

Bioremediation in Upstream Oil and Gas Enterprises: Indonesian Environmental Law Perspectives

Ahmad Rayhan¹, Mahendra Utama Cahya Ramadhan², Tigor Boris Yudha Prakasa Sihotang¹

¹Faculty of Law, Universitas Sultan Ageng Tirtayasa, Indonesia

²Faculty of Law, Istanbul Zaim University, Turkey

Email: ahmadrayhan@untirta.ac.id



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ABSTRACT

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There have been changes in environmental management since the enactment of Law Number 11 of 2020 on Job Creation, particularly in bioremediation—upstream oil and gas Enterprises. It is intriguing since the process includes natural way of cleansing tainted oil in the water without harming the ecosystem. The study aims to examine the implementation of bioremediation in upstream oil and gas activities under Indonesian environmental law. The study also employed a normative juridical or doctrinal approach. According to the findings, bioremediation is being carried out under a profit-sharing contract with SKK Migas (Special Working Unit for Upstream Oil and Natural Gas Business Activities) acting as the implementing agency. The legal relationship position of an oil and natural gas mining company, specifically in bioremediation, is in the government and corporate accountability to carry out the program, referring to production sharing contracts—cooperation contracts and applicable statutory provisions. To summarize, all parties, including national and regional governments, communities, and oil and gas companies, must implement ecologically friendly protection such as bioremediation.



Introduction

As a Maritime country, Indonesia is well-known for its properous and innumerable biological and non-biological natural resources. Referring to the 1945 Law, Article 33 Paragraph 3, it is explained that the earth, water and natural resources contained therein are controlled by the state and used as much as possible for the prosperity of the people¹. Minerals, coal, oil, and natural gas are among Indonesia's exceptional natural resources. As a result, the central and regional governments have developed regulations to aid in its management. For example, upstream oil and gas enterprises necessitate costly administration, thus the government solicits investors for adjacent work to meet domestic oil and natural gas needs.²

Following Law No. 11 of 2020 on Job Creation, the ability to award licences for oil and natural gas mining possessed by regional governments is transferred to the central government.³ It modifies the execution of Indonesia's regional autonomy system, which essentially entails controlling its territory independently. It occurs because regional governments are thought to be closer and more aware of what is going on in their area.⁴ One

¹ Dyah Ayu, Putri Fatimah, and Hari Prasetyo, "Perubahan Politik Hukum Pemberian Hak Prioritas Kepada Badan Usaha Milik Negara Dalam Kegiatan Eksplorasi Mineral Dan Batu Bara," *Selidik* 9, no. 1 (2023): 99–119.

² Faizal Kurniawan, "Bentuk Perlindungan Hukum Terhadap Kekayaan Minyak Dan Gas Bumi Sebagai Aset Negara Melalui Instrumen Kontrak," *Perspektif* 18, no. 2 (2013): 74.

³ Ruhayat, Sandy Gustiawan, dkk, "Kewenangan Daerah Dalam Perlindungan Dan Pengelolaan Lingkungan Hidup Pasca Berlakunya Undang-Undang Cipta Kerja," *Bina Hukum Lingkungan* 7, no. 1 (n.d.): 43.

⁴ Ary Fatanen, "Eksistensi Kewenangan Daerah Dalam Perlindungan Dan Pengelolaan Lingkungan Hidup Pasca Diterbitkannya Undang-Undang Cipta Kerja," *Khazanah Hukum* 3, no. 1 (2020): 1–2.

of the legal instruments used is a contract mechanism in the form of a production sharing contract. The contract is a strategic means of overcoming problems—the implementation of upstream oil and gas Enterprise' exploration and exploitation. Such a contract is used to give legal protection for state assets as well as benefits to the state.⁵

Soil pollution—soil exposure to crude oil and other industrial processes oils wastes that use microorganisms that are hazardous to the environment—will undoubtedly have a negative impact on environmental conditions and quality. As a result, bioremediation is required to restore the function of contaminated soil near mining sites. Bioremediation is the process of healing a contaminated environment by using organisms such as bacteria, fungus, and plants to transform the pollutant into less complicated and, eventually, harmless and non-toxic metabolites.⁶ Legal issues relating to bioremediation permits or waste management were discovered during bioremediation implementation. Consider the instance of PT. Chevron Pacific Indonesia, which occurred in 2013. Based on the existing findings, it was discovered that the bioremediation involved a waste processing permit issued by the waste processing company rather than the waste producing company, ensuring that no elements violated the Ministry of Environment and Forestry's provisions for processing waste products. Bioremediation activities are governed by Law Number 22 of 2001—Oil and Gas, Law Number 32 of 2009—Environmental Protection and Management, and Law Number 11 of 2020—Job Creation, collectively known as the Omnibus Law.⁷ As a result, the study intends to examine regional governments' jurisdiction, particularly in environmental management, as well as the situation of legal connections between governments and firms in upstream oil and gas.

Research Methods

The study employed a normative juridical method involving a statutory approach. Furthermore, secondary data such as Law Number 22 of 2001—Oil and Gas, Law Number 32 of 2009—Environmental Protection and Management, and Law Number 11 of 2020— Job Creation are also utilized. The data was then analyzed qualitatively by means explaining the existing data in words.

Results and Discussion

1. Government Authority in Environmental Management

Bioremediation is a procedure that uses biological agents such as plants, bacteria, algae, and fungi to degrade or detoxify organic and inorganic pollutants, making it an environmentally friendly and cost-effective remediation compared to other methods.⁸ Bioremediation is used to clean up polluted ecosystems caused by petroleum, pesticides, xenobiotics, and other hazardous substances.⁹ Petroleum bioremediation is the optimization

⁵ Kecamatan Kedewan et al., "Soil Fertility Analysis for Traditional Oil Mining in Wonocolo Village , Kedewan District , Bojonegoro Regency Analisis Kesuburan Tanah Di Pertambangan Minyak Tradisional Desa Wonocolo" 8 (2023): 42-49.

⁶ Riryng Novianty, "Biodegradasi Hidrokarbon Crude Oil Di Kawasan PT. Bumi Siak Pusako-Pertamina Hulu Menggunakan Konsorsium Bakteri Indigen," *Photon: Jurnal Sain dan Kesehatan* 13, no. 2 (2023): 83-90.

⁷ Ester Sheren Monintja, "Tinjauan Yuridis Pasal 2 Dan 3 Undang-Undang Tindak Pidana Korupsi Sebagai Delik Materil Menurut Putusan Mahkamah Konstitusi No. 25/PUU/XIV/2016," *Lex Crimen* 9, no. 2 (2020): 97-105.

⁸ Irma Melati, "Pusat Penelitian Limnologi LIPI," *Prosiding Seminar Biotik*, no. Rahayu 2005 (2020): 272-286.

⁹ and Yuharmen Yuharmen Novianty, Riryng, "Biodegradasi Hidrokarbon Crude Oil Di Kawasan PT. Bumi Siak Pusako-Pertamina Hulu Menggunakan Konsorsium Bakteri Indigen," *Photon: Jurnal Sain dan Kesehatan* 13, no. 1 (2023): 83-89.

of biodegradation (a natural process that transforms and decomposes petroleum waste into non-hazardous substances using microbes).¹⁰

Bioremediation strategies can be used in polluted areas based on hypotheses about where they occur. This approach employs microbial remediators composed of indigenous microbial kinds. These bacteria enable natural remediation (natural attenuation), and the biodegradation of harmful compounds occurs slowly. Bioremediation is environmentally friendly and effective as it employs bacteria that naturally present in soil without the addition of any chemicals.¹¹ Bioremediation tries to eliminate petroleum spilt into the ocean in a way that is less harmful to the environment, and it has shown to be the most effective technology since it uses microbes to transform oil into non-toxic molecules. The bacteria utilized in bioremediation will die automatically once the oil has been removed or is no longer present.¹² In principle, bioremediation for managing petroleum waste can be applied in Indonesia as long as it meets technical requirements and is environmentally safe.

The environmental quality must be maintained by society, central or regional government, so that the decline in the quality of life from year to year can be prevented. Poor environmental quality will endanger all elements of life on Earth, necessitating action from all parties affected. Thus, serious and consistent environmental protection and management must be carried out and improved by all stakeholders.¹³ The government's control and guidance of bioremediation activities is governed by Oil and Gas Law Number 22 of 2001. Article 39 paragraph 1 explains the government's commitment to enacting and enforcing environmental regulations in a careful, transparent, and equitable manner.¹⁴ Furthermore, according to article 40 paragraph 3, environmental management entails the requirement to avoid and regulate pollution as well as remediate environmental harm, including post-operation for upstream oil and gas activities.¹⁵ Article 13 of Law Number 32 of 2009—Environmental Protection and Management states that anyone who pollutes the environment is required to take action, with the measure referred to as warning and socializing the pollution and/or environmental damage to the community or involving other methods that are in accordance with the development of science and technology as regulated by government regulations.¹⁶

Bioremediation operations are governed in Chapter VII of Law Number 32 of 2009—Environmental Protection and handling, which covers the handling of hazardous and toxic materials and waste. According to Article 58 of Law No. 32 of 2009, anyone who enters the territory of the Unitary State of the Republic of Indonesia, produces, transports,

¹⁰ Ahmad Redi and Luthfi Marfungah, "Perkembangan Kebijakan Hukum Pertambangan Mineral Dan Batubara Di Indonesia," *Undang: Jurnal Hukum* 4, no. 2 (2021): 473–506.

¹¹ Syafrizal et al., "Biodegradasi Senyawa Hidrokarbon Minyak Bumi Menggunakan Aktifitas Konsorsium Sedimen Laut Dalam," *Lembaran Publikasi Minyak dan Gas Bumi* 54, no. 2 (2020): 81–91.

¹² Widhowati Kesoema Wardhani and Harmin Sulistiyuning Titah, "Studi Literatur Alternatif Penanganan Tumpahan Minyak Mentah Menggunakan Bacillus Subtilis Dan Pseudomonas Putida (Studi Kasus: Tumpahan Minyak Mentah Sumur YYA-1)," *Jurnal Teknik ITS* 9, no. 2 (2021): 97–102.

¹³ Muhamad Farhan and Mitro Subroto, "Jurnal Komunikasi Hukum," *Jurnal Komunikasi Hukum, Volume 7 Nomor 1 Februari 2021* 9, no. 1 (2023): 1105–1118.

¹⁴ Maria Gabriel Wola, "Penegakan Hukum Terhadap Penjual Bahan Bakar Minyak Tanpa Izin Menurut Undang-Undang Nomor 22 Tahun 2001 Tentang Minyak Dan Gas Bumi," *jurnal Larangan Praktek Monopoli Dan Persaingan Usaha Tidak Sehat* 53, no. 9 (2019): 1689–1699.

¹⁵ Subadi Subadi, "Konflik Penguasaan Dan Pengusahaan Sumur Tua," *Arena Hukum : Jurnal Ilmu Hukum* 16, no. 1 (2023): 191–211.

¹⁶ J H Thomas and D Tiopan, "Tinjauan Yuridis Pelaksanaan Perizinan Pembuangan Limbah Medis Rumah Sakit X Berdasarkan Undang-Undang Nomor 32 Tahun 2009 ...," *UNES Law Review* 5, no. 4 (2023): 2242–2254.

distributes, stores, uses, disposes of, processes, and/or hoards B3 (hazardous and toxic materials) must manage it. If a person is unable to manage B3 waste (Hazardous and Toxic Materials) on their own, it is managed by another party. B3 waste management requires permission from the minister, governor, or regent/mayor, depending on their authority.¹⁷

In environmental protection and management, the government and regional governments have the following duties and authorities: (1) establish national policies, implement norms, standards, procedures and criteria; (2) establish and implement policies regarding the national RPPLH (Environmental Protection and Management Plan); (3) establish and implement environmental impact analysis and UKL – UPL policies (Environmental Management and Environmental Monitoring Efforts). Environmental Protection and Management, in general, has a systematic and integrated function that includes planning, use, control, maintenance, supervision, and law enforcement, and it involves the government as a whole. According to Article 68 of Law No 32 of 2009 on Environmental Protection and Management, every person carrying out business and/or activities is required to provide information related to environmental protection and management correctly, accurately, openly, and on time, in order to maintain environmental sustainability and comply with its provisions on quality standards and/or standard criteria.¹⁸

The supervisory function is governed by Law Number 32 of 2009, article 71—Environmental Protection and Management, which states that ministers, governors, regents/mayors must supervise those responsible for business and/or activities to ensure compliance with statutory regulations. They can delegate their authority to officials or technical agencies responsible for the environmental protection and management. Meanwhile, in order to ensure its execution, ministers, governors, regents/mayors can appoint environmental supervising authorities who are functional officials. Law No. 32 of 2009, article 72—Environmental Protection and Management explains that ministers, governors, regents/mayors must monitor the compliance of those responsible for businesses and/or activities with environmental permits. Meanwhile, article 73 explains that the minister can only oversee parties who have received an environmental permit from the regional government if the Government believes that substantial violations have occurred.¹⁹

Law Number 32 of 2009, article 71—Environmental Protection and Management outlines the jurisdiction of environmental supervisory officers as follows: 1) monitoring, 2) requesting information, 3) making copies of documents and/or taking necessary notes, 4) entering specific premises, 5) taking photos, 6) making audio-visual recordings, 7) taking samples, 8) checking equipment, 9) checking installations and/or modes of transportation, and 9) stopping certain violations. Furthermore, they can work with civil servants, investigating officials, and individuals in charge of businesses and/or activities to deem the duties or any obstruction related.²⁰

¹⁷ Sapto Wahyono, “Kewenangan Pemerintah Daerah Dalam Pengelolaan Limbah B3 Berdasarkan Uu No 23 Tahun 2014,” *Jurnal Yustisia FH Universitas Madura* 19, no. 1 (2018): 34–36.

¹⁸ Fatrisia Bukulu, “Perlindungan Dan Pengelolaan Lingkungan Dalam Amdal: Telaah Kritis Penegakan Hukum Nasional.”, *Philosophia Law Review* 3, no. 1 (2023): 61–78.

¹⁹ Fiska Maulidian Nugroho Effendi, Shofi Munawwir, I. Gede Widhiana Suarda, “Formulasi Pidana Penutupan Korporasi Atas Delik Lingkungan Hidup,” *Veritas et Justitia* 9, no. 1 (2023): 138–63.

²⁰ Juvisher Vigoh Rivaldo Sarajar, “Kewenangan Pejabat Pengawas Lingkungan Hidup Menurut Undang- Undang Nomor 32 Tahun 2009 Tentang Perlindungan dan Pengelolaan Lingkungan Hidup,” *Lex Et Societatis Vol. VIII*, no. 4 (2020): 230–37.

Meanwhile, Law No. 11 of 2020--Job Creation--modifies the following categories of environmental licensing instruments: 1) AMDAL assessors, who were initially formed by an AMDAL assessment commission, were transferred to an environmental feasibility test team, 2) The Formation Team assessors for environmental impact analysis was initially formed by the Regional Government, but was later changed to a central government institution (Environmental Due diligence Institute); 3) The preparation of environmental impact analysis initially involved affected communities, affected communities, and environmental observers, but was later reduced to only affected communities. 4) the environmental permission requirements, initially an Amdal/UKL-UPL, then only Amdal and environmental approval, 5) there must be only environmental, 6) The regional government's authority is lessened, while the central government/organizations/individuals chosen by the central government gain power.²¹ The Job Creation Law makes things easier for investors who wish to invest in Indonesia, but it also diminishes regional governments' supervision and authority. In terms of environmental prevention, Regional Governments' jurisdiction has dwindled after the passage of Law No. 11 of 2020.²² The Job Creation Law also eliminates three regional autonomy goals: 1) Political Equality, which includes giving opportunity for the people to participate in political activities. 2) Accountability at the local level, including increased regional capacity to implement community rights. 3) Local Responsiveness, which allows regions to respond to everything that occurs in their area if a problem raises.²³

2. *Legal Relationships between the Government and Companies in the Upstream Oil and Gas Business*

The oil and gas industry is separated into two parts: upstream and downstream. As the implementing agency, SKK Migas (Special Working Unit for Upstream Oil and Gas Business Activities) is the entity empowered to oversee and supervise upstream business.²⁴ The Implementing Agency is governed by Oil and Gas Law Number 22 of 2001, Article 1 Number 23, and Articles 44 to 45. According to Article 1 number 23, the Implementing Agency is an agency constituted to control upstream oil and gas business activity. The implementing agency is a state-owned legal entity with the status of a subject of civil law, as well as an institution that does not seek profit and is professionally managed.²⁵

Cooperation Contract Contractors (KKKS) are parties who have Cooperation Contracts with the Indonesian Government, in this case SKK Migas (Special Working Unit for Upstream Oil and Gas Business Activities). KKKS (Cooperation Contract Contractors) are permanent business entities or a company with management rights in a block or working area that has

²¹ Ruhiyat, Sandy Gustiawan, dkk, Op. Cit, hlm 43-44

²² Nyayu Tiara Masayu, "Implikasi Undang-Undang Cipta Kerja Terhadap Kewenangan Pemerintah Daerah Dalam Melaksanakan Penataan Ruang Nasional Dan Penyelenggaraan Penataan Ruang," *Jatiswara* 36, no. 3 (2021): 238-249.

²³ Nabila Alif Radika Shandy and Allan Fatchan Ghani Wardhana, "Bagaimana Hubungan Pusat Dan Daerah Pasca Penetapan Undang-Undang Cipta Kerja? Kasus Penetapan Pajak Daerah," *As-Siyasi : Journal of Constitutional Law* 2, no. 1 (2022): 93-114.

²⁴ Rachel Octavia Manurung, FC Susila Adiyanta, and Henny Juliani, "Kedudukan Hukum Satuan Kerja Khusus Migas Sebagai Pelaksana Kegiatan Usaha Hulu Minyak Dan Gas Bumi Bagi Tata Kelola Ketahanan Energi Nasional," *Administrative Law and Governance Journal* 5, no. 2 (2022): 135-152.

²⁵ and Zaenal Nento Sulaiman, Herlina, "Analisis Hukum Tindak Pidana Pengangkutan Dan Perniagaan BBM Bersubsidi Tanpa Izin Usaha Menurut Undang-Undang Nomor 22 Tahun 2001 Tentang Migas," *Journal Law And Justice* 1, no. 1 (2023): 1-6.

the right to conduct oil and gas exploration and exploitation activities in Indonesia.²⁶ Production sharing contracts were issued by SKK Migas (Special Working Unit for Upstream Oil and Gas Business Activities) with permission from the Ministry of Energy and Mineral Resources (ESDM), in which there is a division of labor between the Government and KKKS (Cooperation Contract Contractors) both domestically and abroad from exploration, exploitation, and even post-operation activities.²⁷

Contracts for production sharing specify that KKKS (Cooperation Contract Contractors) who have obtained permissions are subject to and obligated to meet the duties spelled out in the contracts. It involves management activities, post-operational hazardous and toxic waste or relate to bioremediation, bearing operational risks from the start utilizing operating expenditures that will be recovered by the government as cost recovery—a model in which the state reimburses contractors for oil operations costs.²⁸ Upstream oil and gas business activities are governed by Law Number 22 of 2001, Article 11 on Oil and Natural Gas, which states that upstream oil and gas business activities are carried out by business entities or permanent business forms under cooperation contracts with implementing agencies.²⁹ In addition, as the implementing agency, SKK Migas (Special Work Unit for Implementing Upstream Oil and Gas Business Activities), must supervise upstream oil and gas business activities so that resources can be extracted. The state's natural oil and gas resources have the ability to provide the state with maximum benefits and earnings in order to maximize people's prosperity.³⁰

Conclusion

To summarize, bioremediation is a cost-effective and environmentally friendly way of removing contaminants from water, notably oil waste. Furthermore, with the passage of Law No. 11 of 2020, the regional government's authority has been lessened and relocated to the central. Bioremediation is carried out based on a production sharing contract with a cooperation contract the Special Task Force for Upstream Oil and Gas Business Activities (SKK Migas) as the implementing agency. Meanwhile, in Indonesia, government policy on environmental protection, in this case bioremediation, is governed by Law Number 22 of 2001 on Oil and Gas and Law Number 32 of 2009 on Environmental Protection and Management.

The legal relationship of an oil and natural gas mining company conducting bioremediation, on the other hand, must refer to production sharing cooperation contract and applicable statutory provisions. The government must be in charge of managing and supervising the activity, as well as offering instruction to KKKS (Cooperation Contract Contractors) who work with the government. Meanwhile, KKKS (Cooperation Contract Contractors) must be in charge of post-operational operations such as controlling hazardous and toxic waste through bioremediation. After the handover point, the corporation must

²⁶ Sang Ayu Putu Rahayu, "Prinsip Hukum Dalam Kontrak Kerjasama Kegiatan Usaha Hulu Minyak Dan Gas Bumi," *Yuridika* 32, no. 2 (2017): 333.

²⁷ Nabila Aulia Rahma, Juan Maulana Alfredo, and Liavita Rahmawati, "Supervision Mining System : Rekonstruksi Pengawasan Sektor Hulu Minyak Dan Gas Bumi Yang Berkeadilan Sosial Di Indonesia," *Jurnal Hukum Lex Generalis* 2, no. 11 (2022): 1017-1038.

²⁸ *Ibid. Ibid.*

²⁹ Marcela Renalda Devi Mamahit, "Wewenang Penyidik Pegawai Negeri Sipil Melakukan Penyidikan Terhadap Pelaku Tindak Pidana Kegiatan Usaha Minyak Dan Gas Bumi," *Lex Administratum* XI, no. 2 (2023).

³⁰ Mahlil Adriaman Rinaldo, Desril, Benni Rusli, "Implementasi Perjanjian Kerjasama Pertashop Dengan Mitra Usaha dan Upaya Penyelesaian Perselisihan Antar Pihak," *SAKATO LAW JOURNAL* 1, no. 1 (2023): 83-90.

confront operational risks and seek a cost return from the government in the form of cost recovery.

Suggestion

There are some recommendations that can be put forward: (1) The Central Government and Regional Governments should provide more support for cost-effective and environmentally friendly marine cleanup activities such as bioremediation, (2) statutory regulations or state administrative regulating bioremediation are required so that the entire community is concerned on this matter, (3) Oil and gas companies that produce hazardous waste must mitigate its environmental impacts and comply with applicable regulation, to be held accountable

References

- Ayu, Dyah, Putri Fatimah, and Hari Prasetyo. "Perubahan Politik Hukum Pemberian Hak Prioritas Kepada Badan Usaha Milik Negara Dalam Kegiatan Eksplorasi Mineral Dan Batu Bara." *Selidik* 9, no. 1 (2023): 99-119.
- Bukulu, Fatrisia. "Perlindungan Dan Pengelolaan Lingkungan Dalam Amdal: Telaah Kritis Penegakan Hukum Nasional." *Philosophia Law Review* 3, no. 1 (2023): 61-78.
- Effendi, Shofi Munawwir, I. Gede Widhiana Suarda, and Fiska Maulidian Nugroho. "Formulasi Pidana Penutupan Korporasi Atas Delik Lingkungan Hidup." *Veritas et Justitia* 9, no. 1 (2023): 138-163.
- Farhan, Muhamad, and Mitro Subroto. "Jurnal Komunikasi Hukum." *Jurnal Komunikasi Hukum, Volume 7 Nomor 1 Februari 2021* 9, no. 1 (2023): 1105-1118.
- Fatanen, Ary. "Eksistensi Kewenangan Daerah Dalam Perlindungan Dan Pengelolaan Lingkungan Hidup Pasca Diterbitkannya Undang-Undang Cipta Kerja." *Khazanah Hukum* 3, no. 1 (2020): 1-2.
- Juvisher Vigoh Rivaldo Sarajar. "Kewenangan Pejabat Pengawas Lingkungan Hidup Menurut Undang- Undang Nomor 32 Tahun 2009 Tentang Perlindungan Dan Pengelolaan Lingkungan Hidup." *Lex Et Societatis Vol. VIII*, no. 4 (2020): 230-237.
- Kedewan, Kecamatan, Kabupaten Bojonegoro, Nindy Callista Elvania, Yenny Sri Margianti, Santi Amanda Tiara, and Dimas Bagus Nugroho. "Soil Fertility Analysis for Traditional Oil Mining in Wonocolo Village , Kedewan District , Bojonegoro Regency Analisis Kesuburan Tanah Di Pertambangan Minyak Tradisional Desa Wonocolo" 8 (2023): 42-49.
- Kurniawan, Faizal. "Bentuk Perlindungan Hukum Terhadap Kekayaan Minyak Dan Gas Bumi Sebagai Aset Negara Melalui Instrumen Kontrak." *Perspektif* 18, no. 2 (2013): 74.
- Manurung, Rachel Octavia, FC Susila Adiyanta, and Henny Juliani. "Kedudukan Hukum Satuan Kerja Khusus Migas Sebagai Pelaksana Kegiatan Usaha Hulu Minyak Dan Gas Bumi Bagi Tata Kelola Ketahanan Energi Nasional." *Administrative Law and Governance Journal* 5, no. 2 (2022): 135-152.
- Marcela Renalda Devi Mamahit. "Wewenang Penyidik Pegawai Negeri Sipil Melakukan Penyidikan Terhadap Pelaku Tindak Pidana Kegiatan Usaha Minyak Dan Gas Bumi." *Lex Administratum XI*, no. 2 (2023).
- Masayu, Nyayu Tiara. "Implikasi Undang-Undang Cipta Kerja Terhadap Kewenangan Pemerintah Daerah Dalam Melaksanakan Penataan Ruang Nasional Dan Penyelenggaraan Penataan Ruang." *Jatiswara* 36, no. 3 (2021): 238-249.
- Melati, Irma. "Pusat Penelitian Limnologi LIPI." *Prosiding Seminar Biotik*, no. Rahayu 2005 (2020): 272-286.
- Monintja, Ester Sheren. "Tinjauan Yuridis Pasal 2 Dan 3 Undang-Undang Tindak Pidana Korupsi Sebagai Delik Materil Menurut Putusan Mahkamah Konstitusi No. 25/PUU/XIV/2016." *Lex Crimen* 9, no. 2 (2020): 97-105.

- Novianty, Riry, and Yuharmen Yuharmen. "Biodegradasi Hidrokarbon Crude Oil Di Kawasan PT. Bumi Siak Pusako-Pertamina Hulu Menggunakan Konsorsium Bakteri Indigen." *Photon: Jurnal Sain dan Kesehatan* 13, no. 1 (2023): 83-89.
- Novianty, Riry. "Biodegradasi Hidrokarbon Crude Oil Di Kawasan PT. Bumi Siak Pusako-Pertamina Hulu Menggunakan Konsorsium Bakteri Indigen." *Photon: Jurnal Sain dan Kesehatan* 13, no. 2 (2023): 83-90.
- Rahayu, Sang Ayu Putu. "Prinsip Hukum Dalam Kontrak Kerjasama Kegiatan Usaha Hulu Minyak Dan Gas Bumi." *Yuridika* 32, no. 2 (2017): 333.
- Rahma, Nabila Aulia, Juan Maulana Alfredo, and Liavita Rahmawati. "Supervision Mining System : Rekonstruksi Pengawasan Sektor Hulu Minyak Dan Gas Bumi Yang Berkeadilan Sosial Di Indonesia." *Jurnal Hukum Lex Generalis* 2, no. 11 (2022): 1017-1038.
- Redi, Ahmad, and Luthfi Marfugah. "Perkembangan Kebijakan Hukum Pertambangan Mineral Dan Batubara Di Indonesia." *Undang: Jurnal Hukum* 4, no. 2 (2021): 473-506.
- Rinaldo, Desril, Benni Rusli, and Mahlil Adriaman. "Implementasi Perjanjian Kerjasama Pertashop Dengan Mitra Usaha Dan Upaya Penyelesaian Perselisihan Antar Pihak." *SAKATO LAW JOURNAL* 1, no. 1 (2023): 83-90.
- Ruhyat, Sandy Gustiawan, dkk. "Kewenangan Daerah Dalam Perlindungan Dan Pengelolaan Lingkungan Hidup Pasca Berlakunya Undang-Undang Cipta Kerja." *Bina Hukum Lingkungan* 7, no. 1 (n.d.): 43.
- Sapto Wahyono. "Kewenangan Pemerintah Daerah Dalam Pengelolaan Limbah B3 Berdasarkan Uu No 23 Tahun 2014." *Jurnal Yustisia FH Universitas Madura* 19, no. 1 (2018): 34-36.
- Shandy, Nabila Alif Radika, and Allan Fatchan Ghani Wardhana. "Bagaimana Hubungan Pusat Dan Daerah Pasca Penetapan Undang-Undang Cipta Kerja? Kasus Penetapan Pajak Daerah." *As-Siyasi : Journal of Constitutional Law* 2, no. 1 (2022): 93-114.
- Subadi, Subadi. "Konflik Penguasaan Dan Pengusahaan Sumur Tua." *Arena Hukum : Jurnal Ilmu Hukum* 16, no. 1 (2023): 191-211.
- Sulaiman, Herlina, and Zaenal Nento. "Analisis Hukum Tindak Pidana Pengangkutan Dan Perniagaan BBM Bersubsidi Tanpa Izin Usaha Menurut Undang-Undang Nomor 22 Tahun 2001 Tentang Migas." *Journal Law And Justice* 1, no. 1 (2023): 1-6.
- Syafrizal, R Rahmaniar, T Partono, Zulkifliani, O Kristiawan, N Ardhyarini, Y Handayani, and Rofiqoh. "Biodegradasi Senyawa Hidrokarbon Minyak Bumi Menggunakan Aktifitas Konsorsium Sedimen Laut Dalam." *Lembaran Publikasi Minyak dan Gas Bumi* 54, no. 2 (2020): 81-91.
- Thomas, J H, and D Tiopan. "Tinjauan Yuridis Pelaksanaan Perizinan Pembuangan Limbah Medis Rumah Sakit X Berdasarkan Undang-Undang Nomor 32 Tahun 2009" *UNES Law Review* 5, no. 4 (2023): 2242-2254.
- Wardhani, Widhowati Kesoema, and Harmin Sulistiyaning Titah. "Studi Literatur Alternatif Penanganan Tumpahan Minyak Mentah Menggunakan Bacillus Subtilis Dan Pseudomonas Putida (Studi Kasus: Tumpahan Minyak Mentah Sumur YYA-1)." *Jurnal Teknik ITS* 9, no. 2 (2021): 97-102.
- Wola, Maria Gabriel. "Penegakan Hukum Terhadap Penjual Bahan Bakar Minyak Tanpa Izin Menurut Undang-Undang Nomor 22 Tahun 2001 Tentang Minyak Dan Gas Bumi." *jurnal Larangan Praktek Monopoli Dan Persaingan Usaha Tidak Sehat* 53, no. 9 (2019): 1689-1699.

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