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A BIBLIOMETRIC ANALYSIS OF CHEMICAL ENGINEERING RESEARCH USING VOSVIEWER AND ITS CORRELATION WITH COVID-19 PANDEMIC CONDITION

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Abstract

Chemical Engineering is a branch of engineering that studies how to convert raw materials and chemicals into a more commercially valuable product by utilizing chemical processes. The purpose of this research is to conduct bibliometric analysis in chemical engineering by combining mapping analysis using VOSviewer software. Application reference manager used to obtain research data. The data obtained is the result of a search based on the keyword "chemical engineering". From the search results, 1000 relevant published articles were found in the range of 2017-2021. The results showed that research on chemical engineering has increased in 2017-2018, but it decreases since 2019. The main reason is that the pandemic situation gave a great impact since chemical engineering relates to laboratory experiments. This study demonstrates the importance of bibliometric analysis in giving analysis data on what phenomena happen. This research is expected to help and become a reference for researchers in conducting and determining the research themes to be taken.

Keywords: Bibliometric, Chemical Engineering, Data analysis, Vosviewer.

1. Introduction

VOSviewer is used to visualize bibliographies, or data sets containing bibliographic fields (title, author, author, journal, etc.) [1-7]. VOSViewer software can reflect the trend, impact, and evolutionary process of the topic's high-frequency [8]. The bibliography itself comes from the Greek "bilio" (book) and "grafi" (writing). Thus, a bibliography can be interpreted as a list of books or magazine articles usually for a certain subject. In the world of research, VOSviewer is used for bibliometric analysis [7, 9], looking for topics that still have opportunities to be researched, looking for the most widely used references in certain fields [10].

One of the important subjects that must be analysed is chemical engineering. Chemical Engineering is a branch of engineering that studies the processes and ways of converting raw materials and chemicals into a more commercially valuable product by utilizing chemical processes, such as chemical and biochemical reactions as well as changes in the physical and chemical properties of these raw materials [3, 11-19].

Many reports on chemical engineering have been carried out, including research conducted by Stankiewicz and Moulijn [18] in examining the transformation of chemical engineering, research conducted by Liang et al. [15] in researching uniform design and its application in chemistry and chemical engineering, research conducted by García-Serna et al. [14] in examining a new trend for design towards sustainability in chemical engineering in green engineering, Nandiyanto group [20-26] in explaining the cost analysis in the chemical engineering processes, as well as Nandiyanto group [11, 27-31] in determining phenomena in the adsorption process. However, there has been less research on bibliometric analysis in the field of chemical engineering research, specifically by utilizing VOSviewer software as a tool in conducting mapping analysis. This analysis is important to determine the quantity and up-to-date of a term.

Based on our previous studies relating to bibliometric [2, 10, 32], this study aims to conduct bibliometric engineering research in chemical engineering by combining mapping analysis using VOSviewer software. This research is expected to help and become a reference for researchers in conducting and determining the research topic to be taken, especially those related to the field of chemical engineering.

2. Method

The article data used in this research is research data from articles that have been published in journals that have been indexed by Google Scholar. In this study, we used Google Scholar because Google Scholar can be accessed for free, in contrast to Scopus which cannot be accessed freely by readers. Indeed, we would use the Scopus database in our future research. Reference managers' application was used to obtain research data. The reference managers application used in this research is Publish or Perish. Publish or Perish was used in conducting a literature review of the theme that we would take. Every article data must be indexed by Google Scholar and in the type of journal articles and having conformity with the search for the themes needed in this study are backed up into a file that is used in the use of VOSviewer. Detailed information regarding VOSviewer and library quest is explained in our previous studies [2, 33].

In this study, each article was filtered, and we took only articles relating to Engineering. We search for data on Publish or Perish by entering the keyword "Chemical Engineering" according to the title, keyword, and abstract criteria. Thus, 1000 articles were obtained which were assessed according to the chosen topic. The articles used in this study were articles published in the 2017-2021 range. The collected articles were then saved in *.ris format. Next, we used the VOSviewer application to visualize and analyse trends in the form of bibliometric maps. We did data mapping articles from database sources that have been prepared. Data mapping consists of three types, namely network, density, and overlay visualization. In addition, we also filtered the terms that would be included in the VOSviewer network mapping visualization.

3. Results and Discussion

3.1. Research developments in the field of chemical engineering

Figure 1 shows a curve of the growth or development of research on chemical engineering from 2017 to 2021. Based on Fig. 1, the development of research on chemical engineering over the last 5 years, namely from 2017-2021 has increased in 2018 and decreased again starting from 2019. This is indicated by the number of articles in 2017 as many as 291 articles, which increased in 2017. 2018 has 311 articles. However, this number has decreased again in 2019 to 260 articles. The decreased number continued from 2019 to 2021, where in 2020, the number of articles decreased to 114 articles and in 2021 the number of articles containing research on chemical engineering decreased drastically to 24 articles.

Based on Fig. 1, we found that a decreasing number of publications were found since 2019. The condition is due to the COVID-19 pandemic. As we know that, engineering relates to the experiment [34], while the COVID-19 pandemic limits the number of experiments (physical distancing) [35]. This makes the number of research drastically down, and the teaching process must be adapted to the online learning process [2-4, 36-48].

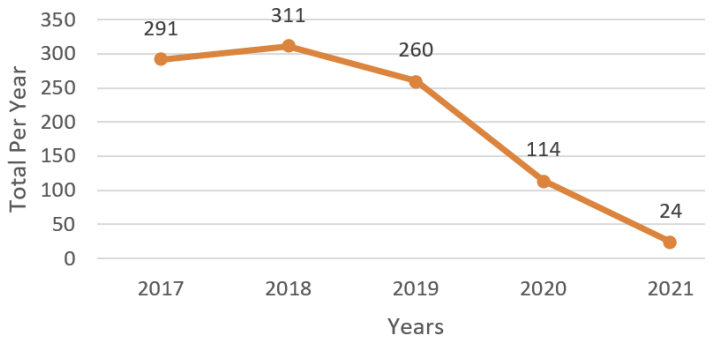

Fig. 1. Level of development of research on chemical engineering.

3.2. Visualization chemical engineering topic area using VOSviewer

According to Al Husaeni and Nandiyanto [2], the minimum number of relationships between terms in the VOSviewer is regulated by 2 terms. Research related to chemical engineering based on analysis mapping visualization is divided into 8 clusters, namely:

(i) Cluster 1 has 65 items, the 65 items are activated carbon, adsorbent, adsorption capacity, adsorption mechanism, adsorptive removal, air-gel, anionic dye, antibiotic, aqueous medium, aqueous solution, batch, biomass, capacitive deionization, challenge, chitosan, concern, copper, detection, dye, dye adsorption, efficient removal, effluent, energy storage, enhanced removal, environmental remediation, experiment, great challenge, great interest, heavy metal, heavy metal ion, high sensitivity, human health, industry, ion, ligand, metal, metal-organic framework, methyl orange, mixture, MOF, MOFs, phosphate, pollution, porous carbon, product, public health, pyrolysis, recovery, removal, selective adsorption, selectivity, separation, solution, technique, waste, wastewater, water, world, zeolitic imidazolate framework dan ZIF.

(ii) Cluster 2 has 56 items, namely anode, asymmetric supercapacitor, battery, carbon, carbon nanotubes, carbonization, CNT, composite, demand, electrode, electrode material, electromagnetic wave absorption, fabrication, facility method, facile synthesis, Fe_2O_4, graphene, graphene oxide, growth, high energy density, high performance, high-performance anode, high-performance asymmetric supercapacitor, high-performance lithium-ion battery, high-performance supercapacitor, hybrid, hydrothermal method, layer, libs, lithium-ion battery, morphology, nanorod, nanosheet, nanostructure, nanotube, novel material, novel strategy, performance, precursor, property, rational design, sodium-ion battery, specific surface area, step method, structure, substrate, supercapacitor, supercapacitor electrode, synergistic effect, synthesis, template, and wearable electronics.

(iii) Cluster 3 has 51 items consisting of ability, advantage, magnet, application, approach, attention, bio, carbon material, ciprofloxacin, conductivity, considerable attention, conversion, development, dopamine, electromagnetic, interference, electrospinning, formation, glucose, great potential, hydrogel, impact, issue, lignin, membrane, modification, oil-water separation, particle, ppm, phase change material, poly, polydopamine, polymer, potential application, practical application, preparation, present work, PVP, recent year, research, review, self-healing, stability, storage, strategy, system, tissue engineering, water treatment, and wide application.

(iv) Cluster 4 has 39 items consisting of Vivo, cocatalyst, combination, construction, double hydroxide, efficiency, electron, evolution, facile, flower, great importance, heterojunction, hydrogen, ibuprofen, layered double hydroxide, LDH, low cost, molybdenum disulfide, nano, organic pollutant, phosphorus, photocatalysis, photocatalyst, photocatalyst activity, photocatalytic degradation, photocatalytic performance, photodegradation, production, reaction, recent advance, semiconductor, surface, tetracycline, TiO2, visible light, wastewater treatment.

(v) Cluster 5 has 37 items, which consist of abstract, activity, adsorption behaviour, ammonia, anammox, big challenge, catalyst, catalyst oxidation, catalyst performance, chromium, denitrification, effect efficient catalyst, influence, investigation, low temperature, MFC, microbial fuel cell, nanoparticle, nitrogen, oxidation, presence, reduction, role, sample, SCR, selective catalytic reduction, series, simulation, simultaneous removal, study, temperature, toluene, treatment, and wetland.

(vi) Cluster 6 has 35 items consisting of activation, advanced oxidation process, AOP, atrazine, biochar, bisphenol, BPA, chemical, coffee, comparison, contaminant, cost, degradation, effective strategy, elimination, enhancement,

environment, great significance, heterogeneous activation, high efficiency, insight, kinetic, mechanism, nanoscale, optimization, organic contaminant, peroxymonosulfate, persulfate, persulfate activation, PMS, process, sulfamethoxazole, sulfate, transformation, and valent iron.

(vii) Cluster 7 has 24 items consisting of addition, chemical engineering, chemistry, China, CO_2, college, correspondence, covalent organic framework, department, education, engineering key laboratory, materials science, ministry, paper PO_4, pollutant, school, science, search, technology, and university.

(viii) Cluster 8 has 16 items consisting of analysis, characterization, degradation, pathway, electron microscopy, FTIR, nanocomposite, pathway, photocatalytic reduction, sem, SiO, SNS, TEM, visible light irradiation, x-ray diffraction, XPS, and XRD.

Cluster 1 is marked in red, cluster 2 is marked in green, cluster 3 is marked in dark blue, cluster 4 is marked in yellow, cluster 5 is marked in purple, cluster 6 is marked in light blue, cluster 7 is marked in orange and cluster 8 is marked with brown colour.

3.3. Network visualization of chemical engineering keyword

The visualization network will display the network between the visualized terms [2]. Figure 2 shows the relationship between terms. The relationships in network visualization are depicted in a network or line that comes from one term to another. Figure 2 shows the clusters in each of the researched topic areas. In Fig. 2, chemical engineering itself is included in cluster 7 with a totalling strength of 432 and occurrence of 63. Chemical engineering is connected to cluster 2, namely term synthesis, cluster 6, and cluster 8, namely term catalyst.

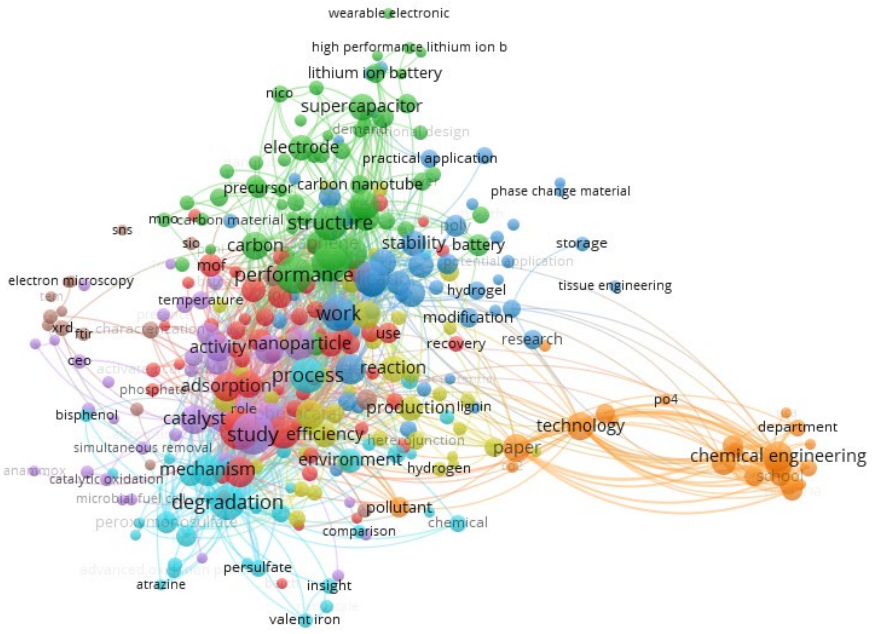

Fig. 2. Network visualization of chemical engineering keyword.

4. Conclusion

This study aims to conduct bibliometric engineering research in chemical engineering by combining mapping analysis using VOSviewer software. Publish or Perish is a references manager application used to collect data in this research. The data obtained is the result of filtering based on the keyword "chemical engineering". The bibliographic data used in this study concerns the topic areas, titles, keywords, and abstracts. From the search results, we obtained 1000 relevant articles published in the range of 2017-2021. In this study, it can be seen that the number of articles researching chemical engineering has been increasing since 2019. Research that is being popularly studied by researchers today is about photocatalysts. To search using the keyword "chemical engineering" produces 8 clusters that have a different number of items in each cluster.

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