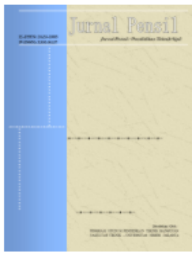
Available *online* at: http://journal.unj.ac.id

Jurnal Pensil | Pendidikan Teknik Sipil

Journal homepage: http://journal.unj.ac.id/unj/index.php/jpensil/index



BIBLIOMETRIC STUDY OF POROUS ASPHALT IN INDONESIA USING VOSVIEWER SOFTWARE

Zenita Sabitri[1*], *Zahra Ghinaya*[2], *Jasmine Al Dhahrani*[3], *Sri Rahayu*[4]
[1,2,3,4] Program Studi Pendidikan Teknik Bangunan Fakultas Pendidikan Teknologi dan Kejuruan Universitas Pendidikan Indonesia,
Jalan Dr. Setiabudi No. 229, Isola, Sukasari, Bandung, 40154, Indonesia
[*1]zenita@upi.edu [2]zahraghina@upi.edu [3]jasminealdhahrani@upi.edu [4]srirahayu@upi.edu

P-ISSN: 2301-8437
E-ISSN: 2623-1085

ARTICLE HISTORY
Accepted:
10 Desember 2022
Revision:
05 Januari 2023
Published:
31 Januari 2023

ARTICLE DOI:
10.21009/jpensil.v12i1.31692

Abstract

This research collects and processes with the aim of examining the development of research on porous asphalt in Indonesia using a bibliometric approach with utilize VOSviewer application. The data is acquired from Google Scholar using publish and perish as the reference manager application. In the data search process, researchers used the keywords 'porous', 'porous asphalt' and 'Indonesia' as a reference so that search results were concentrated and facilitated mapping. From the search results, 224 articles have been found that are relevant to the keywords used. The research time span used as study material is an article contained in Google Scholar for the last 5 years (2018-2022). The results of this research of porous asphalt can be divided into 3 parts, namely asphalt, porous asphalt and Indonesia. The term "asphalt" is associated with 42 links with 233 total link strength. The term "Porous Asphalt" is associated with 25 links with 62 total link strength. For 'Indonesia' is associated with 44 links and 254 total link strength. based on the results of the analysis show an increase in the number of studies on porous asphalt in Indonesia every year but the increase is not so high and so that it can be said that it is still rare. In 2018, 34 articles were published. In 2019 there were 24 articles. In 2020 as many as 50 articles. In 2021 as many as 60 articles and until 2022 as many as 58 articles. The number with the number of published articles relevant to porous asphalt in Indonesia so far in 2021 is 60. This article can be used as a reference for further research related to porous asphalt and other relevant topics.

Keywords: Analysis, Application, Article, Porous Asphalt

Introduction

Indonesia is one of the developing countries that has a fast growth rate. Along with the rapid growth, the role of transportation is certainly an important thing to balance this. In addition, with an increase in accessibility, the mobility will also increase (Khoirunnisa et al., 2022). So the role of facilities and infrastructure such as roads is needed to support activities in various fields for humans (Irawan et al., 2019; Rhoma Putra et al., 2022). Asphalt is one form of technology that can be developed. Asphalt is a binder material in road pavement work, where its composition is about 4%-10% of the total weight of the material (Winarno et al., 2020). One type of mixture or combination made for porous asphalt pavement work.

Porous asphalt has many advantages for infrastructure works (Pradoto et al., 2019; Zhang & Kevern, 2021). Porous asphalt is a combination of asphalt materials made so that asphalt has a higher porosity when compared to other types of pavement (Arlia et al., 2018; Wang et al., 2020). In short, porous asphalt is a combination of pavement materials with low sand content in order to create high pore spaces (R. et al., 2017; Dong et al., 2020). Indonesia is a country that has a tropical climate (Arisal & Sari, 2020). The tropical climate has two seasons, namely dry and rainy. When it rains heavily, sometimes water becomes stagnant on the road. Therefore, porous asphalt can be developed in areas with high rainfall and the potential for flooding. Porous asphalt is one of the asphalt materials developed to overcome problems during the rainy season (Tjaronge et al., 2020). The advantage of porous asphalt compared to other materials is that it has large voids like a sponge so that it can absorb water on it (Z. Zhang et al., 2020)

One of the analytical techniques research development can use on porous asphalt in Indonesia is to use bibliometric analysis. Bibliometric analysis is very rigorous analytical method for capturing and analyzing large amounts of scientific data (Donthu et al., 2021). One form of data meta-analysis is bibliometric analysis search that will help researchers to study the content of bibliographies and analyze excerpts from articles that have been published in other scientific journals (Al Husaeni & Nandiyanto, 2022).

Many articles have used bibliometric analysis methods in their research, including bibliometric analysis in the health sector (Guo et al., 2020), economics (Bonilla et al., 2015), chemical engineering (Ho, 2012), computer and network (Iqbal et al., 2019) and many more bibliometric analyses in various fields.

However, bibliometric research on the discussion of the use of porous asphalt in Indonesia is still rare, especially bibliometric analysis in the last 5 years, from 2018 to 2022 using the VOSViewer application as a medium for mapping analysis.

Therefore, research on scientific articles from indexed Google Scholar journals regarding bibliometric analysis of the discussion of porous asphalt in Indonesia needs to be carried out as a reference for researchers so that they can conduct more detailed research, especially regarding porous asphalt in Indonesia.

Research Methodology

This research uses a literature review method of bibliographic analysis system on articles. The articles used are international publication data from indexed journals on Google Scholar assisted by reference management software, namely Publish or Perish. Until now, this software can only analyze the article in English (Suwandi & Wijaya, 2022). The collection data that used in this article uses the keywords " porous asphalt" and "Indonesia" for the 2018 until 2022 period. To find out the development of international publications, the researcher using VOSViewer software to analyzing the articles then to create 3 types of mapping from processed sources is Network Visualization, Density Visualization and

Overlay Visualization based on networks (co-citation) between existing items.

Results and Discussion

Based on the results of research conducted using the publish and perish application based on Google Scholar data, 242 articles with relevant themes and meeting the criteria were released starting from 2018 to 2022. The article data consists of the name of the author, the year of the journal published, the name of journal, the publisher, the number of citations, article links, and cites URL. Table 1 displays the top 22 articles and starts from the article with the top number of cite. The number of citations from all articles is 242, cites per year is 586.5 and cites per paper is 9.69. All of the articles have an g-index of 9.69 and a h-index total of 24.

It shown in the Table 2 that the development of research related to porous asphalt over the last 5 years, namely from 2018 to 2022 which is contained in Google Scholar. In 2018 there were 34 articles published. In 2019 there were 38 articles. In 2020 as many as 50 articles. In 2021 as many as 60 articles and until 2022 as many as 58 articles. From this question it can be concluded that the development of articles on asphalt porous in Indonesia has increased but is still relatively rare as illustrated in Figure 1.

Table 1. Asphalt porous in Indonesia Publication Data

No	Title	Authors	Years	Cites	Refs
1	Exploring the potential of coconut shell biomass for charcoal production	RK Ahmad et al.	2022	18	(Kabir Ahmad et al., 2022)
2	Development of cigarette butt fibre filter reinforced by opefb fiber composite material for trash can	RW Lubis et al.	2022	16	(Lubis et al., 2022)
3	Lignin nanoparticles: New insights for a sustainable agriculture	AE Santo Pereira et al.	2022	13	(Pereira et al., 2022)
4	Plastic Waste Management Strategies and Their Environmental Aspects: A Scientometric Analysis and Comprehensive Review	S Huang et al.	2022	9	(Huang et al., 2022)
5	Utilization of iron ore tailing as an alternative mineral filler in asphalt mastic: High-temperature performance and environmental aspects	Z Wei et al.	2022	7	(Wei et al., 2022)
6	A review of mechanism and adaptive materials of temporary plugging agent for chemical diverting fracturing	H Zhou et al.	2022	6	(Zhou et al., 2022)
7	Potential of project level construction and rehabilitation plans to attenuate the economic and environmental burdens of flexible road pavements: A review study	AS Mohamed et al.	2022	5	(Mohamed et al., 2022)
8	Alginate : Enhancement Strategies for Advanced Applications.	A Hurtado et al.	2022	5	(Hurtado et al., 2022)

No	Title	Authors	Years	Cites	Refs
9	Effects of Iron Ore Tailing on Performance of Hot-Mix Asphalt	J Gabriel Bastidas-Martínez et al.	2022	4	(Juan et al., 2022)
10	Saltwater intrusion into coastal aquifers and associated risk management: Critical review and research directives	S Basack et al.	2022	4	(Basack et al., 2022)
11	Understanding the behaviors of toluene in asphaltenes	Y Yang et al.	2022	3	(Yang et al., 2022)
12	Conversion of Indonesian Coal Fly Ash into Zeolites for Ammonium Adsorption	H Prihastuti dan T Kurniawan	2022	2	(Prihastuti & Kurniawan, 2022)
13	Seismic velocity recovery in the subsurface: transient damage and groundwater drainage following the 2015 Gorkha earthquake, Nepal	L Illien et al.	2022	2	(Illien et al., 2022)
14	Bacterial community dynamics during MEOR biostimulation of an oil reservoir in sumatera Indonesia	DI Astuti et al.	2022	1	(Astuti et al., 2022)
15	Kinetics of CO2 gas bubbling for the separation of residual solvent from waste solids: Effects of bubble size	F Song et al.	2022	1	(Song et al., 2022)
16	Systematic Review of Plastic Waste as Eco-Friendly Aggregate for Sustainable Construction	O Adiyanto et al.	2022	1	(Adiyanto et al., 2022)
17	Sustainability benefits and commercialization challenges and strategies of geopolymer concrete: A review	A Danish et al.	2022	1	(Danish et al., 2022)
18	Utilization of hazardous waste of black dross aluminum: Processing and application-a review	M Lukita et al.	2022	1	(Lukita et al., 2022)
19	Conceptualising sound making and sound loss in the urban heritage environment	M Parker dan DHR Spennemann	2022	1	(Parker & Spennemann, 2022)
20	Phenomena, factors of wax deposition and its management strategies	SI Ali et al.	2022	1	(Ali et al., 2022)
21	Advances in mild degradation and directional upgrading of lignites: From feature identification to value-added utilization	GH Liu et al.	2022	1	(Liu et al., 2022)
22	A Review of the Sustainable Utilization of Rice Residues for Bioenergy Conversion Using Different Valorization Techniques, Their Challenges, and Techno-Economic …	S Kaniapan et al.	2022	1	(Kaniapan et al., 2022)

Table 2. Development of porous asphalt in Indonesia research

Year of Publications	Number of Publication
2018	34
2019	38
2020	50
2021	60
2022	58

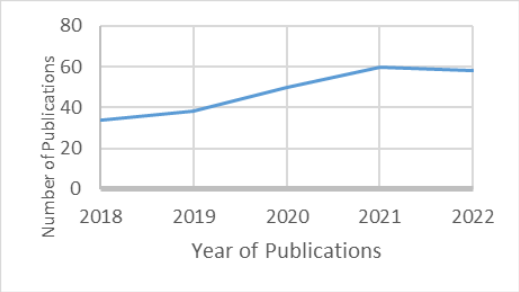


Figure 1. Level of development in porous asphalt research

(i) Cluster 1 has 8 items that are red. 8 items are area has 20 links, example has 12 links, experimental study 8 links, paper has 17 links, part has 13 links, review has 31 links, utilization has 20 links, and water has 21 links. So, all items in cluster 1 has 142 links.

(ii) Cluster 2 has 8 items and marked in green. 8 items are application has 26 links, asphalt binder has 14 links, effect has 35 links, evaluation has 15 links, overview has 10 links, performance has 30 links, preparation has 10 links, and property has 27 links. So, all items in cluster 2 has 167 links.

(iii) Cluster 3 has 8 items and marked in blue. 8 items are analysis has 18 links, concrete has 25 links, improvement has 11 links, Indonesia has 44 links, pavement has 31 links, porous medium has 16 links, potential has 8 links, and technology has 15 links. So, all items in cluster 3 has 168 links.

(iv) Cluster 4 has 7 items and marked in army green. 7 items are asbuton has 15 links, asphalt has 42 links, asphalt mixture has 27 links, Buton island has 14 links, cement has 20 links, filler has 22 links, and petroleum asphalt has 10 links. So, all items in cluster 4 has 150 links.

(v) Cluster 5 has 7 items and marked in purple. 7 items are fly ash has 11 links, mixture has 21 links, rap has 11 links, research has 19 links, study has 34 links, synthesis has 7 links, and use has 20 links. So, all items in cluster 5 has 123 links.

(vi) Cluster 6 has 4 items and marked in cyan. 4 items are characteristic has 17 links, Indonesian has 13 links, porous asphalt has 25 links, and porous asphalt mixture has 18 links. So, all item in cluster 6 has 73 links.

(vii) Cluster 7 has 3 item and marked in orange. 3 items are aggregate has 29 links, binder has 14 links, and development has 16 links. So, all items in cluster 7 has 59 links.

The relationship of each item to the existing items is shown in the listed clusters. Each item in the cluster is given a circle with a different color in each cluster to make it easier to group each cluster. The circle size of each item varies depending on the frequency with which the item appears. The size in the items circle displays a positive relationship with the terms occurrence in abstract and the title. Therefore, it can be stated that the more often the term is found, the the size of the label will be larger. The mapping visualization that has been analysed in this research consists of sections: network

visualization (Figure 2), density visualization (Figure 3), and overlay visualization (Figure 4).

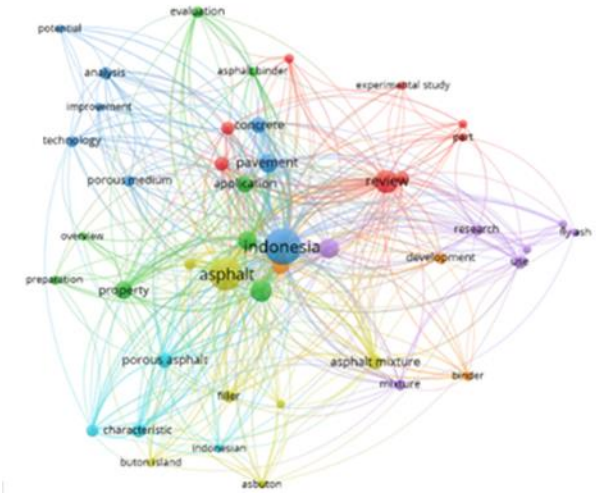


Figure 2. Network visualization

Figure 2 displays the interrelated terms. The relationships of these items are described by a network of relationships. Figure 1 displays the clusters of terms that are often used in research and related to the research focus of porous asphalt. The clusters has contained in the visualization, items or networks formed, it can be seen that the porous asphalt is divided into 3 fields with a total of 782 links.

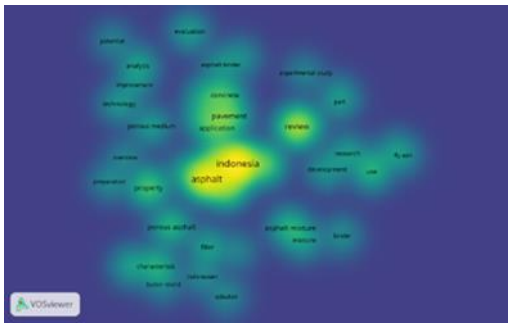


Figure 3. Density visualization

Figure 3 displays a density visualization image. Density visualization illustrates that the color contained in the image if the yellow color means the largest diameter of the circle of the item and more often the term of the item appears. The research at that displays has been done with related terms. Conversely, if the color of the term fades and approaches the background color, it means that the term is small or rarely used. From Figure 3 we can clearly see that research related to the most widely used and frequently used terms are Indonesia, asphalt, review, pavement, application, and concrete.

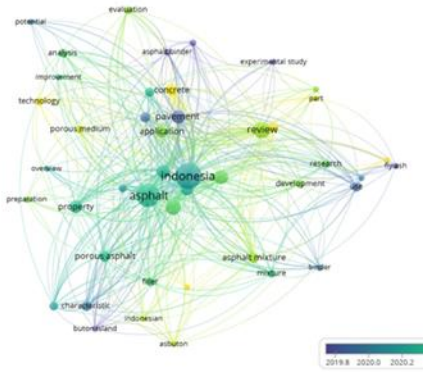


Figure 4. Overlay visualization

Figure 4 displays the overlay visualization of the porous asphalt study. The expanse contained in this visualization displays related to the novelty of asphalt porous research on terms. The overlay visualization of Figure 4 is taken from research data from 2018 to 2022. Thus, the popularity of the term porous asphalt in this study is believed to have been quite long. Therefore, new study can be made easily on porous asphalt research.

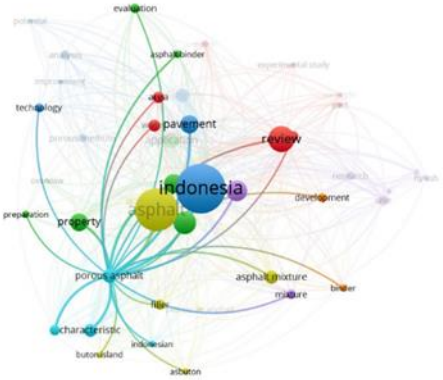


Figure 5. Network visualization of porous asphalt

Figure 5 displays the network of asphalt porous relationships with other terms, namely evaluation, asphalt binder, technology, area, pavement, review,

development, Indonesia, asphalt, property, preparation, asphalt mixture, binder, mixture, filler, characteristic, Indonesian, buton island, and asbuton.

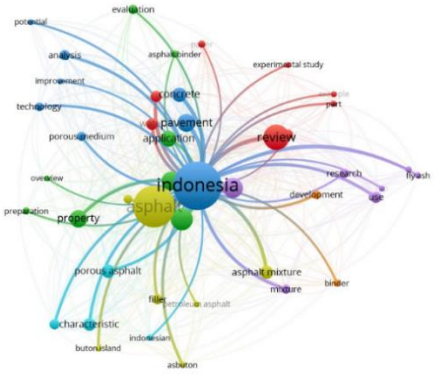


Figure 6. Network visualization of Indonesia

The network of Indonesian relations can be figured with other terms, namely evaluation, potential, analysis, asphalt binder, experimental study, improvement, concrete, technology, development, part, review, application, porous medium, overview, Indonesia, research, fly ash use, development, property, preparation, porous asphalt, filler, asphalt mixture, binder, mixture, characteristic, Indonesian, Buton island, and abuston.

From the data that has been analysed, it displays that asphalt porous is still slightly related with other terms. It can be seen from the mapping results, asphalt porous only has 25 links. In contrast to Indonesia, which has more relevance and is often connected with other terms. Therefore, the terms of porous asphalt can be concluded that asphalt porous researched still on the progress and connected with other terms. So, this study will have a good and higher impact to be used as new research material.

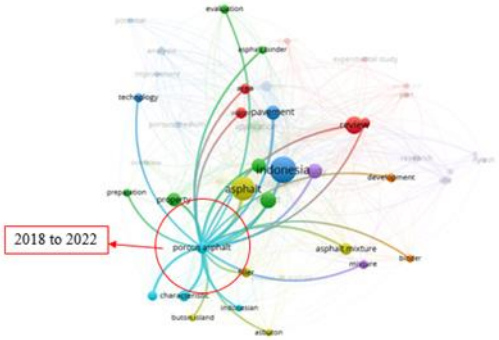


Figure 7. Overlay visualization of porous asphalt term in 2018 to 2022

The article data that has been collected it is resulting about asphalt porous, the keyword porous asphalt is able to be research and can be seen. terms or related fields of porous asphalt are used by most studies. We can see the research on asphalt porous that is more recent and up to date from the results of this study.

Conclusion

This article was created with the aim of analysing bibliometric data mapping of research articles that have been carried out. The theme of this research is "porous asphalt". The articles obtained are search

results using the Publish and Perish software application which is then processed with the help of Microsoft Excel software which is then made a mapping analysis using the VOSViewer application. From the search results, there were 242 articles published from 2018 to 2022 which had titles relevant to the chosen theme. In 2018 there were 34 articles published. In 2019 there were 38 articles. In 2020 as many as 50 articles. In 2021 as many as 60 articles and until 2022 as many as 58 articles. The results show that there are still many opportunities available to conduct research on porous asphalt.

References

Adiyanto, O., Mohamad, E., & Razak, J. A. (2022). Systematic Review of Plastic Waste as Eco-Friendly Aggregate for Sustainable Construction. *International Journal of Sustainable Construction*

Engineering and Technology, *13*(2), 243–257. https://doi.org/10.30880/ijscet.2022.13.02.022

Al Husaeni, D. F., & Nandiyanto, A. B. D. (2022). Bibliometric Computational Mapping Analysis of Publications on Mechanical Engineering Education Using Vosviewer. *Journal of Engineering Science and Technology*, *17*(2), 1135–1149.

Ali, S. I., Lalji, S. M., Haneef, J., Khan, M. A., Yousufi, M., Yousaf, N., & Saboor, A. (2022). Phenomena, factors of wax deposition and its management strategies. *Arabian Journal of Geosciences*, *15*(2). https://doi.org/10.1007/s12517-021-09221-6

Arisal, & Sari, Y. (2020). Analisis Penerapan Arsitektur Tropis Pada Bangunan Kantor Sewa Wisma Dharmala Sakti Jakarta. *Jurnal Arsitektur PURWARUPA*, *4*(1), 53–58.

Arlia, L., Saleh, S. M., & Anggraini, R. (2018). Karakteristik Campuran Aspal Porus Dengan Substitusi Gondorukem Pada Aspal Penetrasi 60/70. *Jurnal Teknik Sipil*, *1*(3), 657–666. https://doi.org/10.24815/jts.v1i3.10011

Astuti, D. I., Purwasena, I. A., Priharto, N., Ariadji, T., Afifah, L. N., Saputro, R. B., Aditiawati, P., Persada, G. P., Ananggadipa, A. A., Abqory, M. H., Amaniyah, M., & Dewi, U. R. (2022). Bacterial community dynamics during MEOR biostimulation of an oil reservoir in sumatera Indonesia. *Journal of Petroleum Science and Engineering*, *208*, 109558. https://doi.org/10.1016/J.PETROL.2021.109558

Basack, S., Loganathan, M. K., Goswami, G., & Khabbaz, H. (2022). Saltwater Intrusion into Coastal Aquifers and Associated Risk Management: Critical Review and Research Directives. *Journal of Coastal Research*, *38*(3), 654–672. https://doi.org/10.2112/JCOASTRES-D-21-00116.1

Bonilla, C. A., Merigó, J. M., & Torres-Abad, C. (2015). Economics in Latin America: a bibliometric analysis. *Scientometrics*, *105*(2), 1239–1252. https://doi.org/10.1007/s11192-015-1747-7

Danish, A., Ozbakkaloglu, T., Ali Mosaberpanah, M., Salim, M. U., Bayram, M., Yeon, J. H., & Jafar, K. (2022). Sustainability benefits and commercialization challenges and strategies of geopolymer concrete: A review. *Journal of Building Engineering*, *58*, 105005. https://doi.org/10.1016/J.JOBE.2022.105005

Dong, Q., Gao, J., Chen, X., & Wang, X. (2020). Development of a Turpentine Cutback Asphalt Mixture for Porous Pavement Pothole Repair. *Journal of Materials in Civil Engineering*, *32*, 5020001.

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*(March), 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

Guo, Y., Hao, Z., Zhao, S., Gong, J., & Yang, F. (2020). Artificial intelligence in health care: Bibliometric analysis. *Journal of Medical Internet Research*, *22*(7), 1–12. https://doi.org/10.2196/18228

Ho, Y. S. (2012). Top-cited articles in chemical engineering in science citation index expanded: A bibliometric analysis. *Chinese Journal of Chemical Engineering*, *20*(3), 478–488. https://doi.org/10.1016/S1004-9541(11)60209-7

Huang, S., Wang, H., Ahmad, W., Ahmad, A., Vatin, N. I., Mohamed, A. M.,

Deifalla, A. F., & Mehmood, I. (2022). Plastic Waste Management Strategies and Their Environmental Aspects: A Scientometric Analysis and Comprehensive Review. In *International Journal of Environmental Research and Public Health* (Vol. 19, Issue 8). https://doi.org/10.3390/ijerph19084556

Hurtado, A., A Aljabali, A. A., Mishra, V., Tambuwala, M. M., & Serrano-Aroca, Á. (2022). *Citation: Alginate: Enhancement Strategies for Advanced Applications*. https://doi.org/10.3390/ijms23094486

Illien, L., Sens-Schönfelder, C., Andermann, C., Marc, O., Cook, K. L., Adhikari, L. B., & Hovius, N. (2022). Seismic Velocity Recovery in the Subsurface: Transient Damage and Groundwater Drainage Following the 2015 Gorkha Earthquake, Nepal. *Journal of Geophysical Research: Solid Earth*, *127*(2), 1–18. https://doi.org/10.1029/2021JB023402

Iqbal, W., Qadir, J., Tyson, G., Mian, A. N., Hassan, S. ul, & Crowcroft, J. (2019). A bibliometric analysis of publications in computer networking research. *Scientometrics*, *119*(2), 1121–1155. https://doi.org/10.1007/s11192-019-03086-z

Irawan, I., Sunarjono, S., Riyanto, A., & Harnaeni, S. R. (2019). *Campuran Beraspal Semi Lentur menggunakan Pasta Semen*. 255–259.

Juan, G. B.-M., Jose, C. de C., Leda, L. C., Márcio, M. de F., & Hugo, A. R.-Q. (2022). Effects of Iron Ore Tailing on Performance of Hot-Mix Asphalt. *Journal of Materials in Civil Engineering*, *34*(1), 4021405. https://doi.org/10.1061/(ASCE)MT.1943-5533.0004034

Kabir Ahmad, R., Anwar Sulaiman, S., Yusup, S., Sham Dol, S., Inayat, M., & Aminu Umar, H. (2022). Exploring the potential of coconut shell biomass for charcoal production. *Ain Shams Engineering Journal*, *13*(1), 101499. https://doi.org/10.1016/j.asej.2021.05.013

Kaniapan, S., Pasupuleti, J., Patmanesan, K., Abubackar, H., Umar, H., Oladosu, T., Bello, S. R., & Rene, E. R. (2022). A Review of The Sustainable Utilization of Rice Residues for Bioenergy Conversion Using Different Valorization Techniques, their Challenges and Techno-Economic Assessment. *International Journal of Environmental Research and Public Health*, *19*(6), 1–30. https://doi.org/10.3390/ijerph19063427

Khoirunnisa, I., Putri, M. N., Cahya, D. L., & Sari, D. A. K. (2022). INTENSITY OF TRANSPORTATION MOVEMENT IN DKI JAKARTA PSBB AND PPKM POLICIES DURING THE COVID-19 PANDEMIC. *Jurnal PenSil*, *11*(3), 242–257.

Liu, G. H., Li, Y. J., Bai, J. J., Gao, Y., Kang, Y. H., Wang, A. M., Lu, C. Y., Bai, H. C., Zong, Z. M., & Wei, X. Y. (2022). Advances in mild degradation and directional upgrading of lignites: From feature identification to value-added utilization. *Journal of Analytical and Applied Pyrolysis*, *163*, 105477. https://doi.org/10.1016/J.JAAP.2022.105477

Lubis, R. W., Yani, M., Siregar, C. A. P., & Gunawan, S. (2022). Development of cigarette butt fibre filter reinforced by opefb fiber composite material for trash can. *Journal of Physics: Conference Series*, *2193*(1). https://doi.org/10.1088/1742-6596/2193/1/012021

Lukita, M., Abidin, Z., Riani, E., & Ismail, A. (2022). Utilization of hazardous waste of black dross aluminum: processing and application-a review.

Journal of Degraded and Mining Lands Management, *9*(2), 3265–3271. https://doi.org/10.15243/jdmlm.2022.092.3265

Mohamed, A. S., Wang, W., Weng, H., Fang, Y., & Xiao, F. (2022). Potential of project level construction and rehabilitation plans to attenuate the economic and environmental burdens of flexible road pavements: A review study. *Journal of Cleaner Production*, *354*, 131713. https://doi.org/10.1016/J.JCLEPRO.2022.131713

Parker, M., & Spennemann, D. H. R. (2022). Conceptualising sound making and sound loss in the urban heritage environment. *International Journal of Urban Sustainable Development*, *14*(1), 264–286. https://doi.org/10.1080/19463138.2022.2103821

Pereira, A. do E. S., Luiz de Oliveira, J., Maira Savassa, S., Barbara Rogério, C., Araujo de Medeiros, G., & Fraceto, L. F. (2022). Lignin nanoparticles: New insights for a sustainable agriculture. *Journal of Cleaner Production*, *345*, 131145. https://doi.org/10.1016/J.JCLEPRO.2022.131145

Pradoto, R., Puri, E., Hadinata, T., Rahman, Q. D., & Az-zuchruf, R. M. (2019). Improving Strength of Porous Asphalt: A Nano Material Experimental Approach. *Jurnal Rekayasa Sipil (JRS-Unand)*, *15*(2), 75. https://doi.org/10.25077/jrs.15.2.75-89.2019

Prihastuti, H., & Kurniawan, T. (2022). *ASEAN Journal for Science and Engineering in Materials Conversion of Indonesian Coal Fly Ash into Zeolites for Ammonium Adsorption*. *1*(2), 75–84.

R Mirza Ghulam., Nariswari, W., S., E. A., & Gunawan, T. (2017). Nilai Stabilitas Porous Asphalt Menggunakan Material Lokal. *Potensi : Jurnal Sipil Politeknik*, *19*(1), 33–40. https://doi.org/10.35313/potensi.v19i1.531

Rhoma Putra, B. H., Alwinda, Y., & Aka Yogie, M. R. (2022). National Road Preservation Based on Irms Method (a Case Study in Japura – Pematang Reba in Riau Province). *Jurnal PenSil*, *11*(2), 120–130. https://doi.org/10.21009/jpensil.v11i2.25720

Song, F., Wang, J., Sui, H., Li, X., & He, L. (2022). Kinetics of CO2 gas bubbling for the separation of residual solvent from waste solids: Effects of bubble size. *Journal of Environmental Chemical Engineering*, *10*(3), 107981. https://doi.org/10.1016/J.JECE.2022.107981

Suwandi, A., & Wijaya, A. O. (2022). *Mobile Learning Trend in Vocational High School*. https://doi.org/10.4108/eai.6-10-2022.2325688

Tjaronge, M. W., Fakhruddin, Caronge, M. A., Zaifullah, M. H., & Rahmat, M. F. (2020). Preliminary Study on Compressive Strength of Porous Asphalt Containing Modified Buton Asphalt, Waste Plastic and Limestone Powder. *IOP Conference Series: Materials Science and Engineering*, *875*(1). https://doi.org/10.1088/1757-899X/875/1/012032

Wang, X., Chen, X., Dong, Q., & Jahanzaib, A. (2020). Material Properties of Porous Asphalt Pavement Cold Patch Mixtures with Different Solvents. *Journal of Materials in Civil Engineering*, *32*, 6020015.

Wei, Z., Jia, Y., Wang, S., Li, Z., Li, Y., Wang, X., & Gao, Y. (2022). Utilization of iron ore tailing as an alternative mineral filler in asphalt mastic: High-temperature performance and environmental aspects. *Journal of Cleaner Production*, *335*, 130318. https://doi.org/10.1016/J.JCLEPRO.2021.130318

Winarno, B., Budi, K. C., Sumargono, Candra, A. I., Muslimin, S., & Sudjati. (2020). Pengaruh Abu Batu Sebagai Filler Terhadap Kinerja Aspal Beton AC-WC Pada Test Marshall. *Jurnal CIVILA*, *5*(2), 468–475.

Yang, Y., Song, J., Sui, H., He, L., & Li, X. (2022). Understanding the behaviors of toluene in asphaltenes. *Journal of Molecular Liquids*, *348*, 118016. https://doi.org/10.1016/J.MOLLIQ.2021.118016

Zhang, K., & Kevern, J. (2021). Review of porous asphalt pavements in cold regions: the state of practice and case study repository in design, construction, and maintenance. *Journal of Infrastructure Preservation and Resilience*, *2*(1). https://doi.org/10.1186/s43065-021-00017-2

Zhang, Z., Sha, A., Liu, X., Luan, B., Gao, J., Jiang, W., & Ma, F. (2020). State-of-the-art of porous asphalt pavement: Experience and considerations of mixture design. *Construction and Building Materials*, *262*, 119998. https://doi.org/10.1016/j.conbuildmat.2020.119998

Zhou, H., Wu, X., Song, Z., Zheng, B., & Zhang, K. (2022). A review on mechanism and adaptive materials of temporary plugging agent for chemical diverting fracturing. *Journal of Petroleum Science and Engineering*, *212*, 110256. https://doi.org/10.1016/J.PETROL.2022.110256