Model Development of a Downstreaming Policy for Crude Palm Oil for Domestic and Export Needs: A Systematic Literature Review and Future Agendas

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Abstract. The main product of palm oil plantations is CPO (HS 15111000) which can be processed into various derivative products. This research aims to examine research gaps and further research agendas for model development of a downstreaming policy for CPO for domestic and export needs at Indonesia. A systematic literature review with a meta-analysis (PRISMA) methodology was performed to evaluate the related articles discussing policy scenario for CPO downstreaming at Indonesia. This study found 104 articles that mapped the policy scenario for allocation and downstreaming of CPO at Indonesia over the last decade. In this research, bibliometric analysis was also carried out to determine the bibliometric network among the 104 articles studied. Mapping and clustering in bibliometric analysis was carried out using VOSviewer software. From the results of this research, several research gaps were obtained and can be used as a further research agenda, including: application of Soft System Dynamic Methodology (SSDM) approach to develop a CPO downstreaming policy model, determining a prediction model for decision indicators for CPO downstreaming policy, dynamic system simulation of CPO downstreaming policy, and CPO downstreaming policy strategy/scenario.

1 Introduction

Crude palm oil (CPO) is the primary output of oil palm plants with the Harmonized System code (HS 15111000) which can be processed into various derivative products, with the opportunity to increase added value through the development of the CPO downstreaming industry [1], with the lowest added value of downstream CPO products obtained from CPO products with added value between 20-50% and the highest added value obtained from specialty products such as: cosmetics, perfumes, detergents, paints, and pharmacy with added value up to 600%. While the added value for refined oil and oleofood is around 150%, for the added value of chemical products such as: glycerin, fatty alcohol, methylester, etc. can reach 200%, and for the added value of other CPO derivative products such as: surfactants, esters, soaps, lubricants, resins, etc. can reach 300% [2]. As part of Indonesia's

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industrialization strategy, downstreaming the domestic CPO industry is crucial to the long-term growth of the country's CPO sector [3]. This is in accordance with Vision 2045 so that Indonesia becomes the global hub for the production and consumption of goods derived from palm oil, so that it can become a global CPO price setter [4]. Through domestic downstreaming by processing CPO into higher added value products both for export purposes and as a substitute for imported products [3]. The further downstreaming product diversification is carried out, the more added value and variety it will provide, so the impact is very significant [5]. In actuality, though, Indonesia has solely focused on CPO exports thus far, so the added value is still minimal [6].

The refinery sector, which converts CPO into intermediate products that may then be processed further to produce additional downstreaming palm oil goods, is the entry point to the downstream palm oil market [3]. Before being processed into various downstreaming products, CPO goes through a CPO refining process to become Refined Palm Oil/RPO (HS 15119020) or Refined Bleached Deodorized Palm Oil/RBDPO (HS 15119036) [7]. In general, palm oil downstreaming in Indonesia are divided into three categories: biofuel, oleochemical, and oleofood [3-4], with a variety of downstreaming Indonesian palm oil products where in 2007 the number consisted of only 54 types of products, then in 2010 it increased to 72 types of products, and in 2018 it increased again to 158 types of products, while in 2021 the number of Indonesian palm oil downstreaming products was 168 types of products and in 2022 it increased to 179 types of products, and in 2030 it is expected that the number of Indonesian palm oil downstreaming products will be 200 types of products [4, 8].

Since Indonesia is the world's largest producer of palm oil, allocation issues for CPO product downstreaming are unavoidable, such as the problem of scarcity of cooking oil due to high demand and falling supply of cooking oil, It has caused the price of cooking oil in Indonesia to increase dramatically. In order to combat this, the government uses Minister of Trade Regulation Number 6 of 2022 to set the highest retail (HET) price for packaged palm cooking oil [9-10]. Another problem is that imports of CPO and CPO derivative products are still being carried out to meet domestic needs, with the amount of imports in 2018 amounting to 448,71 thousand tons with a value of US$ 454,18 million, in 2019 amounting to 454,26 thousand tons with a value of US$ 371,19 million, in 2020 amounting to 147,00 thousand tons with a value of US$ 212,27 million, in 2021 amounting to 129,39 thousand tons with a value of US$ 265,13 million, and in 2022 amounting to 131,13 thousand tons with a value of US$ 307,14 million. This indicates that the allocation for downstreaming CPO products is still less than optimal [11].

Apart from domestic needs, domestic CPO production is also exported to various countries, with exports in 2018 amounting to 35,72 million tons with a value of US$ 22,42 billion, in 2019 amounting to 36,29 million tons with a value of US$ 19,56 billion, in 2020 amounting to 33,00 million tons with a value of US$ 22,29 billion, in 2021 amounting to 34,79 million tons with a value of US$ 36,23 billion, and in 2022 amounting to 35,74 million tons with a value of US$ 40,46 billion [11]. Export revenues were obtained from almost 95% of the two main products, namely Crude Palm Oil with harmonized code is HS 15111000 and Other Palm Oil with harmonized code is HS 15119000. Currently, the amount of exports is dominated by semi-finished products, namely Refined Palm Oil with harmonized code is HS 15119020 [12].

Palm oil downstreaming strategies are divided into two, specifically a mix of import substitution (IS) and export promotion (EP), which together make up four different downstreaming strategy combinations. The amount of foreign cash saved as a result of import substitution must also be considered in evaluating the economic advantages of downstreaming and the palm oil sector overall, in addition to the amount of foreign exchange earned from exports [3, 13].

To develop the CPO downstreaming industry, there are several prerequisites, such as guaranteeing the availability of raw material supplies, which in this case is CPO, which includes price, quantity (allocation) and supply period. Apart from that, there is a need for guarantees or certainty of regulations that do not overlap regarding development, financing and supervision authority [14]. Until now there are no regulations or policies related to the amount (allocation) of CPO for the downstreaming CPO industry. Therefore, a model or instrument or regulation or policy regarding allocation for downstreaming CPO is needed.

There are several complex issues, full of uncertainty and conflicting issues that need to be immediately resolved. The potential for conflict in the allocation for downstreaming CPO requires a holistic resolution through a systems approach and research is needed that can propose the importance of developing a policy model for downstreaming CPO for domestic and export needs that uses policy analysis, statistical and econometric approaches to handle the issues involved various actors and uncertainty factors, soft and hard problems that demand to be resolved through a structured approach and accommodating all existing problems and objectives. Research that applies the Soft System Dynamic Methodology (SSDM) approach developed by [15] can accommodate various actors and factors in the system in the allocation problem for downstreaming CPO in Indonesia. The SSDM approach consists of 10 stages which are built not only on system and conceptual design, but also consider aspects that occur in the real world.

This research aims to examine research gaps and future research agendas for model development of a downstreaming policy for CPO for domestic and export needs at Indonesia.

2 Methodology

The goal of systematic literature reviews (SLR) is to provide an objective, methodical understanding of the body of existing literature. When addressing planned research questions, a systematic literature review (SLR) facilitates a thorough evaluation of pertinent findings and their interpretation with respect to the research topic. This method reduces bias, preserves consistency, and offers a solid foundation for analysis. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines were adhered to during the SLR process. The PRISMA approach is frequently used by preliminary researchers, who also make use of internet resources like as SCOPUS and Publish or Perish, which have particular requirements about publication date and language boundary [16].

2.1 Literature search

Finding bibliographic databases, descriptors or keywords, search strategies, and using peer-reviewed publications to keep an eye on the caliber of the papers in the sample are all part of the first step of the literature review. Restricting the search to publications that follow journal rankings is another method for guaranteeing the caliber and applicability of information sources.

Furthermore, to guarantee a thorough comprehension of the subject matter, publications associated with the study were examined in databases of popular literature. This database's inclusion attempts to cover a large body of literature and offer a comprehensive viewpoint. The digital databases Publish or Perish and Scopus are utilized. Keywords used include “Crude Palm Oil”, “CPO”, “CPO Allocation”, “CPO Downstreaming”, “CPO Model”, “CPO Policy”, “CPO Strategy”, and “CPO Scenario”.

For the previous 10 years, from 2013 to 2023, a search was carried out for academic publications and journals on policy scenarios in allocation and downstream for CPO. 3853 papers were found through the search; 1466 of these came from Scopus and 2387 from Publish or Perish.

2.2 Paper selection and assessment

To gather information, this study methodically looked through pertinent, peer-reviewed scholarly publications. To ascertain the evolution of crude palm oil (CPO) production and consumption, additional data were acquired from government papers or national and international research institutes. This study completed a systematic literature review (SLR) using the preferred reporting items for systematic reviews and meta-analysis (PRISMA) technique, as suggested in [17]. Fig. 1 shows the research flow that adheres to the PRISMA technique. A total of 104 papers were obtained from the PRISMA technique results, and these will be further examined.

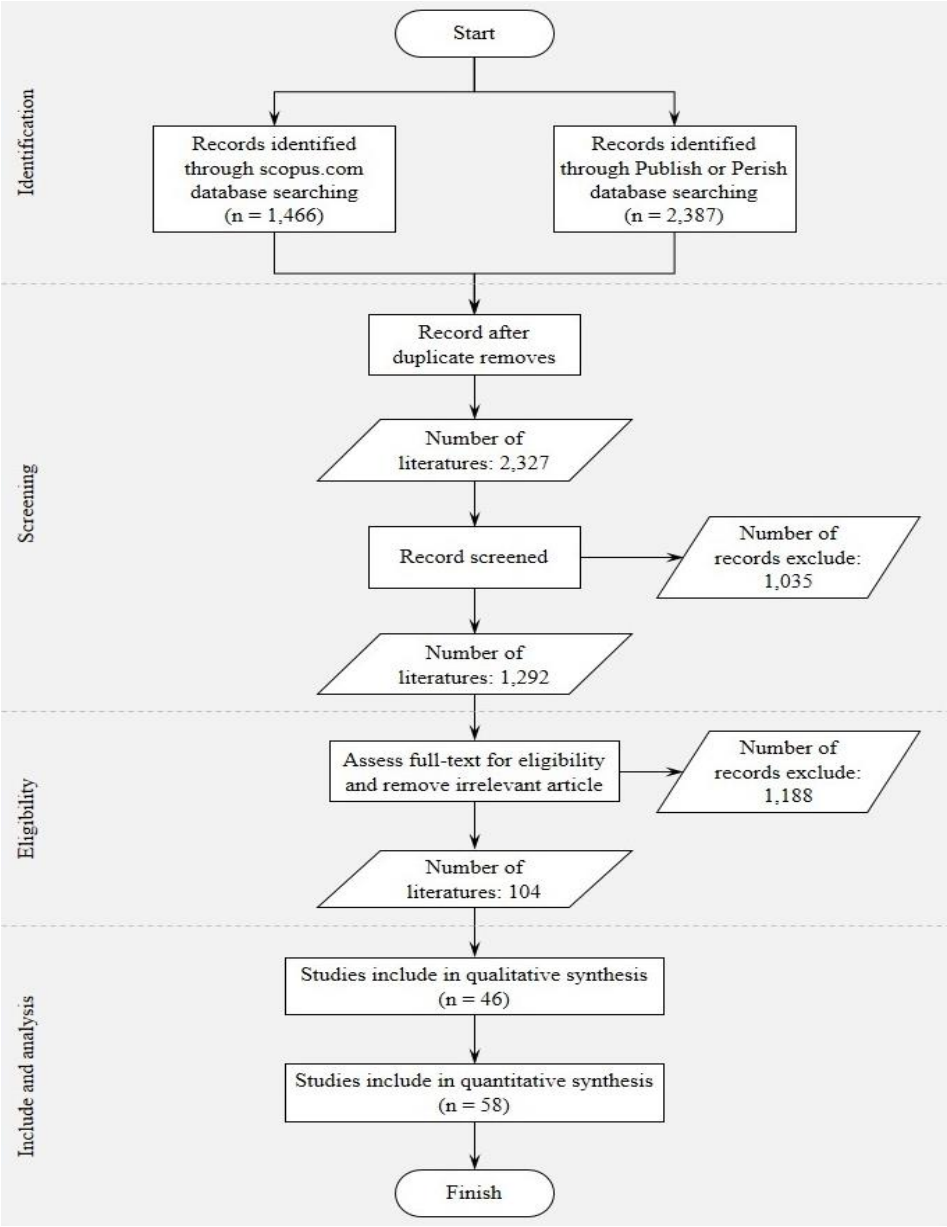

Fig. 1. Flowchart of systematic literature review, adapted from PRISMA

3 Result

3.1 Analysis and synthesis

104 papers about CPO allocation and downstream as well as policies for CPO allocation and downstreaming were assessed by the SLR method utilizing the PRISMA methodology from a variety of high-impact journals, including: Agricultural Economics (Czech Republic), Applied Sciences (Switzerland), Complexity, Energies, Heliyon, IEEE Access, International Journal of Energy Economics and Policy, International Journal of Sustainable Development and Planning, International Journal on Advanced Science, Engineering and Information Technology, Journal of Economic Structures, Journal of Oil Palm Research, Mathematical Problems in Engineering, Resources Policy, Sustainability (Switzerland), and Other. Fig. 2 shows the article distribution as specified by the publisher.

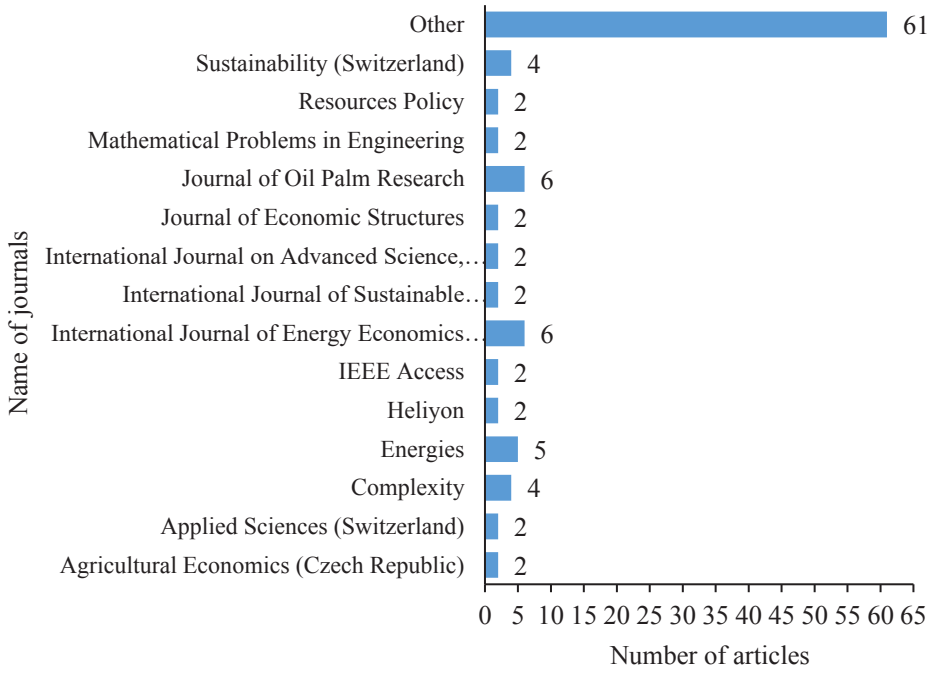

Fig. 2. Article distribution carried out by the publisher

Peer review analysis was done on all pertinent papers that were retrieved from the database for this study. A number of strategies are used, such as comparing, summarizing, synthesizing, and critiquing the complete article. The description, which includes the author, the year the article was published, the study region, CPO potential, CPO allocation and downstreaming, and CPO-related policies, is given in matrix form, illustrating the relationship between the various variables. Additionally, the analysis's findings serve as the foundation for suggestions for several approaches that can be used to address allocation and downstream requirements while taking socioeconomic, environmental, and policy factors into account.

This study conducted SLR on 104 articles published between 2013 and 2023, with the highest in 2021 being 27 articles and the next in 2022 being 26 articles, While the distribution of papers for other years may be seen in Fig. 3, which lists the articles according to the year of publication.

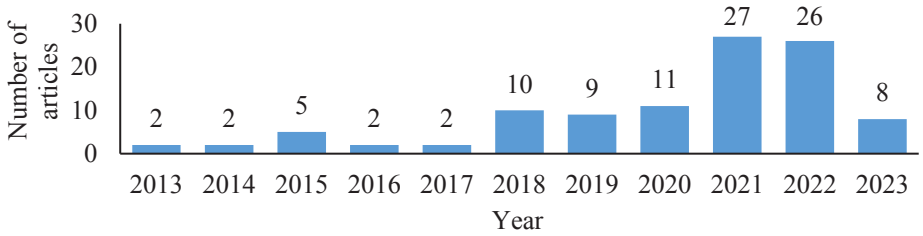

Fig. 3. Distribution of articles by the year of publication

In addition, the articles used in this SLR are limited to reputable journals that have quartile 1 (Q1) to quartile 3 (Q3), with the distribution of articles based on quartiles shown in Fig. 4.

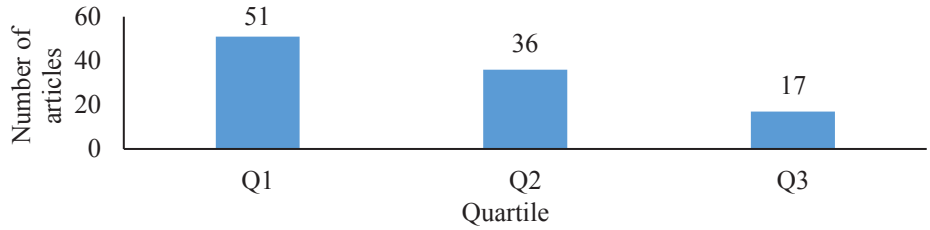

Fig. 4. Distribution of articles by quartile

From the 104 articles conducted by SLR, regions (countries) can be identified that were used as data in the study of these articles. There are 13 regions (countries) used as studies, with details of 50 articles studying Indonesia, 38 articles studying Malaysia, 5 articles each studying China and Thailand, 4 articles studying the USA, 3 articles each studying Brazil and Colombia, 2 articles studying India and 1 article each examines Ghana, Japan, Korea, Nigeria, Taiwan, the European Union and there are 8 articles that use web data, Fig. 5 displays the distribution of papers according to the area (country) under study.

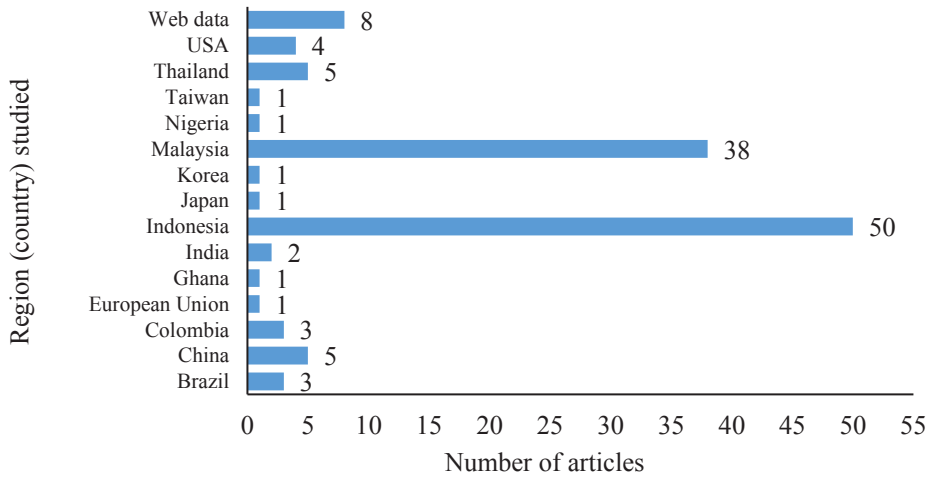

Fig. 5. Distribution of articles by region (country) studied

From the 104 articles conducted by SLR, there are 212 keywords used in the articles, with the highest keyword being palm oil which is contained in 25 articles, the next highest keyword is crude palm oil which is contained in 19 articles, for the distribution of other keywords you can see in Table 1.

Table 1. Article distribution determined on the keywords used

Keyword	Number of articles	Keyword	Number of articles
Biodiesel	6	Malaysia	4
Bioenergy	3	Market efficiency	2
Biofuels	2	Marketing margin	3
Biomass	2	Oil palm	5
Circular economy	2	Oleochemicals	3
Crude oil	6	Palm oil	25
Crude palm oil	19	Palm oil prices	2
Crude palm oil prices	2	Palm oil production	4
Deforestation	4	Spot-futures relation	2
Economic growth	2	Supply chain	2
Energy	2	Sustainability	10
European union	2	System dynamics modelling	2
Exchange rate	2	Thailand	2
Forecasting	6	Total factor productivity growth	2
Fuzzy time series	2	Value chain	2
Indonesia	8	Other	181

3.2 Research gap

In this SLR, bibliometric analysis is carried out, which according to [18] is a collection of quantitative techniques for monitoring, measuring, and evaluating scientific publications. Using visualizations such as networks, overlays, and densities, bibliometric analysis is performed with the goal of identifying the bibliometric network among the 104 articles that will be examined. VOSviewer was used to do mapping and grouping in bibliometric analysis. Using this mapping, one can obtain a comprehensive image of a bibliometric network's structure. Apart from that, To provide a summary or an understanding of bibliometric grouping, clustering is utilized.

Fig. 6 shows Network Visualization It describes the relationship or network between terms or keywords from 104 articles that were investigated in SLR between 2013-2023. The terms are organized into 19 clusters, and each keyword node's color indicates which cluster it belongs to. From network visualization, one of the networks or relationships between terms or keywords that is visualized is system dynamics modelling.

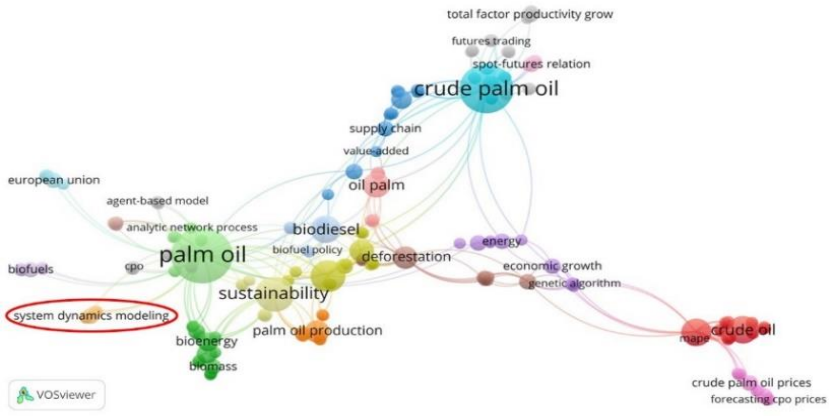

Fig. 6. Network visualization from VOSviewer

The following stage involves mapping and grouping research patterns from the 104 papers that were examined in SLR according to historical trends or the research's year of publication. The data derived from the Overlay Visualization outcomes is displayed in Fig. 7 between 2013-2023. The colors of the nodes in the overlay representation correspond to keywords that show the year of publication.

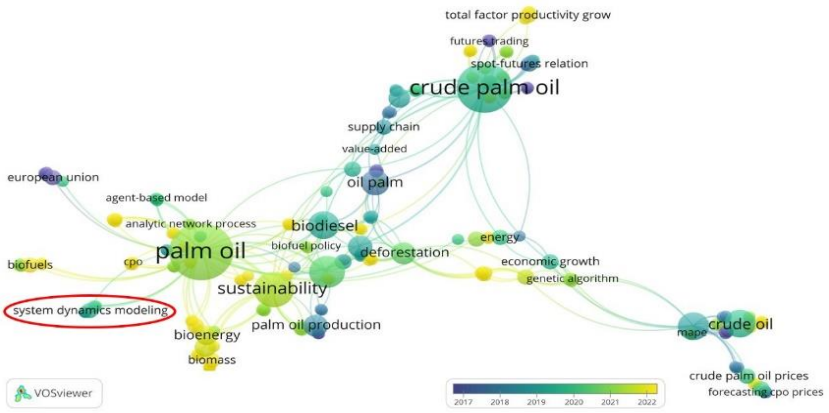

Fig. 7. Overlay visualization from VOSviewer

The terms "european union" and "spot-future relations" have purple nodes in Fig. 7, indicating that articles containing these terms were published in2013-2017. The dark blue nodes for the keywords "oil palm" and "palm oil production" indicate that publications with these terms were published in 2017-2018. The turquoise nodes for the keywords "crude palm oil", "crude oil", and "system dynamic modeling" indicate that papers with these terms were published in 2018-2019. The green nodes for the keywords “palm oil”, “deforestation”, “MAPE”, “economic growth”, and “energy” indicate that publications with these terms were published in 2019-2020. The light green nodes for the keywords “generic algorithm” and “sustainability”, indicating that papers with these terms were published in 2020-2021. Articles with the terms "biomass", "Biofuels" and "total factor productivity growth" have yellow nodes, indicating that they were published in 2021-2023.

The final visualization in VOSviewer is density it serves to illustrate the concentration or focus on research groups among the 104 SLR publications examined., as shown in Fig. 8.

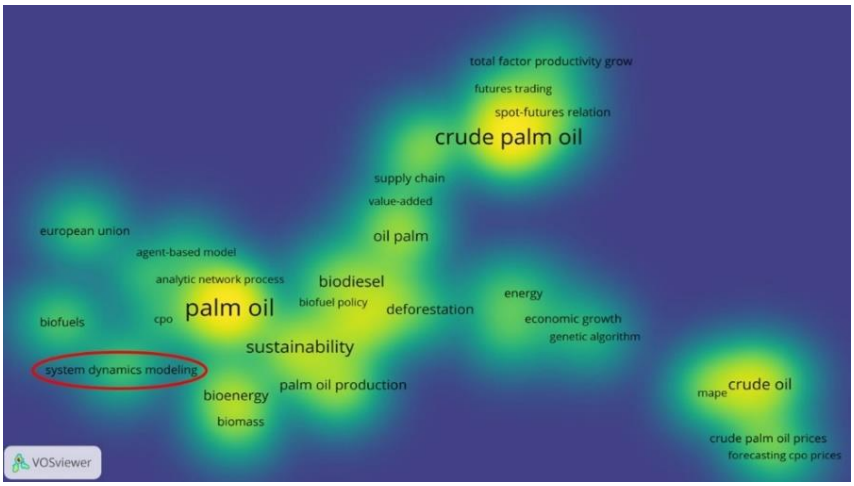

Fig. 8. Density visualization from VOSviewer

Density visualization can be used to determine which parts of research have been little done or which have been done a lot. From the density visualization results shown in Fig. 8 it is evident that each node is separated by regions that are either dense or highly dense. When a high degree of saturation is found in the quantity of keywords, it indicates that the topic has been well studied. An example of this would be the terms "palm oil", "crude palm oil" and "crude oil". Nodes highlighted in dark hue, on the other hand, show that little research has been done on these themes. Research on various issues, such as the keywords “system dynamics modelling”, “economic growth”, “biofuels”, “genetic algorithm” and “total factor productivity growth”, may become possible as a result.

4 Discussion

From the SLR study carried out, there are several themes that could be potential for future research, namely the use of the Soft System Dynamic Methodology (SSDM) approach to develop a CPO downstreaming policy model, where of the 104 articles studied, there was only one article that used SSDM, which was carried out by [19] using mathematical modeling and simulation, which depicts the long-term effects and interactions between variables and supply chain design factors, to assess and create a sustainable palm shell supply system.

Theme of determining a prediction model for decision indicators for CPO downstreaming policies can also be a potential for future research. From 104 articles reviewed in this SLR, no articles were found that discussed the prediction model for the amount of allocation for all downstreaming products from CPO. There are several articles that discuss prediction models, but not for the amount of CPO downstreaming allocation and generally only for one of the CPO downstreaming products, such as the article from [20] which discusses forecasting CPO consumption, the article from [21] which discusses predicting CPO demand, article from [22] which discusses prediction models for palm oil production potential, article from [28–33] which discusses forecasting CPO prices, article from [29] which discusses forecasting CPO futures and spot markets, and article from [30] which discusses forecasting CPO exports.

The theme of dynamic system simulation of CPO downstream policy can also be a potential for future research. From the 104 articles reviewed in this SLR, no articles were found that discussed the dynamic system simulation of CPO downstreaming policies for all downstreaming CPO products. There are several articles that discuss dynamic system simulations, but not for the amount of CPO downstream allocation and generally only for one of the CPO downstream products, as in the article from [31] which discusses dynamic simulation of the palm oil refining process using graphs, an article from [17, 19] which discusses system dynamic for biodiesel, an article from [34] which discusses system dynamic for empty fruit bunch, article from [35] which discusses system dynamics model of capital structure policy, article from [36] which discusses system dynamic for CPO supply chain management, and article from [37] which discusses system dynamics for production of CPO derivatives.

The theme of CPO downstreaming policy strategies/scenarios can also be a potential for future research. From the 104 articles reviewed in this SLR, no articles were found that discussed CPO downstreaming policy strategies/scenarios for all downstreaming CPO products. There are several articles that discuss CPO downstreaming policy strategies/scenarios, but not the amount of CPO downstreaming allocation and generally only for one of the CPO downstreaming products, such as articles from [40-41] which discusses policy for palm oil industry, articles from [17, 19, 42–45] which discusses policy for biodiesel, articles from [17] which discusses policy for bioenergy, articles from [44] which discusses policy for biofuel, articles from [45] which discusses policy regarding the duties that must be collected from exported CPO and its derivative products, articles from [30]

which discusses policy for CPO exports, articles from [46] which discusses policy for CPO price and production, articles from [47] which discusses methods for doing supply chain-wide study on oil palm, articles from [48] which discusses policy for palm oil future market, articles from [34, 51] which discusses policy for futures and spot markets, articles from [50] which discusses policy for sustainable palm oil supply, articles from [31, 53] which discusses techniques to support the CPO sector in adjusting to pricing fluctuations, articles from [36] which discusses policy to sustainable and profitable CPO supply chain management, and articles from [37] which discusses policy options to increase the use of products derived from palm oil.

From 104 articles reviewed with SLR, there has been no research discussing the model development of a downstreaming policy for CPO using SSDM, so this is a recommendation and challenge for future research. The use of SSDM which consists of 10 stages will produce a policy recommendation. However, the challenge that will be faced is implementing the results of policy recommendations, in this case there will be resistance from various parties related to palm oil.

5 Conclusion

After reviewing 104 articles using SLR, several research gaps were obtained and can be used as a future research agenda, including: application of Soft System Dynamic Methodology (SSDM) approach to develop a CPO downstreaming policy model, determining a prediction model for decision indicators for CPO downstreaming policy, dynamic system simulation of CPO downstreaming policy, and CPO downstreaming policy strategy/scenario.

There are several limitations to this research which uses SLR which reviews the model development of a downstreaming policy for CPO, including: this research only uses Q1-Q3 journal articles which were reviewed using SLR in the 2013-2023 period, seminar proceedings were not used in this research, and this research only reviews articles that discuss policies, strategies and scenarios for the downstreaming of CPO and CPO derivative products.

Several recommendations and challenges for future research from the results of this research which uses SLR which reviews the model development of a downstreaming policy for CPO, including: future research can add reputable indexed journal articles and seminar proceedings so that the SLR review can be more comprehensive, future research can add research articles from journals published in Indonesia or study results from palm oil associations in Indonesia, future research can add policies and regulations issued by the Indonesian government, and implementing the results of the development model is a challenge that will be faced by researchers, apart from that, rejection of the results of the development model is also a challenge that will be faced by researchers.

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