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Bibliometric and Visualized Analysis of Scientific Publications on Geotechnics Fields

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A B S T R A C T S

The advancement of civil engineering plays a major role in determining the nation's development. Generally, geotechnical engineering has a great influence as there is a building on the ground. The facts show that there are still many geotechnical problems that arise during the development process. One of the supporting factors in dealing with these problems is the development of research in the geotechnical sector in various fields. This research aims to determine the development of research related to Geotechnical Engineering through a bibliometric distribution map using the VOSviewer application. Data collection is gathered from the dimension site. The keyword used in this study is "geotechnical engineering" with the publication year of the 2017-2020 articles. This search was conducted on 23 October 2020 which resulted in 79,185 articles. The results show that the most productive writer in geotechnical research is Ronald Kerry Rowe. Moreover, China is the largest country in the field of geotechnical research so that many other countries have established cooperative relations with China. The journal that publishes the most articles on geotechnical engineering is the International Journal of Rock Mechanics and Mining Science. As for keyword analysis, it produces bibliometric maps including network visualizations, overlay visualizations, and density visualizations. Four keywords often appear, namely "Displacement", "Strength", "Stress", and "Earthquake". Through the bibliometric approach, researchers can identify keywords on each topic

A R T I C L E I N F O

or research that has been done before, it is, therefore, valuable in determining the novelty of the research that will be conducted in the future.

1. INTRODUCTION

The development of civil engineering to date has had a major influence in the field of infrastructure development, particularly in the field of geotechnical engineering. Geotechnical Engineering is concerned with the application of science and technology to the implementation of civil engineering regarding several aspects of the earth, such as the nature of natural materials on the earth's surface including soil and rock (Holtz *et al.,* 2010).

Geotechnical science has a major role in dealing with several geotechnical problems in the field, such as bearing failure, differential settlement, and ground have. soil instability, liquefaction, landslide, and seepage. Various attempts have been made to address these problems, including through research. Therefore, it is necessary to have a comprehensive study so that it can assist researchers in finding various alternative solutions to geotechnical problems.

This study aims to determine the development of research related to Geotechnical Engineering through bibliometric distribution maps and research publications on the Dimension database using the Vosviewer application. Bibliometrics is an effective way of providing datasets that can be used by policy makers, researchers, and other stakeholders (Nandiyanto *et al.,* 2020). The distribution of maps in this study consisted of the type of publication, the topics studied, and the researchers' country of origin.

Studies have been conducted to ascertain the effect on RBC performance of factors such as recirculation, disk rotational speed, temperature, hydraulic conditions, presence of organic particulate matter, use of supplemental air and scale-up (Cortez *et al.*, 2008; Hassard *et al.,* 2015). Disk rotational speed affects oxygen transfer to the biofilm for substrate utilization while loading conditions determine the overall treatment capacity of the bioreactor.

2. MATERIALS AND METHODS

Bibliometric analysis, also known as scientometrics, is a development of the meta-analysis research method (Nandiyanto *et al.,* 2010). In general, the process of bibliometric research is shown in **Figure 1**.
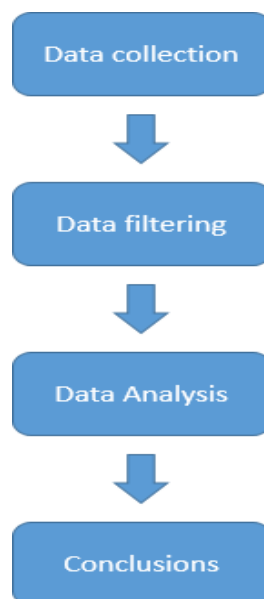

Figure 1. Bibliometric analysis process flow chart

In this study, data collection was carried out from the *dimension* site which provides a dataset of scientific articles that have been published in international journals under open source and can be downloaded in the form of CSV files. Then the dataset is opened using the Vosviewer software, the Vosviewer software will present the dataset into a mapping visualization for analysis. The keyword we used in this study was "geotechnical engineering" with the publication year of the 2017-2020 article, this search was conducted on 23 October 2020 which resulted in 79,185 samples.

3. RESULTS AND DISCUSSION

The dataset in this study uses a span of the year the articles were published from 2017 to 2020. The search results through the dimension database show that research on geotechnical engineering has developed since 2011, totaling 9780 articles. The tracing is shown in **Figure 2.**
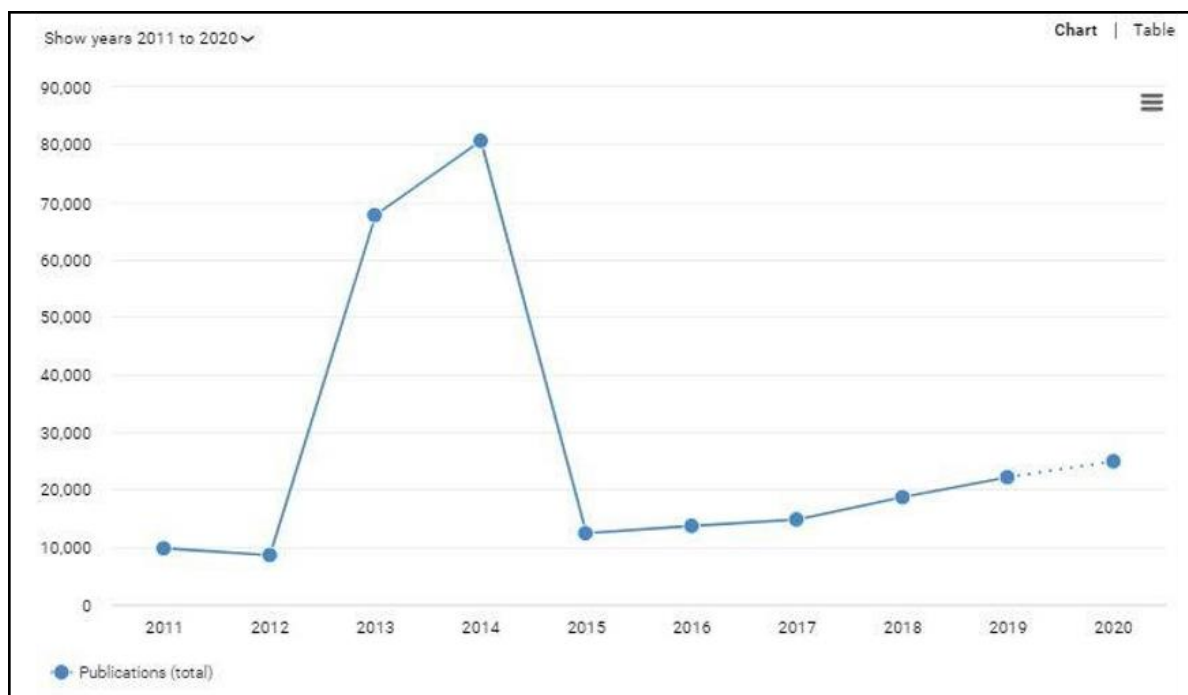

Figure 2. Number of geotechnical engineering research publications from 2011 to 2020

3.1. Author analysis

The most relevant authors based on the number of citations and publications are shown in **Table 1**. Authors from various universities in the world are working hard to research the geotechnical sub-fields of each researcher. Table 1 also shows the relationship between the most productive authors in terms of number of articles and the most cited authors. In this study, we took the top 10 rankings, authors who published on geotechnical engineering.

Table 1. Names of the top 10 ranking authors who publish geotechnicalengineering based on the number of citations (a) and the number of articles (b).

Rank (a)	Authors Name	Citations	Rank (b)	Authors Name	Published Article
1	Ronald Kerry Rowe	8877	1	Ronald Kerry Rowe	381
2	Scott William Sioan	8655	2	Buddhima N Indraratna	378
3	Mark Felton Randolph	8214	3	Charles Wang Wai Ng	360

Rank (a)	Authors Name	Citations	Rank (b)	Authors Name	Published Article
4	Buddhima N Indraratna	7851	4	Yu-Jun Cui	283
5	Charles Wang Wai Ng	7458	5	Anand Jagadeesh Puppata	278
6	Yu-Jun Cui	6487	6	Xi-Ting Feng	257
7	Xia-Ting Feng	3935	7	Mark Feltron Randolph	255
8	Han-Long Liu	2954	8	Shu Cai Li	245
9	Anand Jagadeesh Puppata	2889	9	Han-Long Liu	245
10	Shu Cai Li	2412	10	Scott William Sioan	245

3.2. Country Analysis

Based on the dimension database, 89 countries are researching the field of geotechnical engineering. This is due to the large number of institutions that include the names of their members and countries so that the dimension can read the data. Although 89 countries research the field of geotechnical engineering, we limit it to the top 10 countries that publish the most articles and based on cooperation with other countries in writing, it can be seen in **Table 2**.

Table 2. Ranking of the 10 countries that publish the most research (a), and cooperation with other countries (b)

Rank (a)	Countries	Published Article	Rank (b)	Countries	Total Link Strength
1	China	916	1	China	336
2	United States	286	2	United States	227
3	India	199	3	United Kingdom	127
4	Iran	153	4	Australia	123
5	United Kingdom	137	5	Iran	83
6	Australia	135	6	Canada	72
7	Canada	118	7	Germany	71
8	Italy	102	8	India	61
9	Germany	79	9	Italy	58

| 10 | Vietnam | 31 | 10 | Vietnam | 54 |

The bibliometric analysis based on the country analysis in the field of geotechnical engineering is shown in **Figure 3**. Based on **Figure 3**, China is the largest country in conducting geotechnical research so that many other countries have established cooperative relationships with China. For more than half a century, the Chinese engineering investigation industry has continued to develop and has completed many investigative projects independently. Since the 1970s China's industry has undergone a transition to a "Geotechnical Engineering Mechanism" and made great strides in geotechnical development. China is a vast country and many factors hinder the technical progress of the industry, therefore the concept of "people-oriented" and "scientific development" strategies provides many new opportunities for geotechnical engineers to develop geotechnical engineering (Zai-ming Zhang *et al.*, 2011).
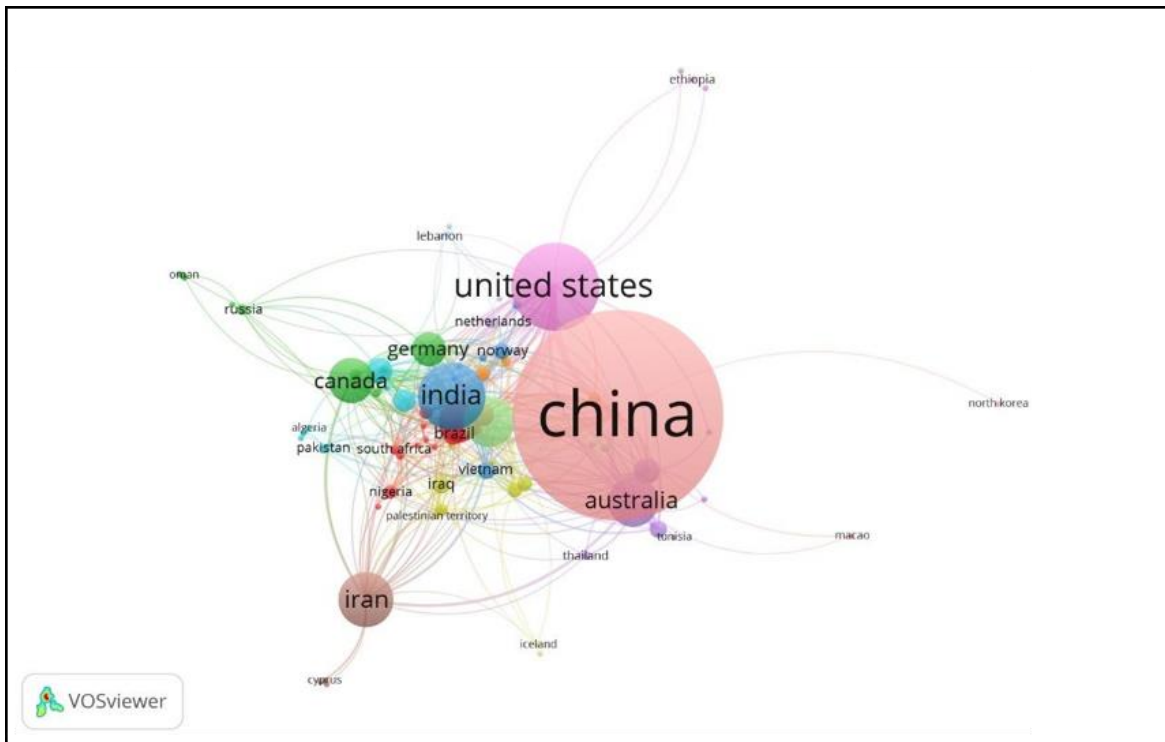

Figure 3. Visualization based on countries researching the field of geotechnical engineering

3.3 Journal Analysis

Based on the number of article publications and the citation of the dimension database analysis results, it shows that the journal that publishes the most geotechnical engineering articles is the International Journal of Rock Mechanics and Mining Science with a publication number of 14094 articles. **Table 3** shows the top 10 journals that publish the most articles on geotechnical engineering. From the results of the top 10 journals dominantly discuss Rock mechanics, Geoenvironmental, Soil Dynamics and Earthquake, Computers and Geotechnics, and Foundations.

Table 3. Top 10 journals ranking that publish the most research (a) and the number of citations (b)

Rank (a)	Journals	Published Articles	Rank (b)	Journals	Citations
1	International Journal of Rock Mechanics and Mining Science	14094	1	Canadian Geotechnical Journal	123166

Rank (a)	Journals	Published Articles	Rank (b)	Journals	Citations
2	Canadian Geotechnical Journal	5528	2	Journal of Geotechnical and Geoenvironmental Engineering	115518
3	Journal of Geotechnical and Geoenvironmental Engineering	4568	3	Geotechnique	109137
4	Engineering Geology	3654	4	Engineering Geology	94701
5	Geotechnical and Geological Engineering	3192	5	International Journal of Rock Mechanics and Mining Science	65045
6	Journal of Geotechnical Engineering	2738	6	Journal of Geotechnical Engineering	56106
7	Geotechnique	2520	7	Computers and Geotechnics	48019
8	Soil Dynamics and Earthquake Engineering	2503	8	Soils and Foundations	44866
9	Computers and Geotechnics	2468	9	Soil Dynamics and Earthquake Engineering	44074
10	Soils and Foundations	2330	10	Geotechnical and Geological Engineering	23377

3.4. Keyword Analysis

Keywords are very useful in interpreting the scope of the research scope and the main themes of each study (Mubaroq *et al.*, 2020). The minimum number of conjunctions in the use of Vosviewer is 10 words. After being analyzed using Vosviewer, there are 4 clusters (red, green, blue, and yellow), this shows the relationship between one topic and another (Hamidah *et al.*, 2020). Vosviewer provides three different mapping visualizations namely network visualization, overlay visualization, and density visualization (Van Eck & Waltman, 2020). Keywords are labeled with a colored circle. The size of the circles shows a positive relationship between the occurrence of keywords in the title and the abstract. Therefore, the size of letters and circles is determined by the frequency with which they appear. The more often a keyword appears, the larger the font and circle size will be (Hamidah *et al.*, 2020). The results of the VOSviewer keyword analysis are shown in **Figure 4-6**.

Figure 4 shows the groups of each topic studied. It can be seen that four keywords often appear, namely "Displacement", "Strength", "Stress", and "Earthquake". which means that the topic is the most researched by researchers.

Figure 5 shows the development from year to year related to geotechnical engineering. It can be seen that 2017 to 2018 was the year when many researchers used geotechnical engineering

keywords in their research, marked in purple towards blue. Meanwhile, from 2019 to 2020 research in the geotechnical sector has decreased.

Figure 6 shows the depth of the study. A large yellow color indicates a lot of research has been done or is undergoing improvement on the topic. Meanwhile, research with a small amount of color fades towards the blue color.

Figure 5-6 shows that the keywords that often appear are displacement, sand, stress, strength, and earthquake. Based on these data, we can find the novelty of geotechnical engineering research. For example, little research has been done on the seismic response in organic soils. In the end, researchers can contribute to overcoming the problem of dynamic response to organic soil using various theoretical and technological approaches. Furthermore, to see the availability of data or information in each topic area, a search can be made using more specific keywords.
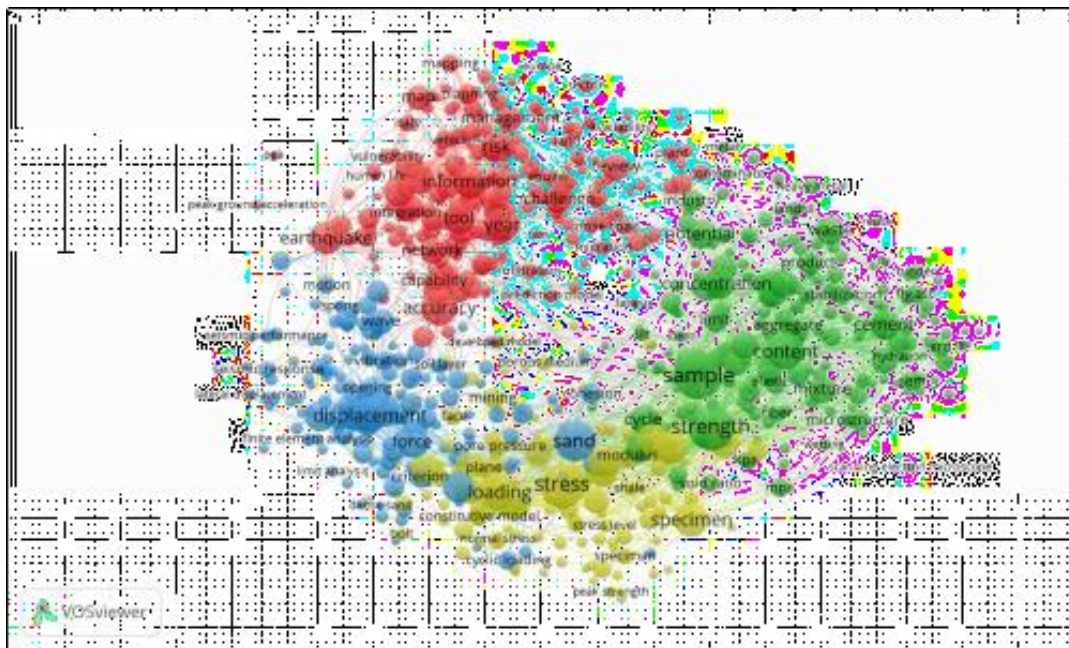

Figure 4. Visualization of keywords (keyword co-occurrence) with network visualizations using Vosviewer.
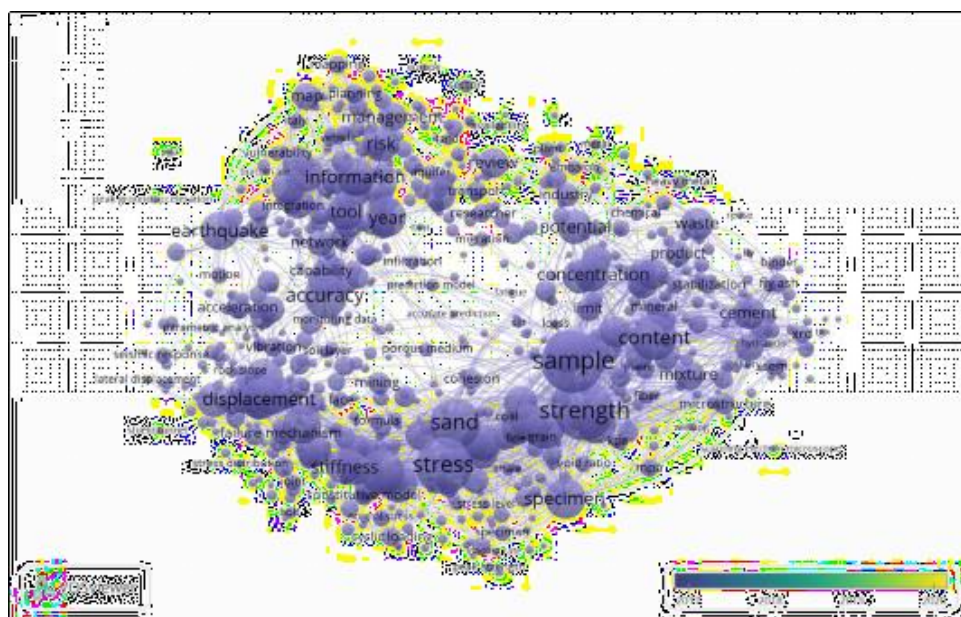

Figure 5. Visualization of keywords (keyword co-occurrence) with network visualizations using Vosviewer.

Figure 6. Visualization of keywords (keyword co-occurrence) with density visualizations using Vosviewer.

4. CONCLUSION

Infrastructure development in the world continues to increase. Therefore geotechnical engineering is needed to overcome various problems related to soil. Based on the results and discussion above, it can be concluded that geotechnical engineering research continues to increase from 2017 to 2020 reaching 24917 articles. Ronald Kerry Rowe is Queens' University's most prolific writer. China is the largest contributor to geotechnical research. The most international publications on geotechnics are published by the International Journal of Rock Mechanics and Mining Science. Based on the results of keyword analysis, there are four keywords that appear most often, namely "Displacement", "Strength", "Stress", and "Earthquake". Through the bibliometric approach, we can identify keywords on each topic or research that has been done before, so it is very useful in determining the novelty of research that will be carried out in the future.

5. ACKNOWLEDGEMENT

6. AUTHORS' NOTE

The author(s) declare(s) that there is no conflict of interest regarding the publication of this article. Authors confirmed that the data and the paper are free of plagiarism.

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