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Mapping Research Trends in Oil Supply Chain Optimization: A Bibliometric Analysis

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ABSTRAK

Industri minyak saat ini beroperasi dalam lingkungan yang semakin kompetitif, sehingga peningkatan efisiensi dalam proses operasional menjadi sangat penting terutama pada logistik transportasi. Rantai pasok minyak umumnya dibagi menjadi tiga tahap: logistik hulu, yang memastikan fasilitas ekstraksi memperoleh material dan peralatan yang dibutuhkan; logistik tengah, yang mencakup transportasi, penyimpanan, dan pemrosesan; serta logistik hilir, yang berfokus pada distribusi produk hasil olahan kepada konsumen. Kajian bibliometrik awal menggunakan perangkat lunak Publish or Perish dan basis data Scopus menunjukkan bahwa penelitian mengenai optimalisasi rantai pasok minyak masih terbatas, dengan hanya 78 publikasi sejak 2014 hingga sekarang, di mana sebagian besar literatur lebih terkonsentrasi pada bidang ilmu pertambangan dan teknik dibandingkan pada perspektif logistik. Untuk menjembatani kesenjangan tersebut, penelitian ini menerapkan kerangka PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) yang menggabungkan pendekatan kuantitatif dan kualitatif, serta memanfaatkan perangkat lunak VOSviewer untuk memetakan dan memvisualisasikan tren penelitian. Hasil analisis menunjukkan bahwa kata kunci "optimisasi" dan "produksi" memiliki keterkaitan yang relatif lemah dengan literatur rantai pasok minyak dan gas, yang menandakan masih lemahnya hubungan riset di bidang ini. Selain itu, pendekatan optimisasi berbasis matematis mendominasi kajian yang ada, sementara metode lain masih jarang dieksplorasi. Ketimpangan ini mengindikasikan perlunya perluasan ruang lingkup penelitian, tidak hanya pada masing-masing aliran rantai pasok minyak, tetapi juga melalui penerapan beragam metode optimisasi. Dengan demikian, penelitian mendatang diharapkan dapat menghasilkan wawasan yang lebih komprehensif, mendukung desain rantai pasok yang lebih tangguh dan efisien, serta memberikan kontribusi praktis bagi industri yang terus menghadapi tekanan kompetisi, transisi energi, dan volatilitas pasar global.

Kata kunci : ***Rantai Pasok Minyak, Optimisasi, Logistik, Analisis Bibliometrik, PRISMA, VOSviewer***

ABSTRACT

The oil industry operates in an increasingly competitive environment, making efficiency improvements across operational processes essential particularly in transportation logistics. The oil supply chain is typically divided into three stages: upstream logistics, which ensures extraction facilities have the necessary materials and equipment; midstream logistics, involving transportation, storage, and processing; and downstream logistics, which delivers refined products to customers. A preliminary bibliometric review using the Publish or Perish software and Scopus database highlights the limited attention given to oil supply chain optimization, with only 78 relevant publications from 2014 to the present, most of which are concentrated in mining science and engineering rather than logistics-focused studies. To bridge this gap, this study applies the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, integrating quantitative and qualitative approaches, combined with VOSviewer software for

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mapping and visualization of research trends. Results reveal that the keywords “optimization” and “production” have a relatively weak connection with the oil and gas supply chain literature, suggesting underdeveloped research linkages. Additionally, mathematical-based optimization methods dominate the existing body of work, while alternative approaches remain underexplored. This imbalance indicates the need for broader investigations that not only focus on individual streams of the oil supply chain but also incorporate diverse optimization techniques beyond mathematical modeling. By doing so, future research can generate more comprehensive insights, support the design of more resilient and efficient supply chains, and provide practical contributions to an industry that continues to face pressures of competition, energy transition, and global market volatility.

Keyword : ***Oil Supply Chain, Optimization, Logistics, Bibliometric Analysis, PRISMA, VOSviewer***

1. INTRODUCTION

Offshore oil logistics encompasses the processes and activities required to support oil exploration and production in marine environments. It involves the planning, execution, and management of the supply chain for oil exploration and production activities. In areas with a high concentration of offshore operations, logistics has a significant economic impact and offers enormous potential for the application of shared and collaborative logistics (El-Thalji, 2024). The shared and cooperative logistics method typically affects stakeholders across the whole business model in dimensions which include social, economic, and environmental. Fundamental elements that characterize the sustainability of the shared logistics include reduced greenhouse gas emissions because of fewer trips, effective resource use, cost savings, improved profit margins for all parties, and adherence to equitable cost-sharing and benefit distribution procedures. The logistics system must be robust to increase production and lower the risk of operational delays brought on by delayed deliveries of commodities to and/or from the offshore field, and efficient to minimize the expenses of delivering goods and services (Aas et al., 2007), (Berle et al., 2011).

Supply operations and supporting logistics are two of the most important operational segments that must execute well throughout every stage of an offshore oil field's lifecycle to make operations both technically and financially viable (MilakoviĆ et al., 2015). Due to the production capacities of crude oil suppliers, lengthy lead times for transit, the constraints of energy planning and management, and the limitations of transportation modes, the logistics network in the oil industry is extremely rigid (Lisitsa et al., 2019). There are many segments that need to be optimized from upstream to downstream. The details of each of these segments can be seen in Figure 1.

Figure 1. Oil Supply Chain

The upstream, midstream, and downstream parts are the three functional divisions of the oil and gas supply chain. Any industry activity that involves the exploration and production of natural gas and oil is referred to as upstream. Upstream companies look for raw material reservoirs and take them out. A common term for upstream companies is E&P (exploration and production).

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The midstream segment is primarily concerned with logistics related to the transportation and storage of natural gas and oil, as well as the transportation of extracted resources to refineries for processing. Midstream firms contain pipelines and all the equipment, including pumping stations, tank trucks, rail tank cars, and intercontinental tankers, required to transport these commodities across great distances. The last section of downstream consists of refineries, which are businesses that transform natural gas and oil into a variety of final goods. Fuels such as gasoline, diesel, kerosene, jet fuels, asphalt for roads, and gas for domestic purposes are among the items we use on a regular basis (Deny, n.d.). We understand that this industry relies mostly on the supply chain to deliver their services and products from upstream to end customers in the downstream therefore the optimization along the chain is considered important (Menhat et al., 2019).

Upstream logistics, more specifically, refers to the processes involved in sourcing, transporting, and managing materials and resources needed for production in various industries, particularly in sectors like oil and gas, manufacturing, and construction. In the oil sector, optimizing upstream logistics entails controlling the movement of supplies, machinery, and data from exploration and production locations to refineries and other processing centers. The delivery of all goods and services required for operations to and from the offshore field, or upstream logistics, makes up a significant portion of the logistics system (MilakoviĆ et al., 2015). The study of shared logistics in the upstream examined the possible advantages and effects of two potential business models: (1) scheduled shared logistics, in which participants share logistics resources like vessels in accordance with predetermined schedules, and (2) ride-shared logistics, in which one logistics resource (vessel) provides an on-demand transportation option to be shipped in a common direction (El-Thalji, 2024).

According to the qualitative study from (Menhat et al., 2019), there are five primary obstacles to optimum performance management in the oil and gas supply chain, they are to guarantee the data's accuracy, streamlined data structures, sufficient collaboration across departments, aligned local content, and to present project at the lowest possible cost, therefore some strategies are required to overcome the problems. Supplier relationship management, integrated planning and scheduling, inventory management, transportation optimization, technology utilization, sustainability initiatives, local sourcing, continuous improvement, risk management, and digital transformation are some strategies that will answer the difficulties faced by the oil supply chain. Supplier relationship management talks about establishing strong partnerships with suppliers of drilling equipment, chemicals, and other essential materials. To ensure suppliers meet quality and delivery standards, performance-based contracts should be arranged. A study on supplier selection in the oil and gas industry was conducted in which they developed a Multi-Criteria Decision Analysis (MCDA) with a real case study of Iranian oil and gas company to provide essential items such as equipment, HR, and transportation to the industry (Yazdi et al., 2022). The findings imply that information reliability techniques applied to conventional economic concepts, such as utility- and efficiency-related factors, can effectively handle the complexity of oil and gas (O&G) operations on supplier selection, especially in business environments marked by a trade embargo as in a country like Iran.

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In addition to putting in place technologies that offer real-time visibility into operations to optimize scheduling and resource allocation, integrated planning and scheduling refers to the use of advanced planning systems to align exploration, drilling, and production schedules with logistics operations. Inventory management refers to optimizing inventory levels of spare parts and consumables to minimize downtime without overstocking (Slater, 2010), and using predictive analytics to anticipate demand for critical materials based on project schedules. For transportation optimization, there is a need to analyze transportation routes for moving equipment and materials to remote locations, minimizing costs and transit times while exploring multimodal transportation options, including trucks, barges, and helicopters, depending on accessibility. Technology utilization is required to leverage IoT devices for real-time tracking of equipment and materials, enhancing visibility throughout the supply chain. Implementing data analytics to improve forecasting and decision-making regarding logistics operations is also considered important in the oil industry in general (Baaziz & Quoniam, 2013; Nguyen et al., 2020). Under risk management, strategies are needed to handle disruptions due to geopolitical issues, natural disasters, or regulatory changes. It is also significant to ensure compliance with environmental and safety regulations, which can affect logistics planning and operations.

Other strategies such as sustainability initiatives consider the integration of sustainable practices in logistics (N. K. W. Ahmad et al., 2017; W. N. K. W. Ahmad et al., 2016a; Raut et al., 2017; Wan Ahmad et al., 2016), for example optimizing routes to reduce emissions and exploring renewable energy sources for transportation or implementing waste reduction strategies focusing on recycling and responsible disposal. In local sourcing, where feasible, source materials are locally provided to reduce transportation costs and improve supply chain resilience. Apart from that, collaboration with local suppliers is also needed to enhance community relationships and support local economies. Regarding the era of Industry 4.0, digital transformation is something that cannot be ignored, including in the upstream logistics of the oil industry (Elijah et al., 2021). This can be achieved by investing in digital platforms that facilitate collaboration and data sharing among different stakeholders in the supply chain, using simulation and modeling tools to predict outcomes of different logistics strategies, allowing for informed decision-making. Digital transformation enables the collection and analysis of large volumes of data from various sources (e.g., sensors, equipment) therefore for example, predictive maintenance can be implemented to minimize downtime and optimize logistics operations in the upstream oil supply chain. Another example would be digital tools that enhance visibility across the oil supply chain, allowing for real-time tracking of materials and equipment then leads to improved coordination, reduced delays, and optimized resource allocation among operations. Blockchain technology, which has gained significant popularity across sectors, can also provide a secure and transparent way to track transactions and logistics in the oil supply chain. This helps in building trust among stakeholders and reduces the risk of fraud.

Lastly, continuous improvement should be ensured by settling relevant performance metrics in which establishing KPIs specific to upstream logistics, such as days of inventory holding (Tripathi et al., 2018), delivery accuracy, lead times, and cost efficiency, and regularly reviewing performance data and solicit feedback from teams to identify areas for

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improvement. Businesses in the oil sector can improve their upstream logistics, cut expenses, and boost operational effectiveness by concentrating on these tactics, which will ultimately result in a supply chain that is more robust and responsive. Unfortunately, there has not been much study done on logistics optimization in the upstream oil sector. Therefore, to close this gap and ensure that its development and use has greater impact in the future, extensive mapping must be developed. This study would like to answer the following questions:

- What are the key trends in the research literature on optimization in the oil supply chain over the years?
- What are the potential future directions and emerging topics in the optimization of the oil supply chain?

2. METHODS

There are several bibliometric analyses in the field of oil supply chain, one of it discussed the use of artificial intelligence (AI) to optimize maintenance logistics on offshore rigs (Ayemere Ukato et al., 2024). As the main infrastructure for exploration, extraction, and processing, offshore platforms are essential resources for the oil and gas sector. For these platforms to function effectively and safely, maintenance logistics are essential. However, maintenance operations are severely hampered by the harsh and isolated conditions of offshore installations. The demands of these conditions are frequently too great for traditional maintenance techniques, which can result in inefficiencies, higher expenses, and possible safety hazards. The use of artificial intelligence (AI) to optimize maintenance logistics on offshore rigs is covered in their paper. They found that AI-enabled maintenance logistics optimization for offshore sites has major advantages in terms of effectiveness, economy, and security. AI technology can be used to improve present maintenance plans and transform offshore maintenance procedures in the future, making operations more resilient and sustainable in the face of changing obstacles.

Another bibliometric evaluation was conducted focusing on sustainable supply chain management (SSCM) in the oil and gas sector. They carried out a thorough bibliometric analysis of thousands of papers from the Web of Science (WoS) database covering publication in 34 years from the year 1978 to 2021 (Sahebi et al., 2024). Their research reveals information that has not been thoroughly covered or included in other evaluations of SSCM in O&G area. Possible subjects for further study are revealed by the study. Their findings explained that there are three main subjects that are predominantly researched in this field, namely, "Greenhouse gas emissions," "Life-Cycle Assessment," and "Sustainability." A field survey regarding logistics in the oil industry emphasized evaluating the incorporation of sustainability into supply chain management and the sustainability reporting practices of oil and gas companies (Wan Ahmad et al., 2016). From an examination of the content of 30 companies' sustainability reports, they found that the requirements for sustainability reporting do not include enough supply chain indicators. The company's capacity to report on its supply chain procedures impartially is impacted by this. The study's findings can be applied as a guide to enhance sustainability reporting procedures and locate pertinent supply chain metrics that can be included in an index for sustainability reporting in the oil and gas industry.

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An Industry 4.0 survey was conducted with a focus on the upstream sector of the oil and gas industry (Elijah et al., 2021). This study examined the most recent initiatives in the O&G upstream industry aimed at I4.0 technology covering publication within 2012 and 2021. They concluded that many upstream O&G industrial sectors had embraced parts of the I4.0. To create an ecosystem that exchanges insights and varied datasets more easily and accomplishes sustainable objectives, further work is necessary to ensure the smooth integration of the I4.0 technologies. Although they are discussed in a few parts, the logistics and supply chain components of upstream logistics are not explicitly explained in this paper.

A newer bibliometric analysis performed to unfold the expansion of research fields of O&G in a broader view (Zhang et al., 2022). Engineering, energy and fuels, geology, environmental sciences and ecology, materials science, and chemistry are among the research sectors that have benefited from the growth of oil and gas wells. The top ten significant research mostly addressed the environmental effects of shale gas extraction. Therefore, it is apparent that research conducted about O&G concerning supply chains and logistics has not been widely acknowledged until this day.

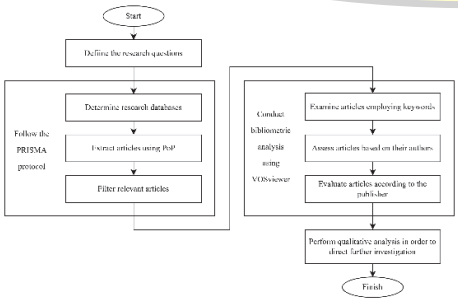

Figure 2. Research Methodology

This study conducted a thorough mapping analysis of upstream logistics optimization in the oil sector using both quantitative and qualitative methodologies. Publish or Perish (PoP) and VOSviewer were the two software programs used for the quantitative analysis. In the meantime, by assessing and scrutinizing the most recent keyword tendencies and issues, the qualitative content analysis was conducted to develop study guidelines for future investigations. Figure 2 illustrates the steps involved in the systematic mapping method that were taken to ultimately determine the most important keywords utilized in the literature on the observed topic.

This bibliometric analysis was conducted by selecting literatures with referring to PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) method. Sequences in scrutinizing relevant articles followed the PRISMA protocol. There are three common international academic databases, namely Web of Science, Scopus, and EBSCOhost (Hu et al., 2022). One of these three databases that can be freely accessed online using PoP is Scopus, which was then used in this study. All articles that satisfied the requirements were abstracted.

The literature review included the factors to provide answers to the queries under investigation. This considered studies from a pool of papers that were published between 2014 and the year 2024. To assure a repeatable and objective article search procedure while maintaining the context's relevance, the search was executed out by utilizing three determined terms. Boolean operators AND and OR were set to combine the search phrases, which included oil, supply chain, and logistics. To ensure advancement and relevance, the first curation process extratced 78 articles from 200 maximum capacity provided by the

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software, with the most cites per year is 12.43 and the fewest being 0. The value of cites/year shows an average number of citations per year for the relevant article.

The gathered publications were filtered by document category, review technique, main research topic, and many others. Document categories can be in writing types of original research article, book chapter, conference proceedings, or others. While language used in the articles that first extracted from PoP can be in English or others therefore should be filtered further. However, only articles in international publications which is written in English were taken into consideration to guarantee the standard of assessment. Each stage of filtration can be seen in the screening section shown in Figure 3. At last, 16 articles were compiled to be analyzed.

3. RESULTS AND DISCUSSION

The collected articles were evaluated using VOSviewer software. It was used to create a map based on bibliographic publication data, a list of articles from various sources obtained from the previous stage of study. With different occurrence rates, the software's keyword co-occurrence criteria were applied. This criterion evaluates the frequency with which specific keywords or concepts appear together in the articles. Co-occurrence was identified by the VOSviewer, and terms that showed concurrently were considered related or connected. Following a title-only analysis of the articles, ten keywords with a minimum frequency of five occurrences were identified. The keywords that were discovered during the latter stages of filtration, as indicated in Table 1, were arranged from the highest to the lowest in the final column according to the strength of the association. The higher the score of occurrences representing stronger co-occurrence relationships with other terms which are more clearly visible in the bigger nodes in Figure 4. The relevance refers to how often one term comes up in relation to others in the dataset.

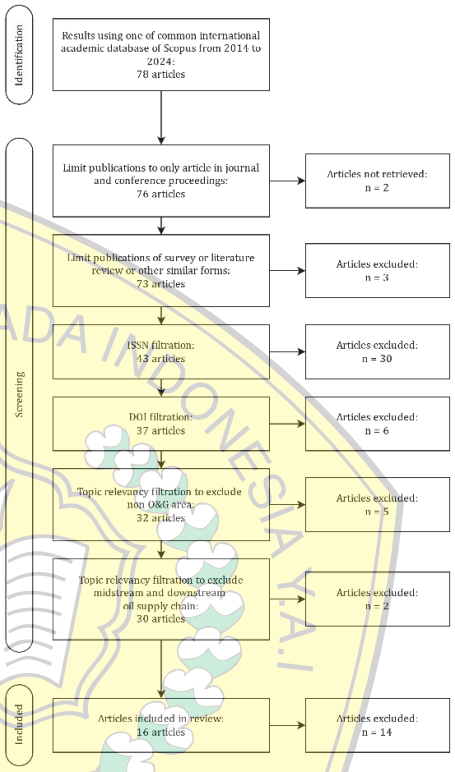

Figure 3. The Framework of Article Collection and Extraction

VOSviewer acknowledges full counting through the title, of the 699 terms, with 10 minimum number of occurrences of a term, there is only 3 terms that met the treshold, they are case study, gas industry, and oil. In which minimum of occurrences reduced by half to 5, there are 4 terms with 60% minimum relevancy that can be found including optimization, production, gas industry, and oil with details as shown in Table 1 and illustrated in Figure 4. This graphic representation makes it easier to pinpoint important topics for upcoming studies. The visual density had an impact on the separation between keywords, in which the closer two vertices were to one

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another, the higher the density. According to Figure 4, the "optimization" node is located far from the term "oil" and, moreover, "gas industry". This intricates a huge research gap on optimization in all parts of the oil supply chain from upstream to downstream that required future attention.

Table 1. Selected Terms for Network Visualization

Term	Occurrences	Relevance
Optimization	16	1.21
Production	14	1.05
Gas industry	10	0.89
Oil	25	0.84

VOSviewer acknowledges full counting through the title, of the 699 terms, with 10 minimum number of occurrences of a term, there is only 3 terms that met the treshold, they are case study, gas industry, and oil. In which minimum of occurrences reduced by half to 5, there are 4 terms with 60% minimum relevancy that can be found including optimization, production, gas industry, and oil with details as shown in Table 1 and illustrated in Figure 4. This graphic representation makes it easier to pinpoint important topics for upcoming studies. The visual density had an impact on the separation between keywords, in which the closer two vertices were to one another, the higher the density. According to Figure 4, the "optimization" node is located far from the term "oil" and, moreover, "gas industry". This intricates a huge research gap on optimization in all parts of the oil supply chain from upstream to downstream that required future attention.

Figure 4. Network Visualization

Table 2 reveals that, out of the 16 carefully chosen and evaluated articles, they are published on 14 different journal/proceedings websites. In the meantime, two relevant studies have been published in Procedia Computer Science and Transportation Research Part C: Emerging Technologies, each. For the study pertaining to optimization in the oil industry, other articles have been published in other media as listed in detail in Table 2, each contributed exactly one article, for a total of 12 items. In general, it can be said that the distribution is relatively balanced, although not yet very wide. In addition, we can see that the media that publish research related to oil supply chain optimization are not dominated by journals related to oil or chemical-material production, but rather industrial engineering, simulation, transportation, operations research, and even Africa Spectrum promoting scientific knowledge on the politics, societies, and economics of sub-Saharan Africa.

Table 2. Selected Terms for Network Visualization

Journal/Proceedings Name	Count
Africa Spectrum	1
Axioms	1
Chemical Engineering Transactions	1
European Journal of Operational Research	1
International Journal of Design and Nature and Ecodynamics	1

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International Journal of Industrial Engineering Computations	1
IOP Conference Series: Materials Science and Engineering	1
Journal of Environmental Management	1
Journal of Geophysics and Engineering	1
Journal of Loss Prevention in the Process Industries	1
Procedia Computer Science	2
Proceedings - European Council for Modelling and Simulation, ECMS	1
TransNav	1
Transportation Research Part C: Emerging Technologies	2

Figure 5 shows the annual classification of articles involving oil supply chain optimization. In the last 10 years, the highest publication frequency was in 2020, up to 4 articles. Mostly only one relevant paper that were published in 2014, 2018, and 2021. For three years, there were no related articles published, namely in the years 2015, 2017, and 2023. In other years, there were only one to two articles that were published annually. A complete illustration is presented in Figure 5.

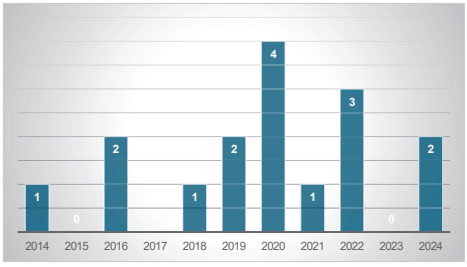

Figure 5. Classification of the Papers Based on Publication Year

Table 3 reveals that, out of the 16 carefully chosen and evaluated articles, 12 discussed topics regarding supply chain in the oil industry in which the utilized methods parallelly aligned. While four others covered a broader area other than supply chain such as social-economy, politics-governmental study, environment, safety risk, or geophysics.

Table 3. Article Classification According to Research Area

Article Name	Supply Chain Area	Non-Supply Chain Area
(W. N. K. W. Ahmad et al., 2016b)	V	
(Kisialiou et al., 2018)	V	
(Kisialiou et al., 2019)	V	
(Vieira et al., 2021)	V	
(Wang et al., 2022)	V	
(Sopot & Gribkovskaia, 2014)	V	
(Engelseth & Pettersen, 2016)	V	
(Scholvin, 2020)	V	
(Rossit et al., 2020)	V	
(Chen et al., 2022)		V
(Nathanael et al., 2024)		V

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(Ramírez & Anguiano, 2023)	V		
(Wongmayura & Wasusri, 2019)	V		
(Iaiani et al., 2024)			V
(Sharipov & Timofeev, 2020)			V
(Rutowicz, 2020)	V		

In Figure 6, we can see that out of the 12 articles focusing on the oil supply chain, most of them used optimization and other quantitative methods like statistics, heuristics and metaheuristics, and simulation. There were only six of them in which they performed optimization restricted to supply vessel routing and scheduling only. Fewer studies were known to utilize qualitative methods.

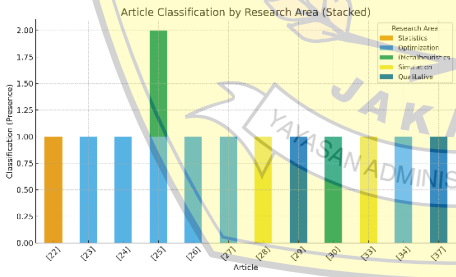

Figure 6. Article Classification According to Research Area

Oil supply chain optimization involves various methods and techniques that can be utilized to enhance efficiency, reduce costs, and improve decision-making. Various methods are commonly employed in the area of general supply chain. Mathematical modeling would be the foundation in maximizing allocation and minimizing costs while meeting constraints like resource availability. Simulation techniques such as Discrete Event Simulation (DES) and Monte Carlo may be used in optimization problems to capture supply chain uncertainty over time by allowing analysis of various scenarios and providing a wide range of potential outcomes. Near-optimum methods, such as heuristics and metaheuristics, are equipped with analytical approaches. There are a lot of algorithms available, including the popular Genetic Algorithms (GA) or Particle Swarm Optimization (PSO). Newer optimization methods are known through data analytics and machine learning implementation. We can provide predictive analytics using historical data to forecast demand and optimize inventory levels in the oil supply chain area. Further, blockchain technology can increase the transparency and traceability of oil industry operations by facilitating better collaboration among supply chain partners.

4. CONCLUSION

In summary, this study examined the written sources that discussed the oil supply chain through a bibliometric analysis. Although the literature search initially focused on the upstream of the oil supply chain, even for a wider area covering downstream and midstream, very few studies were found on logistics optimization. Following PRISMA protocol and utilizing PoP and VOSviewer softwares, investigating the network visualization, co-occurrence have identified in the terms of “optimization”, “oil”, and “gas industry”. However, they were not closely related, explaining that relevant studies have not been conducted much yet. While some optimization methods are applied in the oil supply chain, the number is not significant, and the topic coverage is very limited. This result demonstrates that while recent studies explored the oil supply chain, the gap is still wide, moreover to those related

to the logistics field. Other than that, there was also no literature discussing Indonesia's situation, leaving us numerous opportunities for a huge choice of case studies. We know that Indonesia is one of the important oil producers in the world and has great potential that can be exploited. Untouched basins hold the potential for very large oil reserves, which, if optimized properly, will bring significant benefits to the development of the country.

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