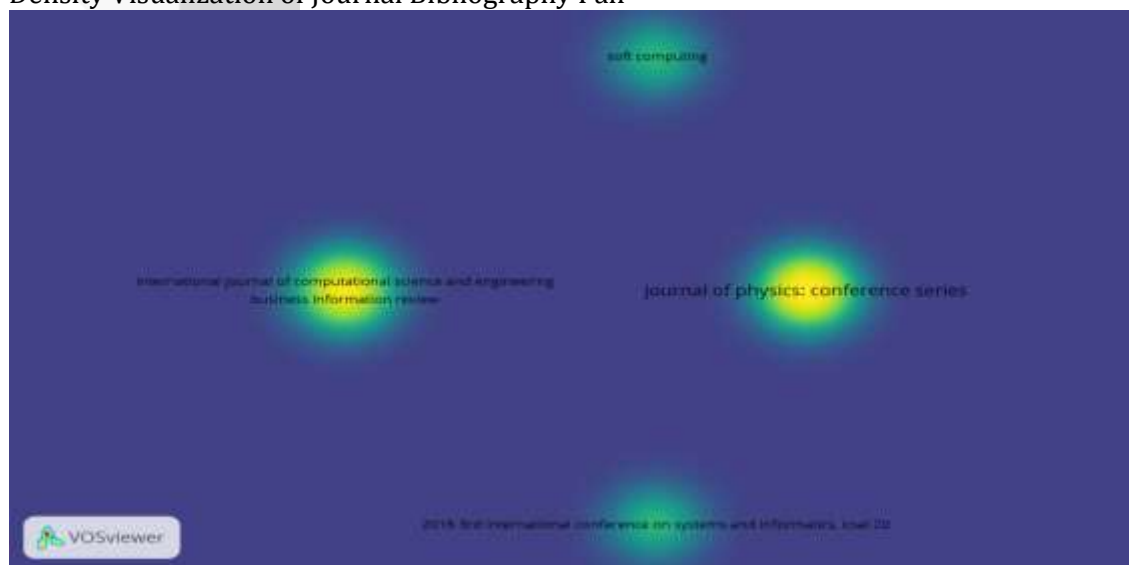Overlay Visualization of Institutional Bibliography Pair

Source: Research Data, 2024

The 2nd, 3rd, and 4th ranks have a total link strength of 240, 13 citations, and 1 publication. These institutions include the Institute of Service Industries and Management, the Research Centre for Environment and Sustainable Development of China, and the Zhongshan Institute. In addition, the institutions are shown with the 1st, 2nd, and 3rd numbers representing total link strength, citations, and publications. These include *Computer Science Department* (Jordan) (106, 17, 1), *Educational Leadership Department* (Jordan) (106, 17, 1), *Library and Information Science Department* (Jordan) (106, 17, 1), *College of Computer Engineering* (46, 8, 1), *Libraries and Archives* (46, 8, 1), *School of Information Science Technology and Design Pillars* (Singapore) (46, 8, 1), *The Aga Khan University* (Pakistan) (42, 27, 1), *The Islamia University Bahawalpur* (Pakistan) (42, 27, 1), Universitas Airlangga (Indonesia) (16. 9, 1), *Computer Science Old Dominion University (United States)* (14, 5, 1), *Computer Science Virginia Polytechnic Institute* (14, 5, 1), *Library Information Centre* (China) (14, 5, 1), *Maternal and Child Care Service Centre* (China) (14, 5, 1), *University Libraries Virginia Polytechnic Institute and State University (United States)* (14, 5, 1), *British Library London (United Kingdom)* (13, 6, 1), *British Library Wetherby (United Kingdom)* (13, 6, 1), *Library Central China Normal University Wuhan (China)* (10, 5, 1), *Department of Information Management* (China) (4, 34, 1), *Department of Control Science and Engineering* (China) (0, 23, 1), *Hebei Women's Vocational College* (China) (0, 6, 1), *Huali College Guangdong University of Technology* (0, 5, 1), *Information Consultation Department, Library of Beijing University of Agriculture* (China) (0, 6, 1).

Journal Bibliography Pair. Figure 5 presents Density Visualization, showing bibliographic connections among journals. In this visualization, yellow denotes journal density, with the darker color indicating a higher volume of publications. This research applied a threshold where each journal must have at least 1 publication cited 7 times, and out of 66 sources, only 8 journals met these criteria. The journals were ranked based on total link strength, with *Library Hi Tech* News occupying the top position with a total link strength of 6, 9 citations, and 1 publication. The sequence includes *New Review of Academic Librarianship, Data Technologies and Applications, International Journal of Computational Science and Engineering, Business Information Review, 2016 3rd International Conference on Systems and Informatics, ICSAI 2016, Journal of Physic: Conference Series and Soft Computing.*

Figure 5.
Density Visualization of Journal Bibliography Pair

Source: Research Data, 2024

Publication Bibliography Pair

Figure 6 shows Network Visualization to show bibliographic connections of publications, with the research applying a constraint where the publication should have a minimum of 10 citations. Out of 80 publications, only 5 met the required threshold. Ahmad (2019) and Ali (2020) occupied the 1st and 2nd positions with 34 and 27 citations, followed by Hou (2017), Hamad (2022), and Wu (2020).

Figure 6.
Network Visualization of Publication Bibliography Pair

Source: Research Data, 2024

Ahmad (2019) was the most influential work on the utilization of *Big Data*, with a total of 34 citations. This article explored the relationship between librarian skills and the implementation of *Big Data* analysis in Pakistan. The data were collected through surveys and analysis using the Pearson correlation method assisted by statistical software for Social

Science version 25. The results showed that librarians used *Big Data* for various library operations, such as acquisition, preservation, curation, and analysis (Ahmad et al., 2019)**.**

The second influential article was by Ali (2020) with 27 citations. Ali et al. (2020) consider the utilization of artificial intelligence (AI) in university library settings, including support through *Big Data* applications. The research analyzed and assessed the potential utilization of artificial intelligence assistance in academic libraries in Pakistan, with a specific focus on technical operations domain and library services for users. The results showed that librarians had knowledge of the existence of artificial intelligence technology. In libraries, services rooted in Natural Language Processing (NLP), such as *Google Assistant, Voice Search,* and *Google Translate*, were used. Additionally, methods including pattern recognition, such as text data mining, were adopted to retrieve library materials and conduct *online* searches. Access to various *Big Data* was achieved through cloud computing services such as OneDrive and Google Drive. However, awareness levels about robotics and chatbots among librarians remain relatively low. Funding challenges and technical capabilities are significant barriers to artificial intelligence implementation in university libraries. The research recommended that university libraries collaborated with computer science departments to establish dedicated laboratories for artificial intelligence purposes (Ali et al., 2020).

The third influential article is by Hou (2017) with 23 citations. The application of *Big Data* was examined in predicting depression based on reading habits. The relationship between reading patterns and depression tendencies was extensively explored among students, using data collected from university libraries archives and mental health questionnaire results (Hou et al., 2017). Subsequently, the fourth influential article was by Hamad (2022) with 17 citations. The research conducted by Hamad et al. (2022) discussed the opportunities and challenges for analytical strategies in Jordanian Academic Libraries. The results showed that libraries enabled the management and storage of large amounts of data, specifically in the provision of effective services. Meanwhile, innovation as well as resource transfer and utilization can be conducted with the assistance of *Big Data*. Librarians are also aware of the utilization to facilitate various decision-making processes in influencing user experiences (Hamad et al., 2022).

The fifth influential article was by Wu (2020) with 13 citations. The main causes of LibQUAL items were examined to improve the quality of library services from a *Big Data* perspective. DEMATEL model and LibQUAL+™ questionnaire were used in data collection and field analysis. The results showed that employees working in the library must possess high motivation to provide *one-on-one* services to users. Additionally, the utilization of the website needs to be promoted to enhance user accessibility (Wu et al., 2019).

Author Bibliography Pair

Figure 7 shows Overlay Visualization to report bibliographic connections. In the application of a threshold, there must be a minimum of 2 publications and 3 citations. Out of 170 authors, only 8 were able to meet the required threshold. Fox, Edward ranks first with a total link strength of 153, 6 citations, and 6 publications. In the 2nd and 3rd positions, Ingram, William A. and Wu, Jian had the same total link strength, citation count, and number of publications. The fourth position was occupied by Banerjee, Bipasha with a total link strength of 129, 6 citations, and 2 publications. In addition, Hou, Yujiao, Ma, Xiaofeng, Sha, Zhengyu, Wang, Chunyu, and Ahmad, Khurshid followed the sequence.

Figure 7.
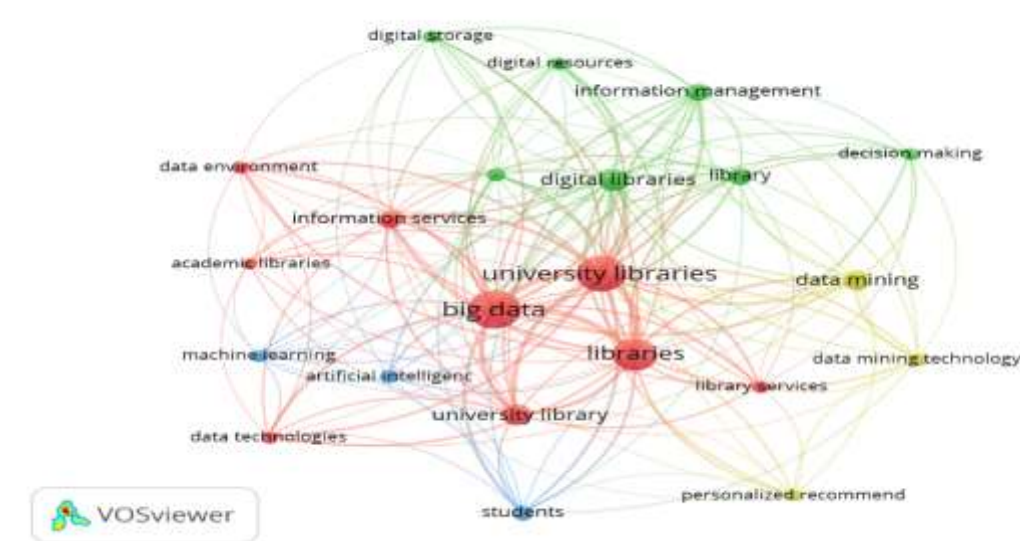Overlay Visualization of Author Bibliography Pair

Source: Research Data, 2024

The data in the figure is presented through Overlay Visualization, with blue, green, and yellow colors representing the publication periods. The yellow indicates newer articles around 2022, while green represents 2021. Fox, Edward A, Ingram, William A., and Wu, Jian were represented by the yellow color after publishing several articles around 2022. Meanwhile, the articles published for a longer time in the field were written by Banerjee and Bipasha.

Co-Occurrence of Keywords from Authors. Figure 8 shows Network Visualization for co-occurrence, with the research using a minimum threshold of 5 occurrences, and out of 658 keywords, only 22 meet these criteria. Meanwhile, *Big Data* ranks first with 57 occurrences and 213 total link strength. This is followed by keywords such as *university libraries, libraries, digital libraries, university libraries, data mining, information services, information management, library, students, data handling, artificial intelligence, data mining technologies, data technologies, library service data environment, decision making, machine learning, digital resources, digital storage, personalized recommendation,* and *academic libraries.*

Figure 8.
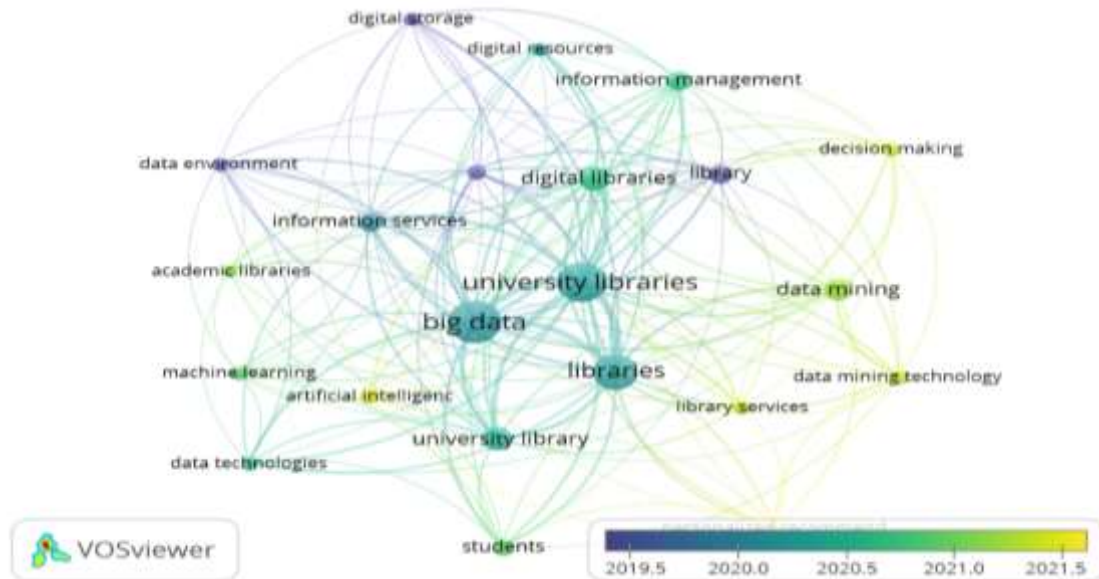Network Visualization of Co-Occurrence of Keywords from Authors

Source: Research Data, 2024

Figure 8 shows related keywords, with the main clusters in red including *Big Data, university libraries, libraries, university libraries, and library services*. This is followed by a data Overlay Visualization in the following figure.

Figure 9.

Overlay Visualization of Co-Occurrence of Keywords from Authors
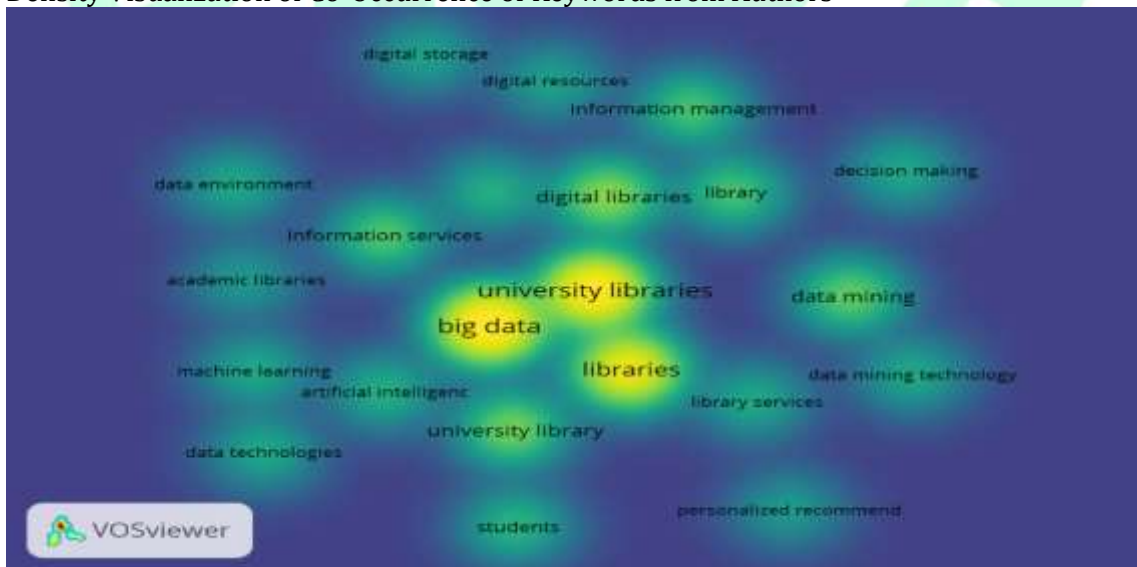

Source: Research Data, 2024

Figure 9 shows co-occurrence of keywords with Overlay Visualization. In this context, yellow color indicates keywords related to the latest publications, such as "*artificial intelligence*" appearing around 2021. This research reports a gap by excluding other variables such as *data mining, decision-making, library services, information services*, and *data environment.*

Figure 10.

Density Visualization of Co-Occurrence of Keywords from Authors

Source: Research Data, 2024

Figure 10 shows a density visualization that presents trends with color differentiation on keywords. The subject is explored to a greater extent when the color of an object tends towards the spectrum from yellow to red. Conversely, when the color shifts towards blue, the subject remains relatively unexplored (Rahmadanita & Hidayat, 2023). Keywords in yellow and have the most discussed topics include *Big Data*, libraries, and university libraries. Meanwhile, topics less frequently discussed include *data technologies, machine learning, artificial intelligence, decision-making, digital resources, and digital storage*. These topics are considered for more in-depth examination by future research.

Discussion of Research Findings. This research examines publications on *Big Data* obtained through Scopus database and visualized using bibliometric analysis. In terms of total link strength, citation, and publication, China ranks first in bibliographic coupling. Other countries significantly influencing publications include Taiwan, United Kingdom, Singapore, Pakistan, Indonesia, Jordan, United States, Thailand, United Arab Emirates, India, Saudi Arabia, and South Korea. The universities' bibliographic coupling shows that the *College of Economics and Management (China)* ranks first in the field. This is followed by the *Institute of Service Industries and Management, the Research Centre for Environment and Sustainable Development of China and Zhongshan Institute, the Computer Science Department (Jordan), the Educational Leadership Department (Jordan), the Library and Information Science Department, the College of Computer Engineering, Libraries and Archives, the School of Information Science Technology and Design Pillars (Singapore), The Aga Khan University (Pakistan), The Islamia University Bahawalpur (Pakistan), Universitas Airlangga (Indonesia), the Computer Science Department at Old Dominion University (United States), the Computer Science Department at Virginia Polytechnic Institute, the Library Information Centre (China), the Maternal and Child Care Service Centre (China), University Libraries at Virginia Polytechnic Institute and State University (United States), the British Library London (United Kingdom), the British Library Wetherby (United Kingdom), the Library at Central China Normal University Wuhan (China), the Department of Information Management (China), the Department of Control Science and Engineering (China), Hebei Women's Vocational College (China), Huali College Guangdong University of Technology, and the Information Consultation Department at the Library of Beijing University of Agriculture (China)*. In bibliographic coupling, Ahmad (2019) ranked first followed by Ali (2020). Subsequently, Hou (2017), Hamad (2022), and Wu (2020) were listed in a sequence. Fox, Edward A., Ingram, William A., and Wu, Jian published several articles in 2022, while Banerjee and Bipasha, wrote earlier research in the field.

Co-occurrence of keywords shows that *Big Data* ranks first. This is followed by keywords such as *university libraries, libraries, digital libraries, university libraries, data mining, information services, information management, library, students, data handling, artificial intelligence, data mining technologies, data technologies, library services, data environment, decision making, machine learning, digital resources, digital storage, personalized recommendation, and academic libraries*. Meanwhile, keywords related to recent publications, such as artificial intelligence, appeared in 2021. In this context, the research shows a gap by excluding other variables namely *data mining, decision-making, library services, information services,* and *data environment*.

The results were consistent with Anna & Mannan (2020) where most *Big Data*-related research in libraries was conducted in China, and the most frequently encountered keyword through Network Visualization was *Big Data*. This research reinforced the previous results by Liu et al. (2020) which examined publication trends using bibliometric analysis. A collaboration visualization was observed among various universities and acknowledged a deceleration in publication growth since 2014. There were differences from the research

conducted by Chigwada (2021), which also focused on *Big Data* but used bibliometric analysis. Chigwada reported challenges faced by libraries producing *Big Data*, such as accuracy, confidentiality as well as security, and availability of technology and processing systems.

Research Limitation. This research only used Scopus database to focus on data processing and analysis. As a recommendation, future research should conduct a more in-depth analysis using the same method but with multiple databases. Additionally, the advantage of the gap identified should be considered regarding topics explored related to using *Big Data* in university libraries. These topics include data technologies, machine learning, artificial intelligence, decision-making, digital resources, and storage. Future research should also examine the topics in the practical implementation of *Big Data* utilization in university libraries.

IV. CONCLUSION

In conclusion, the College of Economics and Management and the publications by Ahmad (2019) and Fox Edward A. were reported to have a significant influence on *Big Data* in University Libraries. Keywords such as libraries and digital libraries were developed as primary keywords after *Big Data* and university libraries. Meanwhile, keywords related to recent publications, such as artificial intelligence, appeared in 2021. These results showed a research gap, regarding the lack of focus on variables such as data mining, decision-making, library services, information services, and data environment. Therefore, future research was expected to explore the field and uncover the potential of *Big Data* utilization in university libraries.

Future Research. Future research can take advantage of the gap, which is related to topics concerning the use of *Big Data* in university libraries. The topics include data technologies, machine learning, artificial intelligence, decision-making, digital resources, and storage.

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