Interactive Visualization Dashboard for Exploring Scientific Publications in Indonesia

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Submitted: 26-06-2023
Revised: 25-09-2023
Accepted: 03-10-2023
Available online: 14-11-2023

How to cite: Sihombing, A., Yaniasih, Indrawati, A., Afandi, S., & Ningsih Maha, R. (2023). Interactive Visualization Dashboard for Exploring Scientific Publications in Indonesia. Khizanah Al-Hikmah : Jurnal Ilmu Perpustakaan, Informasi, Dan Kearsipan, 11(2). https://doi.org/10.24252/kah.v11i2a3

DOI: 10.24252/kah.v11i2a3

ABSTRACT

Numerous bibliometric investigations have been carried out in Indonesia, primarily relying on publication data indexed exclusively in Scopus. This study aims to leverage scientific publication data from the Indonesian Scientific Journal Database (ISJD) by constructing an interactive visualization dashboard for the analysis of Indonesian scientific publications. This dashboard is expected to become an additional reference for researchers in the field of bibliometrics. The stages of making this dashboard consist of Identification of visualization needs referring to previous research; data feasibility check; data correction and update; data visualization; and evaluation to assess the correctness of the data and the resulting visualization. Evaluation results indicate that the dashboard's analysis system is functioning effectively, offering diverse analysis options. Nonetheless, the system has limitations related to data quality in ISJD, necessitating improvements in terms of completeness, appropriateness, and data updates. Future research will enhance the dashboard by incorporating citation analysis calculations to evaluate the performance of authors and journals.

Keywords: Data visualization; bibliometrics; ISJD; Indonesian scientific publications

1. INTRODUCTION

The trend of scientific publications in Indonesia is increasing over time. From 2015 to 2019, there was a 549,71% increase in Indonesian publications indexed by Scopus (Putera et al., 2021). This trend is supported by the Minister of Research and Technology of Higher Education regulation No. 20/2017 regarding the Provision of Professional Lecturer Allowances and Professor Honor Allowances. In addition, regulation No. 44/2015 encourages doctors and masters to publish their scholarly works internationally indexed. With this abundant scientific publication data, much research has been conducted by academia and researchers. As we know, scientific publication analysis is one of the indicators commonly used to measure, evaluate, and become the basis for making science and technology policies.

Yaniasih et al. (2017) used scientific publication growth as data for their research. The research purpose was to assess the funds that the government has provided to support the research ecosystem. Several other studies have also been carried out, including on the growth of scientific publications in the field of sports (Hanief et al., 2021) and research to measure the contribution of Indonesian researchers related to Socio-Scientific Issues (SSI) (Deta et al., 2021). The information and data generated from these studies are expected to be used by policymakers in evaluating and making new policies related to research development in Indonesia. In addition, the Ministry of Research, Technology and Higher Education of the Republic of Indonesia (Kemenristekdikti) published a book titled *Publication Growth Profile of 50 Institutions in Indonesia*. The Director of Intellectual Property Enrichment of the Ministry of Research, Technology and Higher Education said that the information in the book could be used while making policy, research budget allocation, and awarding awards to academics/researchers (Lukman et al., 2016). Information in the books and the findings of the study are helpful. However, it cannot be updated when new information is available. The use of scientific publications indexed in Scopus as a data source is yet another problem since it does not represent the condition of publications in Indonesia. There are still very few Indonesian publications indexed in Scopus.

The Ministry of Research, Technology, and Higher Education tries to answer this problem by creating the Science and Technology Index information system known as SINTA (https://sinta.kemdikbud.go.id/). This platform visualizes ranking information for academics/researchers and institutions based on the number of published documents and citations. The visualization and citation calculations at SINTA are great, but there are no features available to carry out further analysis yet. SINTA does not provide access to users for downloading publication data used in its visualization.

Another primary publication database in Indonesia, aside from SINTA, is the Indonesian Scientific Journal Database (ISJD). Developed by the Indonesian Institute of Sciences (LIPI), now the National Research and Innovation Agency or *Badan Riset dan Inovasi Nasional* (BRIN). ISJD serves as a widely referenced resource. The objective of this study is to construct a publication analysis tool utilizing data from ISJD. The analysis tool in this context is a web-based interactive visualization dashboard. This dashboard is expected to be a new reference for analyzing scientific publications in Indonesia. Previous research on making visualization applications has been carried out by Latif & Beck (2019). The application can provide comprehensive information about the profile of an author. Other researchers Wang et al. (2019) have made visualization applications that can be used to find research collaborators based on their expertise. Both studies used scientific publication data published in international journals. The dashboard developed in this study also shows author profiles and their collaboration, but the data used is from Indonesian national journals.

To our knowledge, this represents the inaugural effort to develop a tool for analyzing scientific publications using data from Indonesian journals. This undertaking is crucial for obtaining a comprehensive overview of the publication landscape in Indonesia, especially considering the abundance of research in this particular domain., such as research by Maryono & Surajiman (2017), Amelia et al. (2017), Deta et al. (2021), and Wahidah & Afriyani (2021), but all the research only used publication data indexed by international indexers such as Scopus or web of science.

Scientific Publications Visualization

There is not much research on developing visualization applications for scientific publications. Wang et al. (2019) created a visualization application called VISPubComPAS. This application has a system for analyzing and comparing authors and institutions based on scientific publications indexed in the IEEE. Users can enter any domain expertise as a keyword, and the application then will provide recommendations for authors with that knowledge. Another similar study was conducted by Latif & Beck (2019). They create a visualization that displays the author's profile equipped with information on scientific fields, research collaborators, and badges to measure the author's achievements. This application is named VIS author profiles. So far, there is no research on developing a visualization dashboard for scientific publications in Indonesia. Several existing studies have only analyzed Scopus data. Visualization is made to see the trend in scientific publications' growth and collaboration patterns. One example is research conducted by Maryono & Surajiman (2017), who analyzed the effect of collaboration with its citations using publications from Gadjah Mada University.

Visualization Theory

Many references explained the theory of visualization. Soma et al. (2016) explain how to make visualizations that are effective and efficient in making visualizations for big data (Big Data) (Soma et al., 2016). Qin et al. (2020) explain that effective and efficient visualization must prioritize user needs and provide visualization recommendations according to user needs. The ability of an interactive system must be feasible until the user gets the required visualization. The interaction from the user can be by adding, subtracting, or changing the search attribute. Users must quickly understand the visualization. The longer it takes to understand visualization, the more likely the user will not get any information from the visualization presented. There are several principles while making visualizations, such as choosing colors, showing data, using the right software, simple visuals, providing detailed information, and including uncertainty (Midway, 2020).

Publication Analysis Application

Scopus and Dimension are some international indexers that perform indexation and citation analysis of scientific publications. The data they produce is often used as bibliometric research data. Furthermore, they also provide visualization features in their applications. In addition to the two indexers above, there are other indexers such as the Web of Sciences (WOS), Microsoft Academic, and Google Scholar (Martín-Martín et al., 2021). Indonesia currently has SINTA as an indexer that uses Scopus and Google Scholar data in citation calculations. "SINTA provides benchmarks and analyzes and identifies the research strengths of each institution, demonstrates research collaboration, and analyzes research trends and expert directories" (Fadhilaturrahmi et al., 2020). SINTA also displays rating information for scientific journals assessed based on their accreditation result (Saputra, 2020).

Visualization

D3JS is one of the tools used to visualize large amounts of data. D3JS is a library of JavaScript that uses Scalable Vector Graphics (SVG), HTML, and Cascaded Style Sheets (CSS) in creating visualizations. D3.JS is an open source that is free but requires a high programming ability to use (Nair et al., 2016). For users who do not have programming skills, alternative tools are available such as Tableau and Power BI. Both of these software have a Graphic User Interface (GUI) page that makes it easier for users to create visualizations by selecting, dragging, and placing. Some basic features are free, whereas users must subscribe for advanced features. Another application that is available for free is Plotly Dash which is one of the libraries of the Python programming language (Kudale et al., 2022). This application does not have a GUI page, so it requires intermediate programming skills to operate.

2. METHODS

There are five stages to the research process: 1) Identification of visualization needs; 2) Identification of the data feasibility; 3) Correcting and updating data; 4) Data visualization; and 5) Visualization evaluation. If the visualization results are incorrect, the data will be corrected, and then it will be re-visualized. The stages of the research are shown in Figure 1.

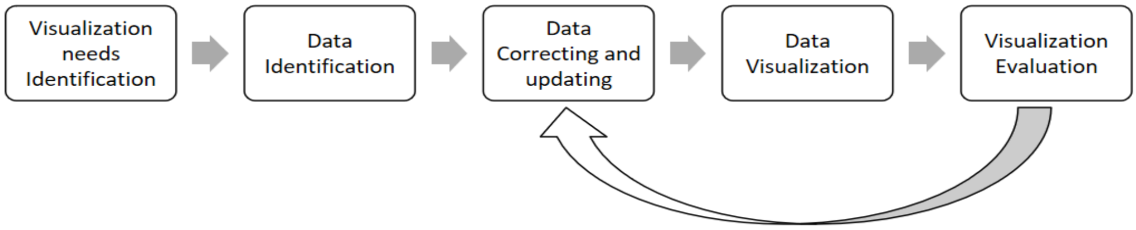

Figure 1. Research stages

Identification of Visualization Needs

Identification of visualization needs is carried out based on several previous studies that utilize data from scientific publications. For example, research by Nandiyanto et al. (2020) explained the research conditions in Indonesia based on the number of publications growth each year. Based on that research, the dashboard will display a graph of the scientific publication growth in Indonesia. Another example is research on collaboration patterns analysis in biodiversity scientific publications by Amelia et al. (2017). Based on that research, the dashboard will display a visualization that portrays the collaboration of publications in Indonesia. Based on the available references, it will then be determined what visualizations need to be made and what analysis can be done on the dashboard. Finally, the visualization will also consider the publication data condition.

Data identification

After determining what visualization needs to be made, the next step is to identify the completeness of the scientific publications metadata in ISJD. Indonesian Scientific Journal Database (ISJD) is an online journal database that has a collection of scientific journals published in Indonesia. It was developed and managed by the Indonesian Institute of Sciences (LIPI), which is currently the National Research and Innovation Agency (BRIN) (Putri et al., 2021). From the ISJD database, five tables were imported as our research data. The tables' names are article, master author, author, category, and journal table. Table 1 shows the fields used from each table.

Table 1. List of tables used as research data

Table Name	Fields
Article	Article ID, Year, Category ID, Author ID, Journal ID
Author Master	Author ID, Author Name, Institution
Author	Article_Author ID, Author ID, Author Number, Article ID
Category	Category ID, Category, Article ID
Journal	Journal ID, Article ID, Publisher

The available data is then checked for its totals, consistency, and also if there are any missing values or data duplication. Examining is done using Python and Ms. Excel. Furthermore, the tables are combined to get comprehensive information from each article. Each article has information such as the year of publication, scientific category, author's name, affiliation, journal name, and journal publishing agency.

Counting the number of collaborations between authors is done using the permutation formula. On the other hand, counting the number of collaborations between agencies is done using the collaboration formula. The purpose of differentiating the counting formula is to make sure any collaboration between the same institution is only counted as one collaboration. For example, if there are five authors in one publication that come from the same institution. Therefore the collaboration number between the institution, in this case, will only be counted once. In contrast, each of the authors will have four collaborations. An example of the calculation is shown in Figure 2.

No	Author's Name	Author's Institution
1	Andre Sihombing	BRIN
2	Sjaeful Afandi	BRIN
3	Ariani	BRIN
4	Seno Yudhanto	University of Indonesia (UI)
5	Yaniasih	University of Indonesia (UI)
6	Wahid Nashihuddin	Gadjah Mada University (UGM)

$$C(n_1, n_2, r) = \left(\frac{n_1!}{r!(n_1 - r)!}\right) + n_2$$

$$p(n,r) = \frac{n!}{(n-r)!}$$

Institution 1	Institution 2	Collaboration Count
BRIN	BRIN	1
BRIN	UI	1
BRIN	UGM	1
UI	UI	1
UI	UGM	1

No	Author's Name	Collaboration Count
1	Andre Sihombing	5
2	Sjaeful Afandi	5
3	Ariani	5
4	Seno Yudhanto	5
5	Yaniasih	5
6	Wahid Nashihuddin	5

Figure 2. Simulation for collaboration of authors and affiliations calculation

Data Improvement and Update

The process of data improvement and updating has an important role in this research. Since the available data is not ready to be directly visualized, it must be corrected first. Furthermore, the data updates will be done periodically every time the data is corrected. Improving the completeness of article metadata in the journal database is one of the concerns before the visualization process, especially when the data acquisition process is still done manually. The research by Putri et al. (2021) confirmed that many article metadata in ISJD databases is incomplete. There is a need for automation in the scientific classification process because there are a lot of problems in the manual process caused by the disproportionate number of officers with the number of articles that must be classified (Nugroho & Marlina, 2018).

Data Visualization

The visualization process follows the steps described in Qin et al. (2020). Including acquisition, preparation, selection of data, and the process of mapping and rendering. Rendering is the process of applying data into a visualization that is carried out automatically by the visualization software. There are several types of visualization software based on their ease of use and cost. Table 2 presents a comparison of five visualization software. Based on this comparison, Plotly Dash Python has been chosen to use to make the dashboard.

Table 2. Visualization software comparison

	Ms. Excel	Tableau	Power BI	D3JS	Plotly Dash Python
Cost	Free	Free and Paid	Free and Paid	Free	Free
Programming Capabilities	Not Needed	Not Needed	Not Needed	Advance	Beginner
Interactive	No	Yes	Yes	Yes	Yes
Data Amount	Limited	Big Data	Big Data	Big Data	Big Data
Data Resources	Excel, CSV	Excel CSV, CSV, Oracle, MySQL databases, and non-relational databases	Excel, CSV, Oracle, MySQL databases	Excel, CSV, Oracle, MySQL databases, and non-relational databases	Excel, CSV, Oracle, MySQL databases, and non-relational databases
Data Storage	Local Disk	Cloud Tableau	Azure	Local Disk / Server	Local Disk / Server
Making Process	Offline	Online and Offline	Online and Offline	Offline	Offline

3. RESULTS AND DISCUSSION

Based on the data identification method, which is checking the totals, consistency, and missing values or data duplication in the available data. It was found that the data used had several problems, and it needs time to correct the overall data. Therefore, it decided to use publication data published between the years 2013 to 2019. The selection of the time range is based on the data availability and condition of the data that is considered to have less time and labor to be corrected. Some of the problems encountered are as follows: 1. There is inconsistency in writing the author's affiliation; 2. There are authors with no affiliation; 3. One author has multiple author IDs; 4. Authors have several publications that do not belong to them; 5. The categories section in journals and articles have not been classified yet.

The entire correction process was done manually to overcome these problems. Except for scientific category filling in journals and articles, it is done automatically with a machine learning classification model (machine learning). Indrawati et al. (2020) have researched the best algorithm for classifying unbalanced data. The ISJD data has this unbalanced data problem since several categories have thousands of articles, while others only have tens or hundreds of articles.

Based on the results of checking the data and referring to several previous studies, it was decided to make the visualization on the dashboard as follows: 1. The institution with the most publications; 2. The author with the most publications; 3. Categories with the most publications; 4. Institutional collaboration; 5. Collaboration of authors, and 6. Information on the growth of the journal. Finally, the visualization in the dashboard can also be analyzed based on their institution, year, and scientific category. Dashboard creation is built using open source software dash plotly from Python. The following is the explanation of the dashboard.

Dashboard Main Page

The main page contains visualizations of institutions and categories with the most publications, the most collaboration between agencies, and the publication's growth from 2013 to 2019. Park & Jo (2015) explain in their research that one of the principles in making dashboards is that the primary information must be the center of attention, considering the limited area on a dashboard display. Therefore, this main page only displays the four main graphics that are static. The four graphs describe the trend of scientific publications in Indonesia in general.

One thing that needs to be considered is the publication growth visualization. It shows a declining trend from year to year. This data does not represent the actual trend. According to Nandiyanto et al. (2020), the publication trend in Indonesia since 2006 has continued to grow. It happened because the number of publications that ISJD acquired is decreasing. Therefore, do not use the publication trend visualization before the ISJD team has updated the data. Figure 3 shows the dashboard's main page display.

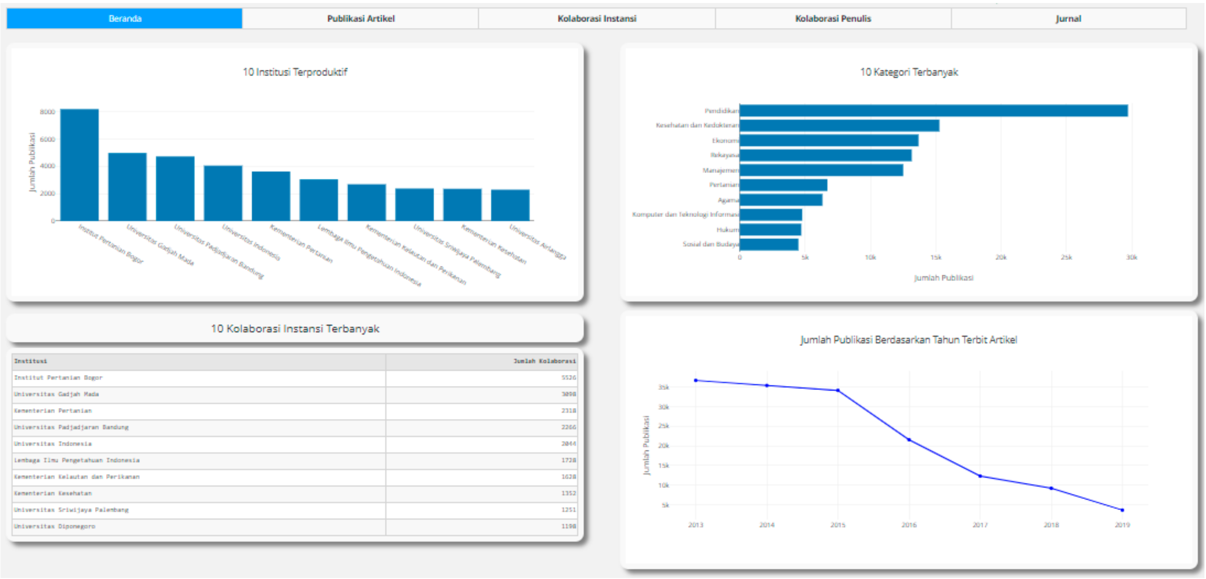

Figure 3. The visualization of the dashboard's main page display
Source: Processed Primary Data, 2022

Article Publication Page

According to Stehle & Kitchin (2020), a dashboard must be able to provide access for users to browse and compare the visualized data. The graph on this page is dynamic so that it can be filtered further based on what analysis you want to do. The article publication page consists of four main visualizations that can be analyzed as follows: 1. The number of publications made by an institution; 2. The number of publications from each category; 3. The most productive authors from each institution; 4. The journal used to publish.

This page has the option to perform analysis by providing tools to perform filtering data. It allows users to filter results by author affiliation, publication category, and year of publication. This tool's availability enables users to do a variety of analyses, including comparing publications produced by various universities, and then comparisons based on year ranges or a range of categories.

The journal section on this page is to see whether an author publishes his/her article in a journal published by his/her institution or a different institution. Analyzing this information is intriguing since many academic or research institutes publish journals to promote their research papers.

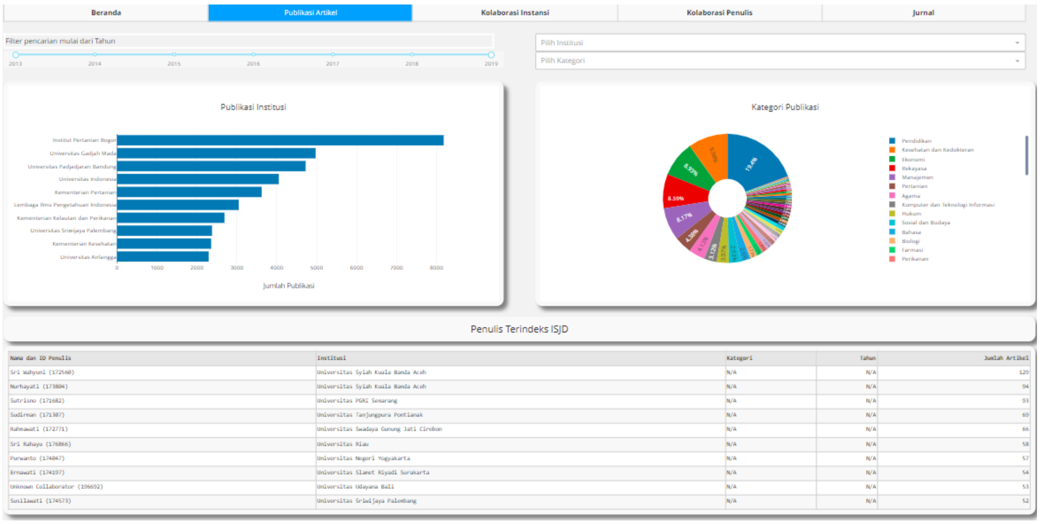

Figure 4. The visualization of the article publication page display
Source: Processed Primary Data, 2022

Institution Collaboration Page

The collaboration page contains a visualization of collaboration publications numbers between institutions. This page has a filtering tool like the article publication page, so it is possible to view or compare the number of collaborations carried out by an institution. If necessary, a comparison between institutional collaboration can also be analyzed for specific years and categories.

Collaborative analysis in this dashboard page is similar to the Amelia et al. (2017) research. She visualizes the comparison of collaboration between agencies in the field of biodiversity. Similarly, Maryono & Surajiman (2017) studied publication collaboration patterns at Gadjah Mada University. On this dashboard, you can also see trends in collaboration from other institutions and categories. Figure 5 shows the Institution collaboration page display.

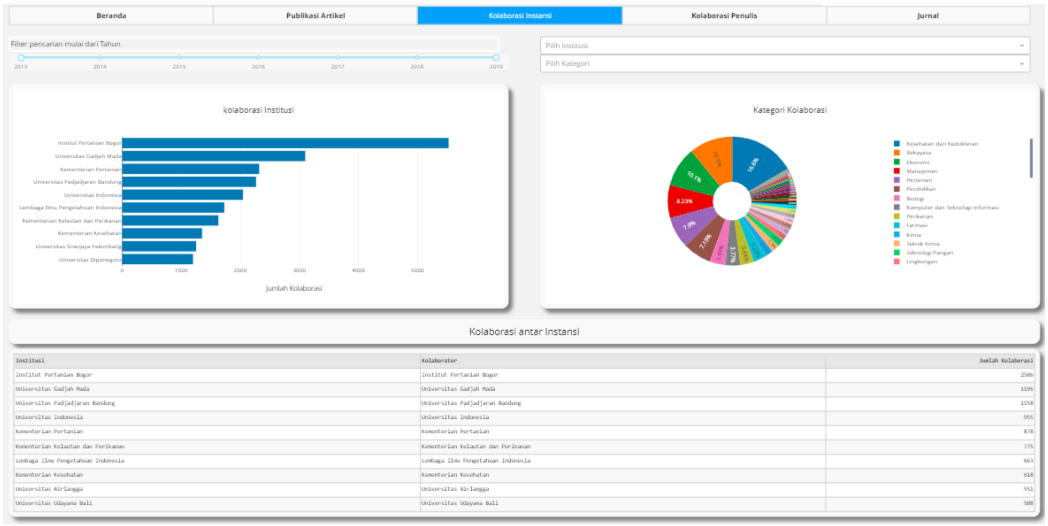

Figure 5. The dashboard display for the institution's collaboration
Source: Processed Primary Data, 2022

Author Collaboration page

The author's collaboration dashboard page contains a visualization of an author's profile based on the number of publications, the number of collaborators, the name of the collaborator, and the category of publications generated. This page also shows the authors who collaborated the most in general or from each institution. Compared to the SINTA publication index that provides citation analysis from Google Scholar and Scopus databases in their publication author profiles, ISJD has a drawback in this. ISJD has not provided any citation analysis on its database. Therefore, we are unable to visualize the impact of the collaboration yet.

The visualization shown on this page refers to the author profile dashboard created by Latif & Beck (2019). However, the author's profile is not as complete as in previous research. The publishing type used in Latif's study is more comprehensive, offering automated text analysis to characterize the author's profile. Figure 6 shows the author's collaboration page display.

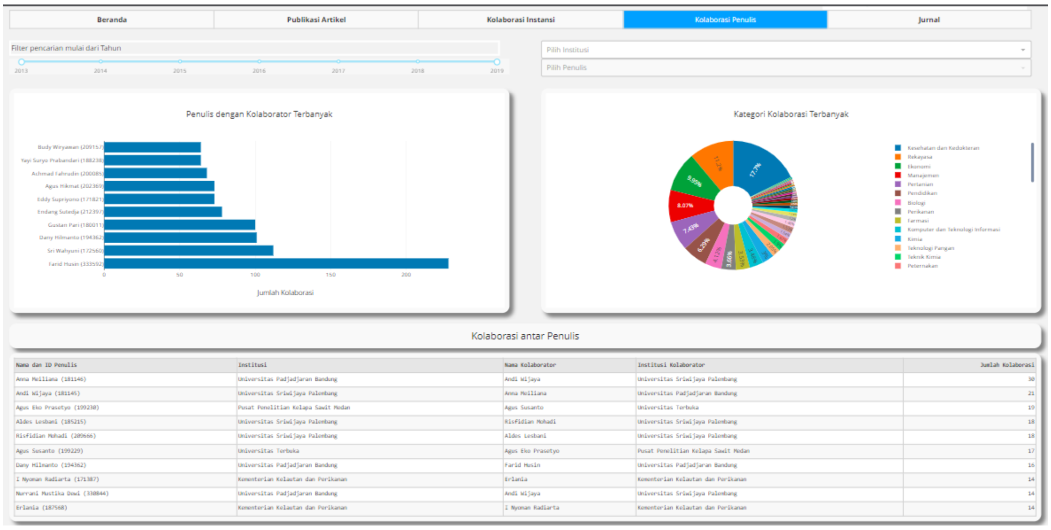

Figure 6. The dashboard displays of the author's collaboration
Source: Processed Primary Data, 2022

Journal Page

The pages Journal pages generally describe the growth of journals in Indonesia from year to year. The dashboard also displays the journal's growth in Indonesia by subject category. This dashboard's limitation is that it is unable to provide journal rankings that are available in the SINTA application (Saputra, 2020). This is because ISJD does not assess the quality of the indexed journals. Figure 7 shows a visualization of the journal page display.

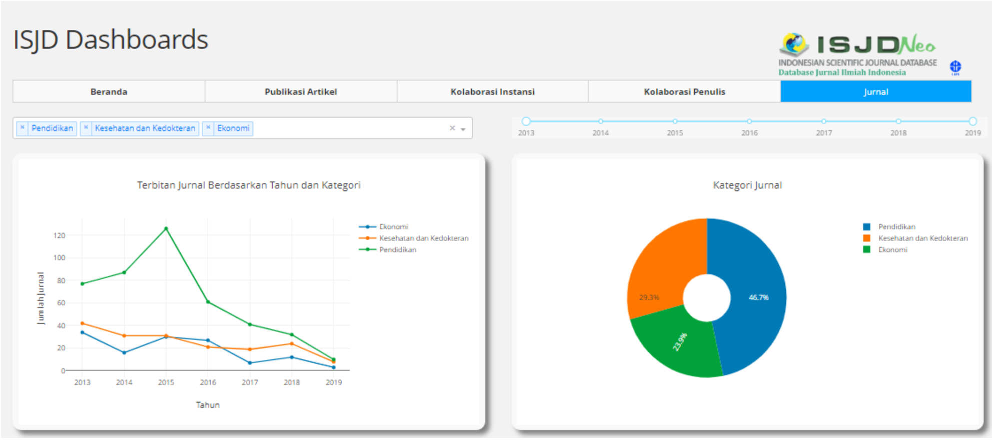

Figure 7. The dashboard display of the journal page
Source: Processed Primary Data, 2022

4. CONCLUSION

The dashboard for scientific publications that have been developed functions as intended. It can perform several types of publication analysis which are not available in the SINTA application yet. Using this dashboard, we can analyze the publication trends, comparing publications from different universities with specific categories and time options. Furthermore, we can see the author's profile contains the number of their publications, the number of collaborators, the name of the collaborator, and the category of their publications. However, the use of scientific publications data from ISJD has several drawbacks.

Therefore, it is necessary to improve the data, including the following: to improve the data entry process of the authors and their affiliations, data from the most recent scientific publications must be acquired automatically, and ISJD needs to add a citation analysis function to its system. Before users can access the dashboard, it is essential to rectify the data in the Indonesian Scientific Journal Database (ISJD). Subsequent enhancements to the dashboard will involve incorporating citation analysis calculations to evaluate the performance of both authors and journals. Additionally, there is a need to expand the scope by including Indonesian scientific publications that are published in international journals. This inclusive approach will contribute to a more comprehensive analysis, offering insights into the overall progress of science and technology in Indonesia.

Acknowledgment

We would like to thank the Head of the Center for Scientific Data and Documentation for the permission to use the data for scientific publications indexed in ISJD and for guidance in this research.

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