Indonesian Palm Oil Green Technology Development Strategy in the Industrial Revolution 4.0 Era

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Abstract

Climate change and ecological deterioration are driving factors in the Industrial Revolution 4.0 era's spread of environmental sustainability. To address these issues, green practices must be applied. The palm oil sector is one of the most major contributors to environmental degradation in Indonesia. The purpose of this study is to investigate Indonesia's strategy for developing green technology in the Industrial Revolution 4.0 era. The design of this study is qualitative, especially phenomenology. The findings demonstrate that developing green technology in Industry 4.0 can be accomplished through the application of strategies such as HAZOP, Digital Oil Field (DOF) technology, standards in POME processing through Combination of Open Lagoon Technology (COLT) and the use of e-concepts and practices. - governments at all levels, from regional to central, must adopt green finance.

Keywords: strategy, development, green technology, Industrial Revolution 4.0

1. Introduction

Climate change and ecological deterioration are catalysts for environmental sustainability to spread. To solve the environmental issues highlighted above, green practices must be introduced. Green information technology is a critical green practice since businesses and organizations rely on information technology (IT) for everyday operations (Attori et al., 2021). Particularly now that we have entered the Industrial Revolution 4.0 era, which is defined by the application of advanced information technology and programs that result in extraordinary and sustainable progress that has a direct impact on the economy, industry, social sector, government, and even politics (Kimura & Chen, 2018).

The Industrial Revolution 4.0 not only brought various opportunities and breakthroughs, but it also presented several problems and obstructions that must be overcome. The growing demand for global supply chains of palm oil in the agricultural sector leads to increased production, which has a detrimental impact on the environment and social economy. This is also demonstrated by the fact that 73 percent of land conflicts in Indonesia occurred in 2018. (Agrarian Reform Consortium, 2018). Additionally, the average emission created by oil palm plantation and fertilizer operations demonstrates some less-than-ideal environmental practices (Harimurti et al., 2021). Additionally, ICT usage has a detrimental influence on the environment, particularly

in terms of carbon emissions and hazardous waste. ICTs are predicted to contribute for 14% of worldwide carbon emissions to the environment, and if current trends continue, the global carbon contribution of ICTs is anticipated to grow tenfold by 2040. (Attori et al., 2021).

Green technology is increasing popularity year after year, and several studies have examined numerous elements of it. To get a better understanding of the present status of research into green technology in Indonesia, namely in the palm oil business. As such, this study will investigate Indonesia's strategy for developing green technology in the Industrial Revolution 4.0 period.

2. Methodology

This study's content and discussions are qualitative. The methodology employed is phenomenology, which has distinct methodological qualities and distinct approaches to and analyses of social phenomena (Bungin, 2015). This study is then discussed analytically descriptively by offering a thorough explanation of particular events associated with existing and occurring symptoms using secondary data, such as journal papers, reports, and website articles (Wirartha, 2006). The author analyzes the implications of the palm oil industry in the discussion section of this paper and then discusses the strategy for developing Indonesian palm oil green technology in the Industrial Revolution 4.0 era.

3. Result and Discussion

3.1 Negative Impact of Indonesian Palm Oil Expansion on Environment and Social

Palm oil is the world's third largest oil crop, accounting for 35% of worldwide vegetable oil output in 2019. This sector is an economically viable option in a number of tropical nations, as it produces the highest yields per hectare of any fatty oil. On the other side, Indonesia, the world's largest producer of palm oil, is one of the possible drivers of deforestation through large-scale palm oil production around the world, particularly in Southeast Asia (Austin et al., 2019).

According to research of Rodriguez et al which is depicted in the map above, there are over 1.2 billion oil palm trees in total and Indonesia covers an area of more than 15 million hectares (Rodrguez et al., 2021). This land expansion for oil palm growth has a negative influence on Indonesia's agrarian conflicts. According to Ayompe, there have been over 600 land conflicts in Indonesia between indigenous peoples and oil palm businesses since 2010. Additionally, other study indicates that 73% of land conflicts in Indonesia happened in the oil palm industry in 2018 and 8% in the forestry sector (Agrarian Reform Consortium, 2018). This tendency, according to Ayompe's explains why this sector has seen a 25% rise in the negative repercussions of land disputes analyzed in 2019. This research demonstrates how these concerns have an

effect on the community's economic and social situations (Ayompe et al., 2021).

In the environmental sector, research conducted by Harimurti et al. indicates that the average emission generated by oil palm plantation activities is 0.08 TCO2e/FFB/year, while fertilization activities generate 0.07 TCO2e/FFB/year (Harimurti et al., 2021). Although no scientific study has been conducted to determine how much the community's water deficit has decreased as a result of oil palm expansion, research conducted by Suryadi. The public view of water availability as a result of plantation growth is highly unfavorable, with 93 percent of respondents from 30 respondent families reporting a clean water problem, as well as a drop in water quantity and ground water level (Suryadi et al., 2020).

3.2 Positive Impact of Indonesian Palm Oil Development in the Industrial Revolution Era 4.0

Despite the negative effects, the expansion of the palm oil industry has aided economic prosperity in a number of nations that cultivate oil palm, notably in Southeast Asia. The palm oil industry's multifunctionality benefits not just Indonesia as a palm oil producer, but also the international society. This study discovered several beneficial consequences of palm oil growth, including a rise in income (33%) and employment (19%) for the majority of people living in developing nations, including palm oil producing countries (World Bank, 2018).

The global society, both directly and indirectly, benefits from Indonesian oil palm farms' multifunctional sustainability, which includes carbon dioxide, oxygen, and water cycle maintenance. According to research undertaken by Europe Economics, the European Union's usage of palm oil provides a sizable economic "cake" each year, meaning job possibilities for 117,000 people. In the 16 EU member states, palm oil consumption produces yearly revenues of 5.8 billion euros in gross domestic product and 2.6 billion euros in tax income. Italy, Spain, Germany, France, the Netherlands, and Finland are the continent's five largest economies, all of which rely on palm oil-related downstream sectors. Additionally, palm oil is utilized for energy reasons, such as biodiesel and electricity generation, with the remaining 60% being used for food, cosmetic components, and toiletries (Tungkot Sipayung & Purba, 2015) (Haryanti et al., 2021).

According to Edwards (2019), the palm oil sector has aided in the emancipation of 2.6 million rural Indonesians from poverty (Edwards, 2019). Other research indicate that oil palm fields have also benefited from reforestation. This was stated in a scientific paper by Jan Horas V. Purba and Tungkot Sipayung, who cited a Landsat Citra analysis, stating that approximately 7.9 million hectares of Indonesian oil palm plantations were reforested in 2013 (land conversion agriculture and abandoned land/shrubs), while 2.5 million hectares were deforested (conversion production forest). According to this study, the rise of oil palm plantations coincided with an increase in reforestation, having a substantial ecological impact (Purba &

Sipayung, 2017).

3.3 Indonesian Palm Oil Green Technology Development Strategy in the Industrial Revolution Era 4.0

The HAZOP (A Hazard and Operability Analysis) technique might well be utilized to ensure a systematic and complete evaluation while adhering to green and sustainable technology requirements when finding solutions for palm oil development in Industry 4.0. This comprehensive HAZOP review technique may be used to the green technology sustainable strategy of the palm oil business. This is due to the fact that HAZOP may enable thorough system inspections and expose possible weaknesses by utilizing IoT (Internet of Things) devices, intelligent processing and monitoring, intelligent prediction, cloud computing, traceability, and smart contracts (Lim et al., 2021).

The DOF (Digital Oil Field) technology is a green technology that can integrate data, automation, and instrumentation to create a realistic image of field processes, allowing for proactive interventions to eliminate production delays. This technology is often employed in the energy and oil and gas industries. However, the researcher believes that this technology should also be developed in the agrarian and plantation sectors, including oil palm, which are in desperate need of real-time monitoring systems for production optimization, better asset integrity management, and, most importantly, overall worker safety and security. achieve substantial cost reductions (Kanu & Afolabi, 2020).

Palm oil mill effluent (also known as POME (Palm Oil Mill Effluent)) is a key issue for this industry. As a result, the palm oil sector, which is being researched by the Roundtable on Sustainable Palm Oil (RSPO) and the Indonesian Sustainable Palm Oil (ISPO), must have guidelines in POME processing in order to reduce greenhouse gas emissions. An alternate technique in Palm oil waste processing is the combination of open lagoon technology (COLT) with composting, biogas technology, composting, biogas technology with membrane and biogas technology, and land usage. According to Ansori Nasution, the highest priority weight is COLT-Biogas plus composting technology, which has a score of 0.470 and can be considered by palm oil industry decision makers when choosing environmentally friendly POME therapy in order to implement sustainable values in the coconut sector palm oil (Nasution et al., 2020).

At the national level, the Presidential Staff Office has two e-government programs, One Data and One Map. The provincial and municipal or district levels use a similar method, with certain modifications to meet their specific demands. Unfortunately, there is currently a scarcity of studies to analyze and measure its overall efficacy on this system. According to Lee (2011)'s research (Perdana, 2020), based on the idea and practice of e-government in Korea, e-government aspires to connect industrial growth, foster a welcoming environment, and business that may contribute to economic development. In this example, central and

regional leadership can utilize e-government to create and monitor pro-poor initiatives for smallholders or smallholders in the oil palm sector. The author emphasizes that this e-government system has the potential to reduce bureaucracy in all development areas, including sustainable oil palm development.

Another strategy the government might employ to promote green technology development in Indonesia is "green funding." Green finance is a new branch of finance that is used to integrate environmental conservation with global aims and economic rewards. The word encompasses a broad variety of technologies, initiatives, and enterprises, the majority of which are associated with nature, habitats, and places, indicating that it is a viable idea for balancing environmental shrinkage caused by carbon uptake in the atmosphere (Ili et al., 2020). Green finance in the palm oil business may be implemented by establishing green carbon reduction initiatives that connect the financial sector, enhance palm oil output, and boost the country's economic growth, which is critical for the industry's long-term sustainable development.

The researchers examine the obstacles and potential associated with transitioning Indonesia's small-scale palm oil sector to organic farms, where intense use of Green Revolution technology results in substantial environmental costs (Fritz et al., 2021). According to the researcher, a transdisciplinary approach based on 'systems knowledge', 'target knowledge', and 'transformation knowledge' from academics and practitioners is required to find feasible routes to organic palm oil farms. All impediments, value and belief systems, and institutional structures, including rules and regulations at all levels, must be overcome, driven by an inclusive approach designed in a participatory way.

4. Conclusion

The Industrial Revolution 4.0 highlighted not only numerous opportunities and innovations, but also threats and impediments that must be handled. While the oil palm development phenomena has had negative consequences, various studies have shown beneficial and multifunctional consequences not only for Indonesia as a palm oil producer, but also for the international community. To identify green technology development solutions for Industry 4.0, researchers employ applied strategies such as the Hazard Analysis and Critical Control Point (HAZOP) method, Digital Oil Field (DOF) technology, standards in POME processing as through (Combination of Open Lagoon Technology / COLT), and the use of e-government concepts and practices at the regional to central level, as well as green financing. The researcher finds that this technique has the potential to maximize the potential of Indonesia's palm oil sector while also promoting sustainable development.

Acknowledgements

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Appendix A. An example appendix

Authors including an appendix section should do so after References section. Multiple appendices should all have headings in the style used above. They will automatically be ordered A, B, C etc.

A.1. Example of a sub-heading within an appendix

There is also the option to include a subheading within the Appendix if you wish.