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Beyond Growth: Examining the Intersections of Development, Poverty, and Freedom towards Decarbonization of South-East Asian Region

Zul Ilham

EDITOR

The Southeast Asian region stands at a pivotal crossroads. Buoyed by rapid economic growth, it grapples with the mounting challenges of environmental degradation, persistent poverty, and uneven development. This summary delves into these complexities, drawing from eight distinct yet interconnected studies in this December 2023 issue of The Journal of Indonesia Sustainable Development Planning to illuminate pathways towards a more sustainable and equitable future.

At the heart of this exploration lies the fundamental question: is unbridled economic expansion compatible with environmental protection and social justice? Research papers “How New Green Technologies are Changing the Indonesian Economy” by Jastacia et al. and “Exploring Sustainable Economic Growth: Promoting Green Development Productivity through Decentralized Environmental Policy and Regional Competitiveness” by Fajri et al. offer promising answers. They showcase how "New Green Technologies" are transforming the Indonesian economy, paving the way for "Promoting Green Development Productivity" through decentralized environmental policies and regional competitiveness. This shift, however, hinges on effective regulatory frameworks. On the other hand, Paper “Regulation on The Utilization of Carbon Services as A Forest Protection Effort in Indonesia” by Siagian et al. explores how "Regulation on The Utilization of Carbon Services" can incentivize forest protection, a crucial step in mitigating climate change and preserving valuable ecosystems.

Moving beyond mere economic metrics, the book review “*Poverty and Freedom: Case Studies on Global Economic Development”* by Komang Ariyanto and policy paper “Overview of Informal Sector Workers Viewed from Education Variables” by Dodi Satriawan remind us that human well-being remains the ultimate measure of progress. Koman Ariyanto in his book review underscores the intricate link

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between poverty and lack of agency. Similarly, Dodi Satriawan's policy paper highlights the marginalization and vulnerabilities faced by informal workers, often trapped in a cycle of poverty due to limited educational opportunities.

The search for sustainable solutions demands inclusive approaches that empower local communities. The research paper with the title " Examining Biogas Potential from Rotting Fruits for Advanced Waste Management, Environmental Conservation, and Sustainable Energy Generation" by Nugraha et al., provides a shining example. This study demonstrates how a community-based cooperative effectively tackled waste management, fostering both environmental responsibility and economic empowerment. Similarly, a commentary "Friend or Foe: Internet to Indigenous People in Indonesia (Lesson Learned from Inner Baduy Request for Internet Blackout)", emphasizes the importance of respecting and learning from indigenous communities as we navigate technological advancements. Zone-based tourism planning, as discussed in research paper, "Zone-Based Tourism Planning Using Satellite Imagery" by Kurniawansyah et al. offers another avenue for inclusive development, ensuring responsible tourism practices that benefit local communities and ecosystems.

In conclusion, this collective examination reveals a complex tapestry of challenges and opportunities for us. Embracing "Beyond Growth" as a guiding principle necessitates forging a new development paradigm, particularly for the Southeast Asian region. One that prioritizes environmental sustainability, empowers marginalized communities, and celebrates our diverse cultural values. By harnessing the potential of green technologies, decentralized policies, and community-driven initiatives, the Southeast Asian region can chart a course towards a future where decarbonization, shared prosperity, and individual freedoms converge. As we are preparing to strategize for the new year 2024, it should be reiterated that this path demands not just policy shifts and technological advancements, but a fundamental recalibration of our priorities, recognizing that true progress lies in fostering a relationship of symbiosis between humanity and the environment. Only then can we build a truly just and sustainable future for the region and beyond.

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How New Green Technologies are Changing the Indonesian Economy

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Abstract

Rapid disruption simplifies company performance improvement. Instead, businesses must be conscious of environmental risks. Innovation in green technology is a business strategy for preventing environmental damage. However, few studies have investigated the internal mechanisms and underlying factors that link ecological innovation to corporate financial performance. The methodology of this research used content analysis to examine companies listed on the IDX in the manufacturing sector with heavy pollution. In addition, it is important to learn that developing more eco-friendly processes and merchandise can boost a business's bottom line. In addition, the company's green reputation could mitigate the effects of innovative green products and new green processes on the bottom line. The results can provide valuable input and recommendations for effectively implementing green technology in Indonesia.

Keywords: green technology innovation; environmental risk; financial performance.

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1. Introduction

Environmental concerns at the national level continue to grow. The preservation of the environment is a critical concern for manufacturing companies, given the substantial accountability they have for their environmental impact. In addition to taking consumer needs and corporate social responsibility into account, according to Liu et al. (2021), pollution is evidence of a corporation's accountability in its pursuit of financial gain. Green technology, which is environmentally benign, is the optimal option for mitigating the effects of pollutants. As a result, green innovation is crucial for addressing environmental issues. Additionally, it has the potential to enhance the market competitiveness of environmentally aware corporate entities. Furthermore, according to Rekik & Bergeron (2017), micro, small, and medium-sized businesses benefit greatly from the implementation of green technology because it restricts environmental exploitation and promotes technological modernization on an economic level. Sahoo et al. (2023) argue that organizations need contemporary knowledge and technology to effectively implement environmentally favorable technological advancements. In addition to incorporating ecologically sustainable approaches, the procedure itself yields environmental benefits (Dragomir, 2020).

Although there is a wealth of international research on the health effects of air pollution, Jakarta, Indonesia, has a dearth of local data regarding the financial toll it imposes. Air pollution impacts over 10.5 million inhabitants in Jakarta. According to data from the DKI Jakarta Provincial Environmental Agency, Jakarta has the maximum annual ambient PM2.5 concentration in Indonesia. The World Health Organization (WHO) states that air pollution causes respiratory disease, cardiovascular disease, and cancer (World Health Organization, 2022). Moreover, the Institute for Health Metrics and Evaluation, (2019) adds that air pollution in Jakarta was responsible for 5,054 fatalities (equivalent to a rate of 54 per 100,000 individuals) and 168,000 years of illness, disability, or premature mortality. Therefore, Indonesia is motivated to adopt green technology to mitigate pollution and address other environmental issues. Indonesia is also home to numerous sectors, including industry, transportation, agriculture, and energy, which collectively contribute to air, water, and land pollution and have a significant environmental impact. Air pollution in major cities such as Jakarta raises concerns about environmental devastation and public health (Syuhada et al., 2023).

Additionally, this occurrence will exacerbate worldwide climate change. Technologies that are favorable to the environment can mitigate these effects. In addition, environmentally sustainable product development and management practices serve as substantial indicators of a firm's performance. Furthermore, the expansion of green technological innovation across all industries is accelerating (Li & Wang, 2022). Nevertheless, despite this innovation's potential, conventional systems continue to provide an extensive array of eco-friendly markets. Enterprises dedicated to environmental sustainability contrast with conventional systems (Wicki & Hansen, 2019). Tidd & Bessant (2018) argue that green technology innovation is considered revolutionary because it diverges from business and market trends and incorporates significant and unpredictable variables. Additionally, Schot (2020) asserts that the majority of businesses continue to disregard environmentally responsible innovation. Fernando & Wah (2017) argue that the favorable consequences of environmentally sustainable innovation have prompted established companies to adapt. Moreover, the matter of uncertain climate change underscores the criticality of innovation in environmentally sustainable management (Wang et al., 2023). This represents an endeavor to mitigate environmental contamination through the implementation of diverse degrees of innovation, including ramifications for business operations, manufacturing procedures, and marketing strategies (Rezende et al., 2019).

In order to address the aforementioned research void and offer further understanding regarding the extent to which environmentally sustainable technological advancements benefit organizations, it is necessary to conduct a comprehensive analysis that identifies the determinants of the performance benefits that green technology implements. Hence, this study aims to investigate how ecological management inventiveness, green innovation in goods, and process innovation contribute to enhancing corporate performance. Content analysis will explore the moderating influence of green image, providing more precise and meaningful insights for organizations, the environment, and society regarding the implementation of green technology innovations.

2. Methods

2.1 Research Design

This study employs quantitative research methods to examine the relationship between financial performance (Y) and green technology innovation, with financial reports of companies serving as the independent variable (X). In addition, green image serves as a mediating variable in determining the effect of environmentally favorable technological innovations implemented by businesses. In August 2022, researchers at Beijing University of Chemical Technology (BUCT) conducted a study to determine the impact of implementing green technology innovation in Indonesia on the evidence and determinants of research findings in China. We employed purposive sampling to select companies for the sample based on their registration on the IDX and their adoption of environmentally favorable technological innovations. This research investigates not only the significance of the correlation between environmentally sustainable process innovation and financial performance but also the applicability of such processes. This analysis examines how proactively implementing sustainable practices can yield economic benefits for businesses, including cost effectiveness, product innovation, reputation enhancement, and brand development. Green technology principles guide the environmentally conscious processes employed by a company, resulting in these advantages. Therefore, the researchers developed a number of hypotheses for this study, including:

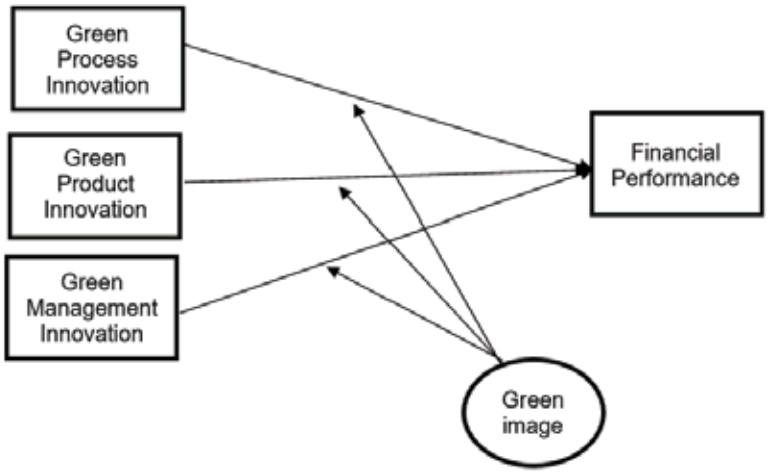

Figure. 1. *Theoretical Framework (Researcher, 2023)*

H_1: The green innovation in process is a significant effect on financial performance
H_2: Green process development positively affect the financial performance.
H_3: Innovation in green management has a beneficial impact on financial performance.
H_4: Green image connects green innovation in processes to financial performance.
H_5: Green image mediates the relationship between for new green products and financial performance
H_6: The green image plays the role of a mediator in the relation across managerial innovation and financial performance.

2.2 Collecting Data

Researchers gathered data by verifying the environmental protection status granted to different business sectors by the Indonesian Ministry of Environment. Furthermore, the verification process will exclude organizations that fail to disclose social responsibility reports, which are mandatory for gathering information on environmentally sustainable product innovation, environmentally sustainable management innovation, and environmentally sustainable image. Studying in further depth how developments in sustainable innovations have influenced business results by utilizing content analysis on company annual reports to extract control variables including financial constraints, total asset turnover, age, and company size. Due to the potential impact on financial performance. We will gather information regarding environmentally friendly product innovation and environmentally friendly management innovation through manual content analysis. Two programmers subsequently encoded the data.

Researchers ascertain the dependence of the two variables by calculating Krippendorff alpha, utilizing an expected value of 0.67 or higher (Hussain et al., 2018). According to Henseler et al., (2015), the HTMT heterotrait macro feature in SPSS is valid for data processing.

2.3 Variables

2.3.1. Dependent variable: financial performance

The return on assets ratio serves as the dependent variable to observe a company's performance, ensuring stable and reliable financial performance. ROA can reflect returns on the Islamic capital market and measure other financial performance that has an impact on company management (Jastacia et al., 2021).

2.3.2 Independent variable: green product innovation and green management innovation

According to Kiefer et al. (2019) (see Table 1), they propose to use them to evaluate product innovation technology. Corporate social an overview of a Company's Responsibility Report (CSR) as an innovative green process using the content analysis method, where each item is scored from 0 to 2: 0 if no associated description, 1 if a single apparent explanation with no actionable details (e.g., complete strategies, execution procedures, or measurable demands, as such proving an organization actually follows pursuits), and 2 if there is a connected description with detail on implementation

Table 1: Measurement and Variables

Variables	Measurements	Data sources	Sources
Financial performance	Return on Asset (ROA)	Firm's Annual Reports	Jastacia et al., (2021)
Green product innovation	Changing product design to avoid harmful or poisonous substances during production or to enhance energy efficiency during utilization	Firm's Corporate Social Responsibility Reports	Kumar et al., (2021)
Green management innovation	Implement advance environment and energy management making a major change to the organization, such management structure or integrating different department	Firm's Corporate Social Responsibility Report	Ma et al., (2018)

Source: Kiefer et al., (2019)

3. Results and Discussions

3.1 Data and Sample

This study's technical analysis employed purposive sampling of companies suspected of having environmental contact. We obtained 20 suitable and ready-to-analyze industry companies (see Table 2) from the IDX for the period 2016–2021, as well as company financial reports for return on assets, debt, DER, turnover, age, and company size.

Table 2.: List of Samples

Name of Company	Description
PT PLN (Persero)	In the development of renewable energy solutions and the evaluation of energy efficiency
PT Pertamina (Persero)	In identifying the environmental impacts of oil and gas operations and their efforts to reduce these impacts.
PT Astra International Tbk	In monitoring fuel efficiency and environmentally responsible practices in the as an automotive industry.
PT Unilever Indonesia Tbk	regarding the monitoring of the environmental impact of the retail product supply chain and sustainable initiatives.

Table 2. Continued

Name of Company	Description
PT Indofood CBP Sukses Makmur Tbk	In the analysis of the environmental impact of food and drink products.
PT Bank Rakyat Indonesia (Persero) Tbk	In assessing the positive impact of green banking initiatives and sustainable finance programs, we consider the following factors.
PT Telkom Indonesia Tbk	In analyzing the energy efficacy of ICT infrastructure.
PT Adaro Energy Tbk	In assessing the environmental impact of coal mining and the mitigation strategies implemented.
PT Danone Aqua Tbk	Monitoring the environmental impact of the distilled water industry and its adoption of sustainable practices.
PT HM Sampoerna Tbk	In assessing the environmental impact of the tobacco industry and their sustainability efforts.
PT Semen Indonesia (Persero) Tbk	In analyzing cement production's carbon emissions and their efforts to reduce them,
PT Matahari Department Store Tbk	In monitoring products' carbon footprints and their efforts to reduce plastic pollution.
PT Kalbe Farma Tbk	In evaluating the environmental impact of the pharmaceutical industry and their ongoing efforts.
PT Vale Indonesia Tbk	Monitoring the environmental effects of nickel extraction and associated mitigation measures.
PT Gudang Garam Tbk	In monitoring the effects of the tobacco industry and their efforts to be socially and environmentally responsible.
PT Blue Bird Tbk	In analyzing the fuel economy and administration of public vehicle fleets.
PT Geo Dipa Energi (Persero)	In monitoring water quality for waste and water conservation initiatives.
PT Pan Brothers Tbk	In the analysis of the product's life cycle and their endeavors to reduce the environmental impact of products, the life cycle of the product is considered.

Source: IDX, 2023

The accumulation of data for analysis of green technology will aid these businesses in measuring, monitoring, and enhancing their sustainable practices, as well as in taking more effective steps towards green development in Indonesia.

3.2 Description Analysis

Table 3 presents the classifiers for the variable and the values of the correlation. An intrinsic correlation exists between green management innovation and green product innovation. In addition, the findings indicate that financial performance and green management have a related value of up to 840. Moreover, green product innovation accounts for 741.29 percent of the mean data.

Table 3. Descriptive Statistic and Correlations

Variables	Descriptive statistics		Correlations	
	Mean	SD	1	2
Financial Performance	604.73	841.154		
Green Product Innovation	741.29	536.574	1.000	-.071**
Green Management innovation	945.24	848.072	-.071**	1.000

** Correlation is significant at the 0.05 le.05 level (2-tailed)

3.3 Normality and Reliability Test

The researchers obtained the data regarding the impact of green product innovation and green management innovation on financial performance through content analysis. Two programmers subsequently encoded the data. Hussain et al. (2018), computed Krippendorff's alpha to assess the reliability of the aforementioned three variables' data. In order to draw meaningful conclusions, the alpha value needs to exceed 0.67. We implemented the KAPALPHA criteria in SPSS to compute Krippendorff's alpha. As recommended by Nili et al. (2020), two coders assigned codes to sixty reports, and we assessed inter-coder reliability through the analysis of this data. Krippendorff's alpha values for the green product innovation and green image indices all exceeded the threshold value of 0.67, providing further evidence for the dependability of the data.

Table 4: Normality Test

	Minimum	Maximum	Mean	Std. Deviation	N
Residual	-1004931776.000	8450805760.000	.000	1519486397.685	51
Std. Predicted Value	-1.704	1.395	.000	1.000	51
Std. Residual	-.648	5.449	.000	.980	51
Test Statistic	0.119				
Asymp. Sig. (2-tailed)	0.116				

a. Dependent Variable: FP

Table 5: Reliability Test

Reliability Statistics
Cronbach's Alpha
.814

Table 4 and 5 display the normality and reliability test of green technology innovation. The test for normality uses the Kolmogorov-Smirnov test with a single sample. The results in Table 4 indicate that the data in this study meet the normality test criteria, suggesting that they follow a normal distribution. Therefore, a significance value (Asymp, Sig.) of 0.116 > 0.05 (see Table 4) suggests that the data follows a normal distribution. In addition, Table 5 shows that the value of Cronbach alpha was 0.814. The value of Cronbach alpha, which is greater than 0.67, indicates that it is reliable.

Table 6: Regression results

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6003674556948 241400.000	2	3001837278474 120700.000	1.248	.296[b]
	Residual	1154419456374 20500000.000	48	2405040534112 927200.000		
	Total	1214456201943 68730000.000	50			

a. Dependent Variable: FP
b. Predictor (Constant), GM, GPI

Table 6. Continued

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence
		B	Std. Error	Beta	t	Sig.	Lower Bound
1	(Constant)	-1520,348	5034,338		-0,302	.764	-116.466.612
	GPI	.062	.053	.167	1.186	.241	-0,043
	GM	.444	.464	.135	.957	.343	-0,489

a. Dependent Variable: FP

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.222[a]	.049	.010	1550819310.59	1.908

a. Predictors: (Constant), GM, GPI
b. Dependent Variable: FP

The findings presented in Table 6, which were derived from the SPSS analysis, indicate that neither green product innovation (GPI) nor green management innovation (GMI) significantly impact the performance of the organization, with a mere 4.9% variance. This renders the implementation of green innovation technology in Indonesia potentially fruitful, with only a minority of green innovation products and green innovation management failing to influence the performance of the organization. Therefore, the advancement of green technology in Indonesia has the potential to generate novel products that are more sustainable (Hu et al., 2021).

3.4 Innovation in Green Products and Green Management

Good green management innovation is required for the proper adoption of innovative ecological products, including the development of strategies to increase product differentiation. Additionally, green product innovation with a substantial market share can have a positive effect on green management innovation. As a result, in order to enhance financial performance, the business community in Indonesia must develop environmentally sustainable product innovations and management practices. Sellitto et al. (2020), concur that a cohort of furniture manufacturers in Brazil may enhance their operational efficiency through the introduction of environmentally friendly products. In addition, this strategic move fosters a positive corporate image and broadens the market segment, which aligns with the growing public concern for ecological conservation. Additionally, it can decrease business expenses. Green innovation ultimately represents a concerted effort by businesses to mitigate their environmental footprint and pollution levels. Ouyang et al. (2020), concur that air pollution has the potential to impact a company's Total Factor Productivity (TFP). Therefore, adopting green innovation offers consumers a fresh perspective, decreases organizational expenses, and contributes to environmental sustainability. Additionally, Liao (2018) emphasized that environmentally responsible innovation has a positive effect on financial performance and mitigates the adverse environmental effects of global activities in the Chinese automotive industry. Consequently, environmentally responsible innovation correlates with an organization's success. Therefore, organizations can utilize this innovation in environmentally friendly products to promote environmental management performance and safeguard the adjacent environment.

Four performance metrics pertaining to environmentally responsible product innovation are available for consideration by businesses. Companies begin by selecting products that exhibit minimal polluting tendencies during the process of product development or design. Following this, businesses select product materials that require the least quantity of resources and energy during product development or design. Thirdly, companies minimize the use of materials in the production and development of product designs. Companies must ultimately give careful consideration to a number of factors during the process of product development. For example, if products are easily recyclable, reusable, and decomposable, they

are considered environmentally favorable (Liu et al., 2021). The objective of environmentally sustainable product innovation is to modify and alter products in multiple ways. As a consequence, novel perspectives are required concerning the quantity of life cycles, the manufacturing-to-distribution process, and the implementation of product mechanisms. Moreover, environmentally sustainable products may have associations with sectors that have a propensity to generate pollution. Organizations require cutting-edge products that feature enhanced longevity and capacity for recycling (Xie et al., 2019). As a result, the organization will mitigate recurring production expenses due to the product's reusability.

3.5 Sustainable New Products and Image Impact on Firm Performance

Innovations in environmentally sustainable management have a substantial impact on financial performance. According to Khan et al. (2021), the development of green products requires green management innovation. Because employees and upper management are able to assist in the implementation of environmentally favourable technological innovations, this also entails the implementation of ecological management practices. Conversely, Kanda et al. (2020), assert that there is a lack of consensus within the operations management community regarding green production. In contrast, researchers and practitioners of conventional production operations management may be more unfamiliar with the terms, concepts, and methodologies associated with "green" than the sustainability community.

Literature, theory, and empirical evidence support the influence of market, regulatory, and economic conditions on technological progress (Ouyang et al., 2020). Xie et al. (2019), conducted a study to investigate the effect of green technology implementation on the financial performance of businesses. The researchers then focus on the paradigm that corporations employ in relation to sustainability and innovation. Furthermore, market failure is a factor in reducing emissions and encouraging the implementation of environmentally responsible solutions. According to Dangelico & Vocalelli (2017), a green image signifies a business's commitment to and care for the environment. Moreover, the organization will experience an increase in customer loyalty and a positive impact on public perception (Schot, 2020). Indeed, consumers are now willing to pay a premium for products that are environmentally beneficial (Xie et al., 2019). However, there are still certain deficiencies and constraints, such as the relatively limited number of businesses considered environmentally conscious (Przychodzen et al., 2020). Moreover, a dearth of literature reviews exists concerning ecological innovation in Indonesia. Therefore, these results may serve as a benchmark for assessing the impact of environmentally sustainable product development, environmentally favorable innovation, and environmentally sustainable management in Indonesia.

3.6 Economic Benefit of Green Technologies

Job creation: The green economy is expected to create millions of new jobs in Indonesia

Green economic policy implementation in Indonesia is expected to boost job growth. The staffing needs of many different fields, including renewable energy, energy efficiency, sustainable transportation, waste management, and sustainable agriculture, present the potential for the green economy to create both direct and indirect employment opportunities (Sulich & Sołoducho-Pelc, 2022). Apart from that, Miao et al. (2023) also highlighted that the green economy in the future is projected to have an overall favorable influence. However, trained and competent workers are required for the green economy transition (Napathorn, 2022). Another big issue in Indonesia is the requirement for transition funding. Developing new eco-friendly technologies and infrastructure requires substantial resources (Gobena & Kant, 2022). Nonetheless, Indonesia can use and advance green technologies (Rhofita et al., 2022). As a result of economic diversification, Indonesia will be less reliant on fossil fuels and will have a smaller impact on the environment (Rahman et al., 2021).

Economic diversification: Green technologies can help Indonesia reduce its reliance on fossil fuels and diversify its economy

By 2021, Indonesia will have overtaken the United States as a major consumer and producer of fossil fuels (Herindrasti, 2022). Despite this, the economy has grown at a steady 5 percent each year during the past decade (Rahman et al., 2021). Meanwhile, fossil fuels provide a disproportionate share of Indonesia's

energy needs at home. Apart from that, Kurniawan et al. (2020) also mentioned that the use of coal for electricity consumption is more than 90%. There will be long-term consequences for things like air quality, global warming, and economic stability as a result of this action. As a result, eco-friendly technology can be a solution to these issues (Aithal & Aithal, 2021). According to Langer et al. (2021), Indonesia is rich in potential sources of renewable energy, including geothermal and wind power. In this way, energy efficiency and decreased carbon emissions will play a role in Indonesia's efforts to diversify its economy. In contrast, Kurniawan & Managi (2018) noted that Indonesian rules are the single most important factor in facilitating a green transition toward enhancing Indonesia's economy.

Improved air quality and public health: Green technologies can help reduce air pollution and improve public health

Public health is tied to pollution problems (Manisalidis et al., 2020). Air pollution is responsible for an estimated 7 million deaths annually around the world (Cohen et al., 2017). Moreover, this is a major issue that has the potential to lessen air pollution and improve the health of the general population. One possible technological fix is the widespread adoption of electric vehicles, which would significantly cut down on transportation-related pollution (Shah et al., 2021). Indonesia's humid environment and infrastructure are the key obstacles to the widespread adoption of electric vehicles (Miao et al., 2023). However, improving public transportation, walking, and biking can help cut down on pollution in major cities (Glazener & Khreis, 2019). In addition, 24% of world emissions come from producing power (Oberschelp et al., 2019). Industrial activities contribute nearly as much to air pollution in Indonesia. Therefore, it is worthwhile for every business to adopt eco-friendly technologies (Paparoidamis & Tran, 2019). Surya et al., (2021) agree that sustainable economic growth in Indonesia will be influenced by the use of environmentally friendly technology.

Enhanced climate resilience: Indonesia is particularly vulnerable to the impacts of climate change, and green technologies can help the country adapt and mitigate these impacts

As a country with an archipelagic geography and a tropical climate, Indonesia is particularly vulnerable to the effects of climate change, which are reflected in rising sea levels, droughts, forest fires, and frequent storms (A. Kumar et al., 2021). However, environmentally friendly technology can mitigate these effects and play an important role in helping Indonesia adapt to the changing climate (Dharmayanti et al., 2023).

3.7 Challenge and Opportunities

Financing the transition to a green economy: Indonesia will need significant investments to transition to a green economy

Changing to environmentally friendly technologies is a pressing issue for the world economy (Walz et al., 2017). Its use ensures continued economic growth while also combating climate change and decreasing reliance on fossil fuels. According to González-Ruiz et al. (2018), this substantial funding was allocated to the incorporation of eco-friendly technologies in the creation of sustainable practices and the improvement of existing infrastructure. An investment of $3 trillion to $5 trillion is required. Martawardaya et al. (2022) stated that Indonesia can make the shift to a green economy. Financial sources that can be maximized are domestic government financing, international financial institutions, private sector investment, and environmentally friendly bonds. Whiteside (2020) noted that this is still happening in the present day. Legislative changes and public-private partnerships can mobilize private capital. Furthermore, the development of financing instruments that can be used to fund green initiatives is crucial. Even though Indonesia has a richness of natural resources and a growing product market, the country still requires assistance from a variety of stakeholders in order to implement environmentally friendly technology (Sharvini et al., 2018). Regulatory or policy barriers, a lack of ability and competence in environmentally friendly finance, and a general lack of awareness and understanding of environmentally friendly financing alternatives all contribute to this. Therefore, the government of Indonesia has to improve capacity development by training its citizens, streamlining its policies and regulations, and encouraging cooperation and the exchange of information regarding environmentally friendly technologies.

Building capacity and expertise in green technologies

The transition to a green economy is gaining momentum across the world, driven by the urgency of addressing climate change and environmental degradation. Green technologies, which include solutions

for sustainable energy production, resource conservation, and pollution reduction, play an important role in this transition (Söderholm, 2020). However, Kamis et al. (2018) state that the successful implementation and use of environmentally friendly technology requires a skilled workforce equipped with the necessary knowledge and expertise. Therefore, building capacity and expertise in environmentally friendly technologies is essential for countries to effectively transition towards a greener future (Muench et al., 2022). Nowotny et al. (2018), informing that rapid technological progress, emerging fields, and multidisciplinary knowledge can increase the capacity of expertise in environmentally friendly technologies. Ramdhani et al. (2017) also agree that education and training, as well as advanced research and development, need to be carried out to build capacity and expertise in green technology in Indonesia. So, in the future, it will accelerate the adoption of environmentally friendly technology, increase innovation and sustainable economic growth, and preserve nature through sustainable development.

Seizing opportunities for green exports and attracting green investment

The global transition to a green economy presents many opportunities for countries to harness their environmental strengths and drive sustainable growth (Ali et al., 2021). Alamsyah et al. (2020) adds that as demand for environmentally friendly products and services increases, countries that can effectively position themselves as environmentally friendly export hubs and attract environmentally friendly investment will gain significant economic and environmental benefits. Green exports, which include a variety of environmentally friendly goods and services, are experiencing rapid growth as consumers and businesses around the world seek sustainable alternatives (Khan et al., 2020). Apart from that, it can attract environmentally friendly investment in the form of projects and collaboration between countries (Yin, 2019). Thus, identifying comparative advantages, developing targeted strategies, promoting environmental collaboration, and involving stakeholders.

Conclusions

Top management and employees embrace environmentally friendly technological improvements that boost financial performance. Operations managers disagree on green manufacturing. Economic, regulatory, and commercial factors affect technological growth. Environmental dedication helps green firms build customer loyalty and goodwill. Lack of environmentally conscious enterprises and ecological innovation literature reviews in Indonesia are constraints. According to the findings, green innovation technology improves firm performance. Thus, this is consistent with Liao (2018), Xie et al. (2019), Ouyang et al. (2020), and Liu et al. (2021). We utilized case studies of Chinese green innovation technology from diverse industries. Despite no significant impact, the proportion was 4.9%. With only a small number of things and management failing to increase organizational performance, environmentally friendly, innovative technology in Indonesia may succeed. This report predicts millions of jobs in renewable energy, energy efficiency, sustainable transportation, waste management, and sustainable agriculture in Indonesia's green economy. The change requires skilled workers and large investments in green technologies and infrastructure. Indonesia has various renewable energy sources. Thus, green technologies can diversify its economy and reduce its fossil fuel dependence. Green solutions can improve air quality and public health since air pollution kills 7 million people annually. The humid environment and infrastructure of Indonesia limit electric vehicle adoption, which could reduce traffic pollution. Public transportation, walking, and biking lessen pollution in major cities. Climate change threatens Indonesia, but green technologies can help it adapt. Indonesia faces challenges and opportunities with green technologies, but with the right laws and regulations, it can achieve sustainable economic growth and reduce its environmental impact. Indonesia needs significant investments to transition to a green economy for economic growth, climate change mitigation, and fossil fuel reduction. Government financing, international financial institutions, private sector investment, and green bonds can do this. The country requires stakeholder support to implement green technology. Lack of green finance skills, regulatory constraints, and financing possibilities contribute to this issue. The government must train citizens, streamline policies, and encourage cooperation to increase capability. Successful implementation demands green technology expertise. New domains and rapid technological progress can improve green technology expertise. Green technology development in Indonesia requires education, training, and sophisticated research. Green trade and investment can profit from environmental advantages and sustain countries. Eco-friendly export centers and investments can enhance economies and the environment.

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Exploring Sustainable Economic Growth: Promoting Green Development Productivity through Decentralized Environmental Policy and Regional Competitiveness

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Abstract

The freedom of regions in regulating territories is now being promoted with the decentralization of environmental policies. This policy serves as the forerunner in empowering regions to function autonomously, thereby playing a role in practical politics. Therefore, this research aimed to analyze the role of decentralization of environmental policy and local government competition in navigating green development productivity in Indonesia. The slack base model and dynamic panel regression were used to generalize the method of the moment. The results showed that the decentralization of environmental policies and local government competition negatively affected the productivity of green development. Meanwhile, budget allocations for research and development, along with strategic initiatives in economic sectors such as agriculture and mining, showed a substantial positive effect.

Keywords: Environmental Policy Decentralization; Green Development; Local Government Competition.

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1. Introduction

Environmental policy decentralization is important in increasing decision-making and implementing actions aimed at preserving and safeguarding the environment. Local authorities, often have a better understanding of the unique environmental challenges and requirements of the respective regions, which are better equipped to make well-informed decisions. Decentralization empowers the local authorities to make quicker decisions on local conditions, thereby leading to more timely and effective measures against environmental issues. Local authorities can also consider cultural, social, economic, and geographic factors influencing environmental dynamics, which increases the possibilities of policies being successful and sustainable over the long term. Additionally, environmental decentralization policies include granting regions the freedom to actualize development. In this approach, decisions and responsibilities are distributed among various levels of government, non-governmental organizations, and communities, making it easier to understand specific environmental problems and respond quickly to environmental changes (Udeagha & Breitenbach, 2023). The decentralization of environmental policies contributes to achieving environmental stability and fosters regional innovations, thereby promoting ecologically based and sustainable inclusive economic growth (Fredriksson & Wollscheid, 2014; Wu et al., 2020).

Modern production activities can cause significant environmental harm, specifically when conducted without a commitment to sustainability and responsibility. Production activities that produce liquid waste cause threaten water quality, putting aquatic life at risk and disrupting the balance of aquatic ecosystems (Khalish et al., 2022). Moreover, gas emissions due to excess production also have the potential to pollute the air and disrupt human and animal health. Activities such as agriculture and plantations, which are associated with production, contribute to deforestation and excessive logging, decreasing wildlife habitats and increasing the possibility of natural disasters such as landslides and floods (Sarkodie & Strezov, 2018). Other production-related activities, including mining, infrastructure development, and industrial operations, have the potential to damage the soil in the form of erosion, decrease soil quality, and loss of biodiversity (Worlanyo & Jiangfeng, 2021). Production activities that use natural resources such as water, wood, and minerals can lead to over-exploitation, thereby reducing the availability of these resources for future generations (Sarkodie, 2018).

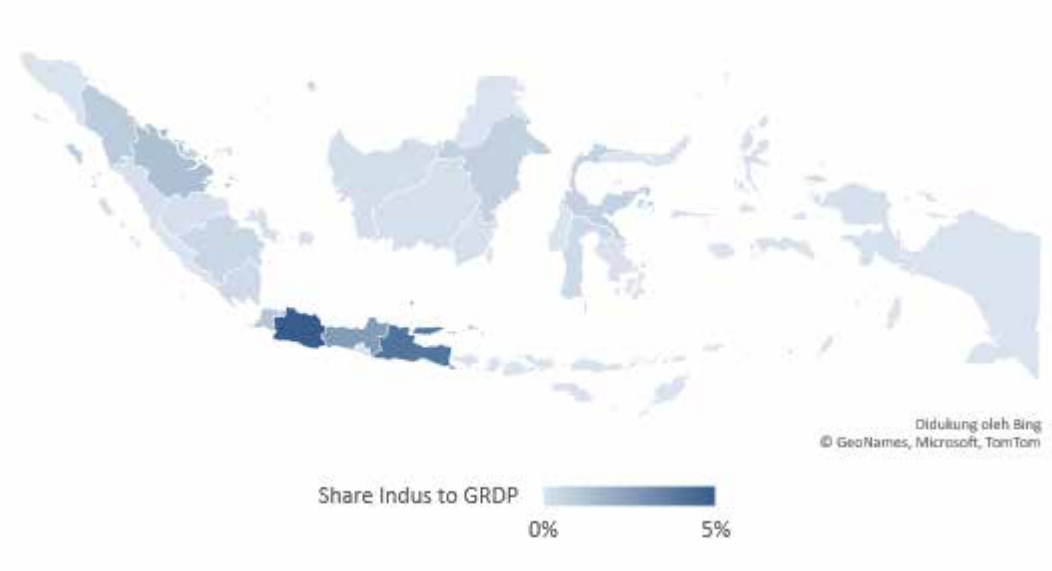

Figure 1. Distribution of Industrial Sector Orientation in Indonesia, from Research data, processed
Sources: (BPS, 2022)

Java Island is the most densely populated island in Indonesia with several big cities and witnessing the rapid expansion of industrial zones, including Jakarta, Surabaya, and Bandung. Industrialization on Java Island has played an important role in increasing economic growth to a current value of 56.6% (Buchori et al., 2017; BPS, 2022). However, the island has severe environmental challenges due to various human activities such as agriculture, industry, and urbanization. The compounded impact of these activities in addition to overpopulation, poses an ongoing challenge for Java to maintain ecological

balance. Figure 1 shows a massive industrial concentration on Java Island with the increasing potential for pollution accumulation due to the significant use of coal energy.

The development of physical infrastructure aimed at improving connectivity also plays an important role in improving the sustainability of environmental ecosystem resilience. In addition, the potential for land clearing is also increasingly massive outside Java Island, leading to a decrease in the availability of an adequate environment. As a result of this phenomenon, the development of private vehicles in various regions is increasing with an imbalance in public transport. This condition led to environmental issues that pose a threat to the future sustainability of the economy with a high number of private vehicles experienced in some regions. Figure 2 shows that the concentration of motorized vehicle growth is increasing in Java due to the rise in the number of private cars and motorbikes by 19,508,454 and 131,134,878 units, respectively. Meanwhile, other public vehicles such as buses have experienced relatively stagnant growth at around 6% (POLRI Traffic Corps, 2023). Uncontrolled vehicle growth has caused environmental degradation in densely populated regions, disrupting economic activity in general.

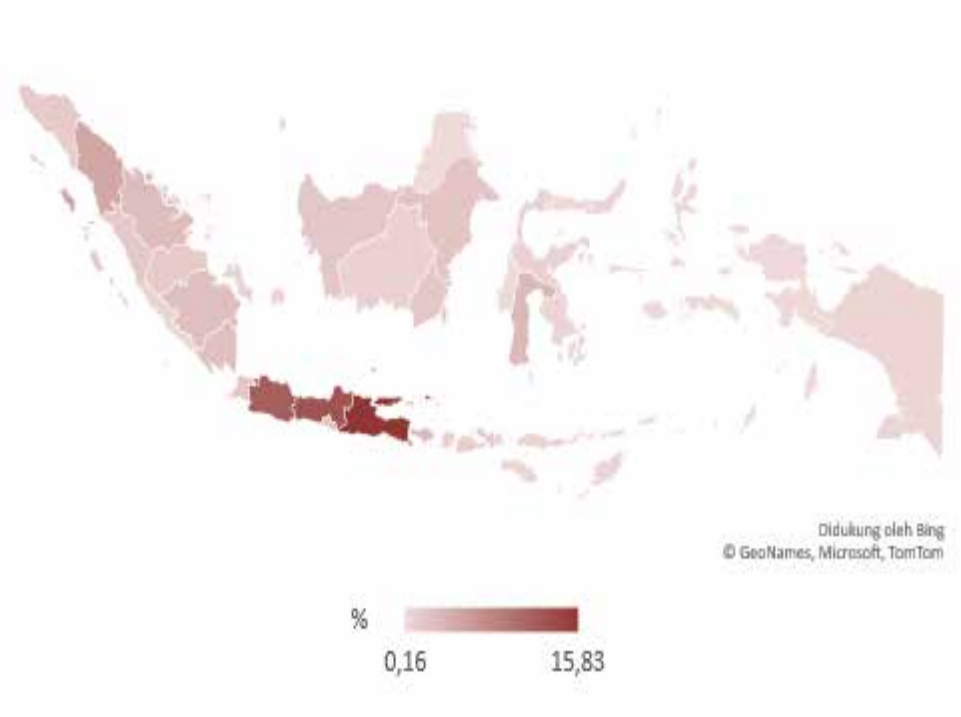

Figure 2. Distribution of Vehicle Growth in Indonesia, processed
Sources: POLRI Traffic Corps (2023)

Environmental protection in Indonesia is relatively similar, showing that land cover remains adequate. This is presented in Figure 3, showing that most of the greatest environmental protection is supported by regions with the highest land cover. Land cover comprises information on the types of land present in regions, comprising features such as forests, agricultural land, urban regions, water bodies, etc. Changes in land cover produce significant impacts on the environment, contributing to habitat degradation, ecosystem damage, and deterioration in water and air quality, as well as other environmental issues. Some regions with tropical and monsoon rainforest land cover are still scattered in Kalimantan and Papua. Meanwhile, others such as Java, Sumatra, and Sulawesi are supported by natural forests and adequate water quality.

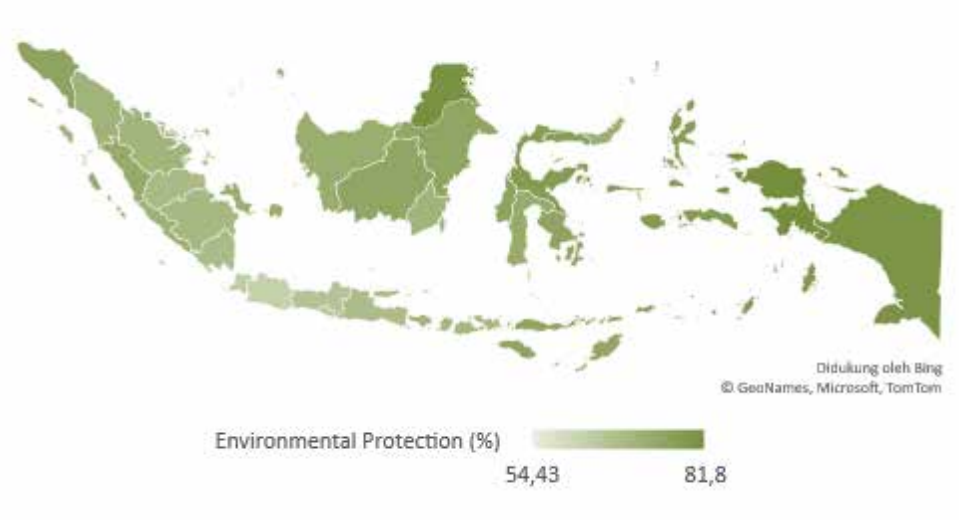

Figure 3. Distribution of Environmental Protection in Indonesia, processed
Sources: The Minister for Environment and Forestry (2021)

Target-oriented economic development often ignores environmental considerations, leading to serious environmental problems, such as air pollution and natural destruction in regions focused on physical development and trade dominance. To address these challenges, it is important to navigate various aspects and create environmentally friendly economic development. One important future orientation for maintaining environmental and global economic sustainability is green economic sustainability (Khanra et al., 2022). The concept of green development comprises sustainable economic progress based on renewable resources, aimed at minimizing negative impacts on the environment while improving the quality of human life (Feng & Chen, 2018; Zhu et al., 2019). In this process, natural resources are processed efficiently and developed sustainably to increase the availability for future generations. This approach promotes the use of renewable resources and clean technologies that reduce carbon emissions, contributing to the fight against climate change and improvements in air quality (Shao et al., 2016; Yang et al., 2019). Green development promotes innovation and investment in environmentally friendly technology and infrastructure, increases competitiveness, and promotes sustainable economic growth (Qiu et al., 2021).

According to Liu et al. (2022), the impact of environmental decentralization is determined by tax incentives. The collection of environmental protection tax provides economic incentives for local governments, which also increases government utilities and promotes regional green development. Zhang & Li (2022) stated that environmental decentralization promoted green technology innovation. Zou et al. (2019), stated that environmental decentralization promotes development in neighboring regions. Meanwhile, Luo et al. (2023) and Fang & Cao (2022) reported that environmental decentralization hinders the productivity of green economy development and reduces the quality of information disclosure.

Several research provided insights into the issue of unfair competition among governments impacting the productivity of green development. Particularly in cases of "bottom-to-bottom" competition among local governments, the pursuit of high-quality resources dominates environmental control efforts, thereby leading to environmental degradation (Kuai et al., 2019; van der Kamp et al., 2017). Additionally, the process of urbanization, which led to industrial agglomeration also affects the environmental quality of region (Zhang et al., 2020). The swift agglomeration of urban populations and the expansion of distorted urban spaces contribute to a decrease in the productivity of green development. Guild (2020) analyzed the allocation of research funds as measured from green finance toward sustainable development. The results showed that the allocation of these funds positively influences the productivity of green development, thereby making development more environmentally friendly.

The concept of green development is frequently associated with fiscal decentralization (Li & Xu, 2023; Liu et al., 2022; Wang et al., 2022; Wang et al., 2022; Zhu et al., 2022). These discussions

predominantly center on the efforts of local governments in allocating fiscal resources specifically for environmental purposes. Meanwhile, other research established connections between green development and regional innovation, exploring how regions could anticipate innovation and examine aspects of innovation financing through various models (Li et al., 2020; Yuan & Xiang, 2018). Research on green development related to policy decentralization in Indonesia remains limited. In Indonesian context, research on green economic development have primarily focused on conceptual aspects and have yet to delve into the practical role in fostering sustainable economic growth (Martawardaya et al., 2022; Masdar et al., 2022). The relationship of this development to local government competition has not been discussed to promote better innovations. Therefore, this research examined the impact of the decentralization of environmental policies and local government competition on green development in Indonesia.

This research provides theoretical insights into the measurement of green development efficiency in Indonesia. Furthermore, it also implicatively evaluates the efforts used to decentralize environmental policies and navigates local government competition towards achieving stability.

2. Methods

2.1 Data

Secondary data were collected from 34 provinces in Indonesia from 2016 to 2021. These provinces include Aceh, North Sumatra, West Sumatra, Riau, Riau Islands, Jambi, South Sumatra, Bengkulu, Lampung, Bangka Belitung Islands, DKI Jakarta, Banten, West Java, Central Java, DI Yogyakarta, East Java, Bali, West Nusa Tenggara, East Nusa Tenggara, West Kalimantan, Central Kalimantan, South Kalimantan, East Kalimantan, North Kalimantan, South Sulawesi, West Sulawesi, Southeast Sulawesi, Central Sulawesi, North Sulawesi, Gorontalo, Maluku, North Maluku, Papua, and West Papua.

Table 1. Definition of Research Variables

Variable	Definition	Period	Unit of Measurement	Source
pgd	Productivity of Green Development	2016-2022	Percent	Author Estimation
ed	Environmental Decentralization Score	2016-2022	Probability Score	Author Estimation
fc	Regional Competition Indeks	2016-2022	Probability Score	Author Estimation
Ln fdi	Natural logarithm of foreign investment	2016-2022	Percent	BPS
Ln rnd	Natural logarithm of research and development	2017-2022 (2016 backast using inflation)	Percent	Bappenas
Ln eb	Natural logarithm of environmental financing	2018-2021 (2016-2017 and 2022 backast & forecast using inflation)	Percent	The Ministry of Environment and Forestry
Ln urb	Natural logarithm of urban dwellers	2016-2022 (chow lin using population)	Percent	BPS
Ind	The share of the industrial sector to GRDP	2016-2022	Percent	BPS
Agri	The share of the agricultural sector to GRDP	2016-2022	Percent	BPS
Mining	The share of the mining sector to GRDP	2016-2022	Percent	BPS

The start of this data from 2016 is relevant to the updating of the research after the change in nomenclature of Presidential Decree No. 16 of 2015 came into effect. In addition, environmental issues have been dominant over the past five years and the use of the data is important for interpreting green development productivity. The analysis includes measuring green development productivity using output-based slack modeling, considering air quality and gross regional domestic product. Meanwhile, on the input side, factors such as investment, labor, and electricity consumption are considered.

Environmental policy decentralization is calculated through environmental protection shift share, using the provincial environmental quality index compared to the national index. Regional competition is estimated using fiscal budget information on regional revenues and expenditures. Additional data includes foreign direct investment (FDI), budget for research and development, budget for environmental mitigation, urban population, and the share of industry, agriculture, and mining to GDP. These data help understand how internal factors such as population growth, government efforts for the environment, and the performance of key economic sectors influence green development. These data are then adapted as controls to actualize green development efficiency properly.

2.2 Empirical Models

Environmental Policy Decentralization Model

Decentralization of environmental policies is determined using shift-share proxies for water, air, and land cover quality indices. The construction is associated with a particular form of management delegated to the regions by the central government for handling natural and non-natural damage (Zhang & Li, 2022). The main objective is to effectively supply public goods to protect the environment, including the effectiveness in terms of regulations and conditions in the field. In addition to the increasingly complex diversification of regional governments, establishing more precise measurement validations is possible. The measurement process for environmental policy decentralization is formulated as follows:

$$ed_{it} = \left[\frac{\frac{leqi_{it}}{lpop_{it}}}{\frac{neqi_{it}}{npop_{it}}}\right] \times \left[1 - \left(\frac{GRDP_{it}}{GDP_t}\right)\right] \quad (1)$$

Where i and t denote province and year, respectively, ed_{it} represents the decentralization of environmental policy, and $leqi_{it}$ is the local environmental quality index. The local quality can be changed by exchanging the local water, air, and land cover quality index. Furthermore, $neqi_{it}$ is the national environmental quality index, $lpop$, and $npop$ denote the total population at the province and national levels. Finally, $GRDP_{it}$ and GDP_t are local and national gross regional domestic products, respectively.

Based on the measurements above, a higher ed value indicates better protection and vice versa (Ran et al., 2020). According to Botta & Koźluk (2014), the environmental quality index is equivalent to the performance index that represents policies in each country. The comparison results showed that the higher the value of the environmental performance index, the stronger the environmental care policies and vice versa. Meanwhile, Indonesia has implemented this index to describe the navigation movement of regional environmental indicators as a means to control and follow up regulations. The process of supporting information including water quality, air, and land cover is achieved as follows:

$$ed_{it} = [0.3 \times edW_{it} + 0.3 \times edA_{it} + 0.4 \times edLC_{it}] \times \left[1 - \left(\frac{GRDP_{it}}{GDP_t}\right)\right] \quad (2)$$

$$ed_{it} = \left[0.3 \times \frac{\frac{leqw_{it}}{lpop_{it}}}{\frac{neqw_{it}}{npop_{it}}} + 0.3 \times \frac{\frac{leqa_{it}}{lpop_{it}}}{\frac{neqa_{it}}{npop_{it}}} + 0.4 \times \frac{\frac{leqlc_{it}}{lpop_{it}}}{\frac{neqlc_{it}}{npop_{it}}}\right] \times \left[1 - \left(\frac{GRDP_{it}}{GDP_t}\right)\right] \quad (3)$$

Where ed is determined through fixed proportions of edW, edA, and $edCL$, which are decentralized moderation of water, air, and land cover, respectively. This fixed weighting portion refers to the pattern of determining the environmental quality index set by the Ministry of Environment and Forestry through the formulation of the quality standard for environmental statistics. These are 0.3 for water and air quality, and 0.4 for land cover, which are then implemented in the weighting of environmental decentralization to prevent the equalization process from changing. Therefore, from this information, the decentralization of environmental policies is examined based on more minor indicators, as shown in Table 2.

Table 2. Decomposition of Environmental Decentralization Policy Score

Label	Definition	Unit of Measurement	Source
leq	Provincial Environmental Quality index	Percent	Kemen LHK
leqw	Provincial water quality index	Percent	Kemen LHK
Lequ	Provincial air quality index	Percent	Kemen LHK
Leqlc	Provincial land cover quality index	Percent	Kemen LHK
Neq	National environmental quality index	Percent	Kemen LHK
Neqw	National water quality index	Percent	Kemen LHK
Neqa	National air quality index	Percent	Kemen LHK
Neqlc	National land cover quality index	Percent	Kemen LHK
Lpop	Province population	Person	BPS
Npop	National population	Person	BPS
GRDPit	Gross Regional Domestic Product	Billion Rp	BPS
GDPt	Gross domestic product	Billion Rp	BPS

Regional Government Competition

Local government competition shows that the higher the competition for fiscal decentralization, the more monopoly the region has in accommodating the various policies. The local government competition model was formulated as follows:

$$fc_{it} = \frac{pfr_{it} - fe_{it}}{pfr_{it}}; pfr_{it} \neq 0 \quad (4)$$

Where fc_{it}, pfr_{it}, and fe_{it} denote fiscal, regional income, and total regional expenditure, respectively. When the competitive value is relatively large, the regional pressure to use the budget is higher, which enables it to delegate policies through budget independence (Ran et al., 2020).

Table 3. Decomposition of Regional Competition using Fiscal Decentralization Measurement

Label	Definition	Unit of Measurement	Source
pfr	The amount of regional original income, general-specific allocation funds, and profit-sharing funds also known as regional income	Milliard Rp	The Ministry of Finance
fe	The amount of regional expenditure of the province	Milliard Rp	

Green Development Productivity

Green development productivity (PGD) is measured through a slack-based model to determine the optimal output from the increasingly massive economic development results (Yang et al., 2018b). This productivity follows the deterministic modeling that *K (k=1,2,…, K)* uses *N(n=1,2,.., N)* inputs, with expected and unexpected outputs as *M (m=1,2,.. , M)* and *I(i=1,2,.., I)*. s is the slack of each of the input, output, and unexpected output indicators. Meanwhile, x,y, and b are the coefficients for input, output, and unexpected output, respectively. Lastly, z is weighted vector of coefficient that respectively to the equation. The measurement process can be calculated as follows:

$$pgd_{it} = min\left[\frac{1 - \frac{1}{N}\sum_{n=1}^{N}\frac{s_{nt}^{x}}{x_{nt}^{j}}}{1 - \frac{1}{M+1}\left(\sum_{m=1}^{M}\frac{s_{mt}^{y}}{x_{mt}^{j}} + \sum_{i=1}^{I}\frac{s_{it}^{b}}{x_{it}^{j}}\right)}\right] \quad (5)$$

$$\text{s.t} \sum_{k=1}^{K} z_k s_{nt}^{m} + s_{nt}^{x} = x_{nt}^{j}, \text{ where } n = 1, 2, \dots, N \quad (6)$$

$$\sum_{k=1}^{K} z_k s_{mt}^{k} - s_{mt}^{y} = y_{mt}^{j} \text{ where } m = 1, 2, \dots, M \quad (7)$$

$$\sum_{k=1}^{K} z_k s_{it}^k - s_{it}^b = b_{it}^j \text{ where } i = 1, 2, \dots, I \quad (8)$$

$$\sum_{k=1}^{K} z_k = 1 \quad (9)$$

$$z_k \geq 0, s_{nt}^x \geq 0, s_{mt}^y \geq 0, \text{and } s_{it}^b \geq 0 \quad (10)$$

Based on the estimation results, pgd has a maximum value of 1, which means using renewable energy transmission is more productive in achieving green development. When the value is less than one, it can be ascertained that the increase in production inputs has implications for environmental pollution and vice versa.

Table 4. Decomposition of Slack Base Productivity of Green Development Measurement

Indicator	Label	Definition	Unit of Measurement	Sources
Input	M_1	Gross Fixed Capital Formation	Billion Rp	BPS
	M_2	The amount of labor	Person	
	M_3	Electricity Consumption	GwH	
Desirable Output	N_1	Gross Domestic Product	Billion Rp	PLN
Undesirable Output	I_1	Air Pollution	Index	Global Change Data Lab (GC)

2.3 Empirical Models

Effect of Decentralization of Environmental Policy and Local Government Competition on Green Development Productivity

Previous research stated that foreign investment, urbanization, and mining share negatively affected the productivity of green development (Li et al., 2022). Meanwhile, it was positively affected by the budget allocated for research and development, and environmental considerations, including industry and agriculture shares of GRDP (Feng et al., 2017). Foreign investment was perceived as a potential driver of massive economic growth, opening up possibilities for new value-oriented industries. Meanwhile, higher rates of urbanization were associated to concentrated populations and the potential formation of slum regions, contributing to reduced green development productivity (Shang & Liu, 2021). Rapid urbanization was associated with deforestation, habitat destruction, and increased pollution, negatively impacting the environment and overall green development efficiency. The mining share was also suspected of hindering productivity due to basins and land clearing, creating environmental challenges (Gao et al., 2019). Budgets allocated for research and development purposes, along with environmental interests, were perceived as critical in establishing a more ecologically sound policy climate at the regional level (Feng & Chen, 2018). The share of the industrial sector played a crucial role by supporting the adoption of the latest technology and new renewable energy, with the potential to increase economic productivity (Guo & Liu, 2022). Finally, the agricultural sector is also an essential promoter of creating green development productivity (Yu et al., 2020).

To evaluate the effect of decentralization on environmental policies and local government competition in the productivity of green development, a dynamic panel regression known as Generalized Method of Moments (GMM) was used. The choice of GMM over VAR panel regression was motivated by the need for a model that accommodates short periods, specifically in the context of a limited number of provinces. GMM panel regression, designed for changes in time series, adopted variable lag terms in this research. The model aims to analyze the impulse response of changes in the overall unit decentralization of environmental policy, water, air, and land cover qualities. It also examined the influence of these decentralized aspects, alongside green development in the preceding and recent years. To obtain accurate results and address classic issues of autocorrelation and heteroscedasticity, Arrelano-bond and Sargan post-estimator tests, were conducted (Arellano & Bond,

1991; Arellano & Bover, 1995). This approach aims to enhance the reliability and accessibility of the research findings.

$$pgd_{it} = \alpha_0 + \beta ed_{kit} + \alpha_1 fc_{it} + ln\, fdi_{it} + ln\, rnd_{it} + ln\, eb_{it} + ln\, urb_{it} + ind_{it} + agri_{it} + mining_{it} + u_{it} \quad (11)$$

Where pgd_{it} is green development productivity, ed_{kit} is an indicator of environmental policy decentralization, $\ln fdi_{it}$ is the natural logarithm of foreign investment, $\ln rnd_{it}$ is the natural logarithm of expenditure for research and development purposes, $\ln eb_{it}$ is the natural logarithm of spending on environmental needs, $\ln urb_{it}$ is the natural logarithm of urbanization, ind_{it} is the share of the industrial sector (% of GDP), $agri_{it}$ is the share of the agricultural sector (% of GDP), $mining_{it}$ is the share of the mining sector (% of GDP), u is another factor, i and t are province and year, respectively.

3. Results and Discussion

3.1 Descriptive Statistics

The following descriptive statistics present measures of concentration, distribution, and location.

Table 5. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Pgd	204	0.86	0.061	0.753	1
Ed	204	99.756	99.548	3.578	477.811
Fc	204	-0.202	0.414	-2.18	1
Fdi	204	874.901	1201.61	5.9	5881
Rnd	204	48.116	65.498	7.731	379.516
Eb	204	45.549	56.587	-6.023	356.769
Urb	204	4348.428	7444.541	131.46	39837.293
Ind	204	0.751	1.381	0.008	6.735
Agri	204	0.411	0.46	0.015	2.06
Mining	204	0.234	0.403	0.003	2.296

Source: Author Estimation Result

The results of statistical measurements show that the productivity of green development is currently static and inefficient, as presented by a gap level of 0.14 in absolute productivity (absolute productivity=1). The decentralization of environmental policies is moderately low, depicting that it has not been completely adopted by most local governments. Table 2 shows the inefficiency in green development productivity, which tends to remain static at 0.86. This simply means that to enhance the efficiency, the input productivity gap should be reduced by a scale of 0.16. In terms of environmental policy decentralization, the score is relatively small at approximately 99.75, signifying that many local governments are yet to fully implement these policies. This was shown by the environmental policy decentralization score that reached a maximum value of 477.81. However, local government competition had a relatively low value of -0.202, showing a competitive regional setting, where each region competes to enhance the developmental capacity. Based on the calculation, the average FDI was 874,901, showing a continuous influx of new capital. This condition also implied that foreign financing sentiment was still relatively good. The budget allocated for research and development, including environmental purposes is relatively minimal, with magnitudes of 48.1 and 45.54, respectively, in addition to the maximum value which tends to be greater. Urbanization, represented by the urban population, remains substantial at 4348 individuals. Meanwhile, certain provinces show a shift toward the industrial sector in the economic structure, surpassing concentrations in agriculture and mining. When further analyzed, it was discovered that all research variables were free from data outlier problems, allowing for estimation in the subsequent stages.

3.2 Correlation coefficient

The following represents the estimated correlation coefficient for the research variables:

Table 6. Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) pgd	1.000									
(2) edm	-0.071	1.000								
(3) fc	-0.070	0.100	1.000							
(4) fdi	0.378*	0.369*	0.108	1.000						
(5) rnd	0.433*	0.395*	0.103	0.729*	1.000					
(6) eb	0.434*	0.392*	-0.107	0.713*	0.967*	1.000				
(7) urb	0.220*	0.429*	0.122*	0.764*	0.655*	0.649*	1.000			
(8) ind	0.352*	0.410*	0.150*	0.760*	0.711*	0.694*	0.966*	1.000		
(9) agri	0.248*	0.493*	0.132*	0.352*	0.357*	0.349*	0.693*	0.754*	1.000	
(10) mining	0.527*	0.172*	0.001	0.093	0.064	0.065	0.060	0.195*	0.332*	1.000

** shows significance at p<0.1*

Source: The results of the author's estimation

Table 6 showed an overall moderate relationship which does not correlate with the decentralization of environmental policies and green development productivity. On the contrary, foreign investment, budget for research and development, including the environment, urbanization rate, industrial, agricultural, and mining sectors showed positive correlations at a significance level of 10%. The regression estimation stage enabled a smooth continuation due to the unavailability of autocorrelation.

3.3 Estimation Results

Table 7. The results of the estimation of the effect of decentralization of environmental policies and local government competition on the productivity of green development

	GMM Difference				GMM System			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	PGD	PGD	PGD	PGD	PGD	PGD	PGD	PGD
_cons	1.067***	1.322***	1.54***	1.529***	0.805***	0.954***	1.269***	1.23***
	(0.12)	(0.215)	(0.26)	(0.291)	(0.062)	(0.131)	(0.171)	(0.188)
L.pgd	0.231***	0.218***	0.223***	0.223***	0.261***	0.173***	0.245***	0.252***
	(0.03)	(0.035)	(0.038)	(0.038)	(0.027)	(0.026)	(0.035)	(0.031)
Ed	-0.001***	-0.001***	-0.001***	-0.001***	0***	0**	-0.001***	-0.001***
	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Fc	-0.006	-0.009	-0.004	-0.017*	-0.025	-0.037***	-0.021	-0.023***
	(0.011)	(0.011)	(0.011)	(0.01)	(0.017)	(0.014)	(0.017)	(0.009)
Lnfdi	0.001	0	0	0	0	0	0	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Lnrnd	0.021	0.026	0.016	0.044**	0.052**	0.07***	0.039	0.052***
	(0.023)	(0.023)	(0.024)	(0.022)	(0.022)	(0.016)	(0.029)	(0.02)
Lneb	0.016	0.012	0.015	0.007	0.011	-0.007	0.005	0
	(0.013)	(0.012)	(0.013)	(0.013)	(0.017)	(0.015)	(0.019)	(0.014)
Lnurb	-0.062***	-0.099***	-0.127***	-0.137***	-0.051***	-0.063***	-0.107***	-0.105***
	(0.015)	(0.025)	(0.034)	(0.037)	(0.009)	(0.015)	(0.023)	(0.024)
Ind		0.046**	0.031*	0.021		0.035*	0.028*	0.018
		(0.02)	(0.018)	(0.015)		(0.019)	(0.016)	(0.014)
Agri			0.081	0.072			0.124***	0.112**
			(0.071)	(0.066)			(0.043)	(0.044)
Mining				0.04*				0.049**
				(0.021)				(0.024)
F-Test	80.52***	77.31***	99.73***	94.59***	405.08***	581.21***	231.51***	200.31***
P(AR(2))	0.8506	0.8559	0.9357	0.9554	0.5895	0.3189	0.7418	0.8449
P (Sargan)	0.2828	0.2933	0.3574	0.3057	0.1921	0.1714	0.5044	0.5463
Observations	134	134	134	134	169	169	169	169

Standard errors are in parentheses; *** p<.01, ** p<.05, * p<.1

Source: The results of the author's estimation

The results of the estimation are shown in Table 7, with each process including the addition and subtraction of sectoral variables. In general equations (1) to (4) were estimated using GMM difference, whereas (5) to (8) were calculated by applying GMM system. The results of the estimation shows that environmental policy decentralization, local government competition, and urban population consistently had a significant negative effect on green development productivity. Meanwhile, the budget for research and development, agricultural, and mining sectors had a positive impact. This pattern remained consistent across sectors, showing the stability of results in absolute terms. The influential factors are attributed to the budget allocated for research and development, as well as the economic contributions of the agricultural and mining sectors. Meanwhile, a hindering factor was identified in the form of a higher urban population. Finally, this model proved to be the best fit due to the absence of autocorrelation AR(2), and the sargan probabilities in line with the GMM. Therefore, this model is suitable for describing the actual conditions.

3.4 Ranking of Environmental Policy Decentralization Indicators, Local Government Competition, and Green Development Productivity

The provided details offer an overview of the distribution of indicators for environmental policy decentralization, local government competition, and green development productivity across 34 provinces from 2016 to 2021.

Table 8. Rating of Environmental Policy Decentralization Indicators

Province	Green Development Productivity	Rank	Environmental Policy Decentralization	Rank	Regional Government Competition	Rank
Aceh	0.805672	30	55.3436	21	-1.51212	35
Bali	0.808735	28	60.85166	18	-0.18475	29
Banten	0.84121	22	16.79549	31	-0.12353	22
Bengkulu	0.807568	29	138.4204	8	-0.1049	18
Yogyakarta Special Region	0.779257	35	57.23369	20	-0.37787	32
Jakarta Special Capital City	0.978379	3	13.65203	32	-0.02059	4
Gorontalo	0.782254	34	245.8418	3	-0.00171	3
Jambi	0.890114	8	73.10355	17	-0.0887	15
West Java	0.885368	10	3.805037	35	-0.11674	20
Central Java	0.875469	13	6.485574	33	-0.06505	13
East Java	0.906397	6	5.244279	34	-0.06065	11
West Kalimantan	0.846927	18	54.36467	22	-0.04823	8
South Kalimantan	0.825629	25	60.57962	19	0.065022	2
Central Kalimantan	0.853642	16	107.8222	12	-0.03812	7
East Kalimantan	0.984492	2	80.91905	16	-0.15976	26
North Kalimantan	0.889892	9	450.1822	1	-0.184	28
Bangka Belitung Islands	0.819448	27	183.6427	6	-0.15056	24
Riau Islands	0.990338	1	120.173	9	-0.03231	6
Lampung	0.842352	21	27.92873	29	-0.05331	10
Maluku	0.786556	33	168.7156	7	-0.07998	14
North Maluku	0.836178	23	243.9581	4	-0.1207	21
West Nusa Tenggara	0.794959	32	49.07444	24	-0.05002	9
East Nusa Tenggara	0.796755	31	48.30886	25	-0.22706	31
Papua	0.945593	4	93.57935	15	-1.50372	34
West Papua	0.904837	7	340.4289	2	-0.84706	33
Riau	0.929263	5	35.77019	26	-0.15541	25
West Sulawesi	0.846188	19	209.4706	5	-0.12945	23
South Sulawesi	0.882227	12	30.5754	27	-0.06475	12
Central Sulawesi	0.854943	15	96.2628	14	-0.02679	5
Southeast Sulawesi	0.833511	24	108.6236	10	-0.17177	27

Province	Green Development Productivity	Rank	Environmental Policy Decentralization	Rank	Regional Government Competition	Rank
North Sulawesi	0.822189	26	108.2969	11	-0.10051	17
West Sumatera	0.846188	19	49.19864	23	-0.1059	19
South Sumatera	0.852536	17	30.06466	28	0.084215	1
North Sumatera	0.884124	11	16.9964	30	-0.09557	16

Source: The results of the author's estimation

Based on the ranking calculations, the top five regions with the highest green development productivity are Riau Islands Province, East Kalimantan, DKI Jakarta, Papua, and Riau. This achievement was influenced by diverse factors, and provinces such as Riau Islands, Papua, and Riau had favorable environmental quality indicators. Meanwhile, DKI Jakarta and East Kalimantan attributed high productivity to the proactive government approach in formulating environmental policies. The decentralization of environmental policies is significant in provinces characterized by relatively good ecological quality, such as North Kalimantan, West Papua, Gorontalo, North Maluku, and West Sulawesi. The ecological excellence in these regions was supported by favorable land cover and water quality. Finally, from the aspect of local government competition, South Sumatra, Kalimantan, Sulawesi, Gorontalo, and DKI Jakarta were perceived as the major players. The varying levels of competition are primarily dominated by the fiscal dynamics and deficits in the respective provinces.

3. 5 Discussion

The act of decentralizing environmental policies was associated with a decrease in green development productivity. The results of this research are in line with Fang & Cao (2022), and Luo et al. (2023), that environmental decentralization has a negative effect on the productivity of green development. However, the absence of environmental policies in certain regions does not always correlate with a decline in green development quality. The environmental policies were also affected by several other factors, including unfavorable geographical conditions, such as barren soil or low rainfall, which required assistance in building parks or green open spaces. Less economically developed regions may face budget constraints for green environmental initiatives, while densely populated regions tend to encounter challenges in finding space for parks or green open spaces.

Effective environmental policy implementation plays an important role in enhancing the quality of green development in region. However, through properly enacted environmental policies, the development and maintenance of parks and open spaces was facilitated, which significantly improved resident quality of life.

Promoting fair competition in the government can promote a decrease in the productivity of green development. This is in line with the research conducted by Kuai et al. (2019) and van der Kamp et al. (2017), that competition among local governments tends to reduce the monitoring of environmental pollution. However, this competition does not consistently result in high-quality green developments. A monopoly-like competition can promote local governments to actively engage in the development and maintenance of the environment. This engagement includes practices such as the use of environmental impact analysis, establishing public green facilities, and implementing various measures supporting environmental stability. However, unhealthy competition, such as vying for funds or projects from the central government, can hinder coordination among local governments. This lack of coordination poses a challenge to the implementation of environmental and pro-stability programs. Neglecting the development and maintenance of the environment including the creation of parks and green open spaces can also lead to a generally low quality of green development. This negligence arises from insufficient budget, limited human resources, or lack of awareness regarding the importance of a green environment. Consequently, local governments must prioritize environmental development and maintenance as integral components of regional development agendas. Achieving this requires increased budget allocations, and human resources, including heightened public awareness regarding the importance of fostering a green environment. In addition, fostering effective coordination between local governments is important for improving the quality of green development in a given region.

The growing concentration of urban residents was associated with a decrease in the productivity of green development. This is in line with the research conducted by Zhang et al. (2020), that the rapid

agglomeration of the urban population and the continuous expansion of its space, have led to a deviation from high-quality, and efficient sustainable development. The direct correlation between urban population growth and the low quality of the green environment is not universally applicable (Zhang et al., 2020). Meanwhile, controlled urban population growth can trigger the development of a better green environment, which ensures the growth is in line with ideal spatial planning, and capable of resulting in environmental damage as well as a decline in green quality. Rapid urban population growth can lead to uncontrolled land use, deforestation, and the depletion of natural habitats, all of which are detrimental to the environment. High population density in urban regions can complicate the allocation of land for parks and green open spaces, contributing to overcrowding, increased pollution, and reduced air and water quality, affecting human health.

In this context, strategic spatial planning and effective environmental policies help to reduce the negative impacts of urban population growth. The deliberate development of parks and green open spaces helps improve the quality of the environment. Simultaneously, the enforcement of environmental policies focused on reducing emissions and pollution plays a crucial role in preserving good air and water quality.

The productivity of green development receives a significant improvement through the allocation of funds for research and development (Feng & Chen 2018; Guild, 2020). The results focused on the essential role of research and development funds in promoting sustainable development. Allocating these financial resources in the field of green development led to the opportunity to stimulate increased productivity. This investment can to the creation of innovative and environmentally friendly technologies, thereby enhancing the efficiency and quality of green development. Furthermore, research and development efforts contribute to a deeper understanding of optimal practices for developing and maintaining a green environment, comprising eco-friendly water and waste management methods, effective greening methods, and environmentally sustainable architectural designs.

The allocation of funds for research and development also strengthens the capacity of institutions and professionals in green development. By increasing this capacity, there is a simultaneous enhancement in the effectiveness and efficiency of efforts focused on its development and maintenance. The government and private institutions need to allocate dedicated funds for research and development in green development in order to achieve success. Such allocation will increase the progress of green development productivity and also improve the quality of life and reinforcement of environmental sustainability.

The mining and agricultural sectors positively contributed to green development productivity, although this is contrary to the research conducted by Gao et al. (2019). This present research focused on the essential role of these sectors in green development, stating that the impacts depend on how these sectors are managed and regulated. Specifically, in agriculture, increased productivity can be achieved through sustainable practices. These include minimizing the use of pesticides and hazardous chemicals, adopting efficient irrigation systems, applying environmentally sound tillage methods, and promoting crop diversification and biodiversity. However, unsustainable agricultural practices, such as monoculture and excessive use of chemicals, can damage the environment and reduce the productivity of green development.

The mining sector can provide natural resources needed for green development, such as minerals and materials for eco-friendly technologies and infrastructure. However, the potential harm from unsustainable mining practices to the environment, human health, and biodiversity is a significant concern. To reduce these risks, there is a pressing need for well-structured arrangements and regulations. This entails promoting sustainable practices in both agriculture and mining, enforcing restrictions and controls to prevent adverse environmental impacts, and fostering the development of environmentally sound technologies and innovations.

Conclusions

In conclusion, the decentralization of environmental policies and competition among local governments had a significantly negative impact on the productivity of green development. It was followed by urbanization, particularly when the rates got higher, resulting in a gradual decline. Meanwhile, a positive relationship was identified between the research and development budget and the productivity of green development. Finally, economic sectors such as agriculture and mining were found to have significantly positive effects on the productivity of green development.

The increase in fiscal policy decentralization and local government competition was reported to require careful moderation, coupled with gradual assistance from the central government. Several implications were considered, including the need to reduce the impact of unilateral policymaking, meaning that the central government was informed about the diverse efforts made by local governments, while deciding on the implementation of specific initiatives. Additionally, the central government had to address the disbursement of funds for research and development to prevent a dilemma resulting in decreased productivity. Finally, arrangements for urban maturity and its development were carried out for prospective new growth centers to prevent population increases from interfering with the productivity of green development.

This research faced limitations due to the use of spatial aspect analysis, preventing the interpretation of spillover impacts between regions. To overcome this, future research was suggested to direct attention towards spatial aspects, allowing for the improvement and further investigation of potential information connections.

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Zone-Based Tourism Planning Using Satellite Imagery

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Abstract

Tourism planning serves as a strategic approach to mitigate and address the damage incurred by tourist attractions, such as the Tangkolak Bahari Center (TMC) mangrove ecosystem, which has experienced a loss of 2 hectares. The primary objective of this research is to formulate a zone-based tourism plan utilizing PlanetScope Dove-R sensor satellite imagery to provide spatial information specific to its application in December 2022. The methodology encompasses various techniques, including observation, structured interviews with tourists, focus group discussions involving tourism managers and local government representatives, digitization, and delineation. The result of research is Zones within the TMC tourist attractions, comprising Main and Supporting Space Plans, Primary and Secondary Circulation Plans, Avicennia, Rhizopora stylosa, and Sonneratia Conservation Vegetation Plans, as well as Plans for Nature, Conservation, Culinary Activities and Facilities, and Green Planning. Notably, the TMC tourist attraction remains viable, covering an area of 2.73 hectares in the West TMC and 1.79 hectares in the East TMC. It is imperative to underscore the importance of considering the sustainability of the mangrove ecosystem in utilizing these areas.

Keywords: Planning; Tourism; Zone; Mangrove Ecosystem; Satellite Imagery.

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1. Introduction

Coastal ecosystem resources, as recognized, encompass mangrove ecosystems, coral reefs, seagrass, and small islands (Asyiawati & Akliyah, 2017). In Indonesia, the mangrove ecosystem spans approximately 3.36 million hectares (Ministry of Environment and Forestry, 2022), equivalent to around 20% of the world's total area (Harini et al., 2019; World Bank, 2023). Mangroves are a variety of tropical coastal communities dominated by several species of typical trees or bushes that can grow in salty waters (Martuti et al., 2019). These ecosystems can endure high salinity (Rahman et al., 2020) and harsh conditions such as frequent high tides and storms (Mafi-Gholami et al., 2019). Additionally, they contribute to carbon absorption (Zhu & Yan, 2022), play a role in element cycles, and address climate change challenges (Liu et al., 2020; Yu et al., 2020). Their significance extends to mitigating the impact of natural disasters like tsunamis and typhoons (Nurdin et al., 2015), preventing erosion and abrasion, serving as a nutritional source for biota, and supplying resources for both human and marine tourism (Prihadi et al., 2018; Tufliha et al., 2019). According to Martuti et al. (2019), Harini et al. (2019), Marlianingrum et al. (2019), Hajializadeh et al. (2020), and Jariego et al. (2023), mangroves function as habitats, shelters for various marine biota, feeding grounds, nursery grounds, and spawning grounds. Consequently, mangroves foster thriving communities of diverse species (Etemadi et al., 2019). Various types of mangrove wood products, such as paper, building materials, charcoal, and construction materials, are essential (Soedarmo, 2018; Jariego et al., 2023). Furthermore, non-wood products, including honey, medicines, tannin, drinks, fish, shrimp, and crabs, are obtained, contributing to valuable packaged products for communities. In summary, the mangrove ecosystem emerges as a potent resource due to its rich processes and multifaceted utility.

Ecologically, coastal ecosystems are intricately linked to human behavior and activities (Utina et al., 2017). Within the realm of human activities, certain practices can exert a negative or detrimental influence, causing harm to mangrove ecosystems, which evident at the Tangkolak Maritime Center (TMC) tourist attraction in Cilamaya Wetan District, Karawang Regency, where a significant portion (2 hectares) of the ecosystem area was lost in 2019. The reduction in mangrove ecosystem area poses severe repercussions for the affected location, including the loss of plant and animal species (Rajan et al., 2013), as well as adverse economic and ecological conditions (Rahmayanti, 2014). This decline has been observed in recent years (Canty et al., 2018; Soanes et al., 2021). Following its inauguration at the end of 2018, the tourist attraction experienced a substantial surge in visits, which directly contributed to the ensuing damage. The considerable influx of tourists, characteristic of tourist attraction development (Poedjiastoeti et al., 2022), can influence the stability of the mangrove ecosystem, with potential harm caused by tourist activities. While an increase in visitor numbers can positively impact the local economy, it may also jeopardize the sustainability of existing resources (Rajan et al., 2013); Ely et al., 2021). Tourist visits, a significant aspect of tourism activities, have the potential to generate plastic waste, particularly microplastics. These particles can accumulate in sediment, disrupting the ecosystem's balance and adversely affecting the biota and food chain associated with it (Anggraini et al., 2020). Continuous natural and social disturbances (Sarastika, 2021) can gradually diminish or even eliminate this restorative capacity (Hanggara et al., 2021). Human utilization of mangrove ecosystems for tourism activities poses a potential threat to the ecosystem. Consequently, there is a need to plan tourism activities based on zones, providing information on existing spaces according to their designated use, which is the aim of this research. The objective is to contribute valuable insights to the local government as a regulatory body, facilitating the realization of sustainability and balance in the utilization of the mangrove ecosystem. This, in turn, will continue to offer economic and environmental benefits to the community surrounding the TMC tourist attraction location.

To safeguard the mangrove ecosystem from potential harm, regional mapping plays a crucial role in equipping local governments with essential knowledge for formulating effective policies within the tourism sector. Broadly defined, planning is an intricate process that involves considering various approaches and aspects to achieve specific goals and address existing challenges (Kasim, 2021). It is characterized as an activity undertaken with foresight, where the outcome is contemplated before choosing among available alternatives (Persada, 2018). Specifically, tourism planning is geared towards ensuring tourist satisfaction, promoting community welfare, and preserving ecological integrity (Hermantoro, 2018). The conceptual framework for tourism planning, as articulated by Zain (2011) regarding the mangrove ecotourism site plan includes inventory, analysis, synthesis and planning.

The remote sensing approach is a valuable method for regional mapping in coastal areas due to its efficiency and speed, especially for large, inaccessible, and costly objects such as mangrove ecosystems (Fawzi, 2016; Fatmawati et al., 2017). The *PlanetScope Dove-R* sensor, part of the *PlanetScope* system, offers a spatial resolution of 3x3 meters, enabling the recording of a total area ±575 km^2. Oktaviani & Johan (2016) classify this spatial resolution as high, and high spatial resolution satellite imagery is known to provide more detailed mapping of mangroves (Samanta et al., 2021). This approach aligns with the perspective of Zain (2011), who asserts that spatial presentation of zoning during the final planning step can be more efficient and accurate through remote sensing data analysis. Consequently, this research will utilize *PlanetScope* satellite imagery with *Dove-R* sensors to plan tourism activities based on zones, aligning with the previously mentioned research aim.

2. Methods

2.1 Study Area

The research is centered on TMC, situated in Sukakerta Village, with coordinates at 107°562'334" East Longitude and -6,182,019 South Latitude. TMC shares its borders with the Java Sea to the north, Blanakan District in Subang Regency to the east, Ciasem District in Subang Regency to the southeast, and Cilamaya Kulon and Banyusari Districts to the west and south (refer to Figure 1). Notably, the Cilamaya Wetan District encompasses an area of 69.66 km^2, constituting 3.97% of Karawang Regency's total area. Muara Village holds the largest area at 14.11 km^2 (20.26% of Cilamaya Wetan District), while Tegalsari Village has the smallest area at 1.98 km^2 (2.84% of Cilamaya Wetan District's total area). Further details about the area of each village can be found in **Table 1** below.

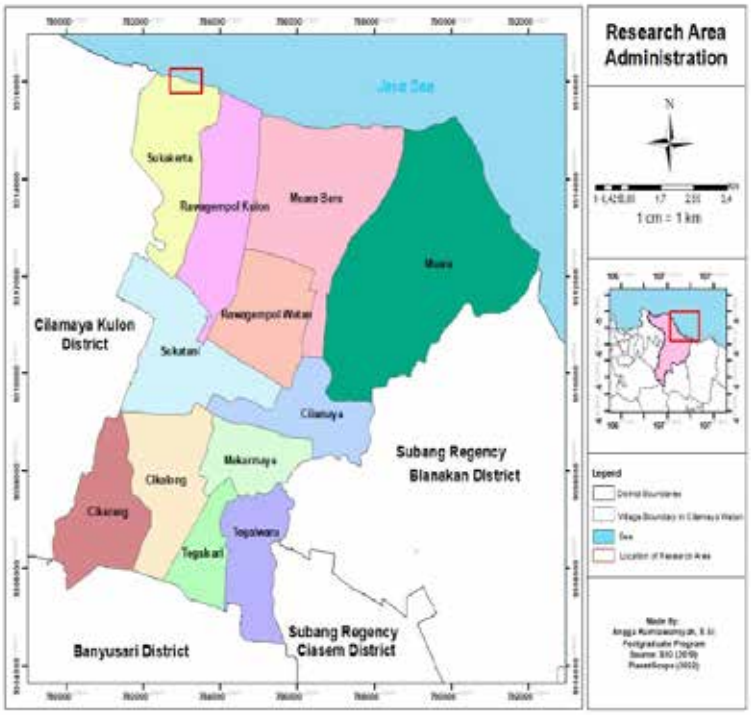

Figure 1. Administration of Cilamaya Wetan District, Karawang Regency
Source: Badan Informasi Geospasial (2019) and Data Processing (2022)

Table 1. Village Area in Cilamaya Wetan District, Karawang Regency

No	Village	Total Area	
		Km²	%
1	Cikarang	3,50	5,02
2	Cikalong	4,11	5,90
3	Cilamaya	3,79	5,44
4	Mekarmaya	3,97	5,70
5	Muara	14,11	20,26
6	Muara Baru	9,43	13,54
7	Rawagempol Kulon	5,64	8,10
8	Rawagempol Wetan	4,82	6,92
9	Sukakerta	6,36	9,13
10	Sukatani	7,91	11,36
11	Tegalsari	1,98	2,84
12	Tegalwaru	4,04	5,80
Total		**69,66**	**100,00**

Based on data from the Karawang Regency Regional Government Work Plan Book (Rencana Kerja Pemerintah Daerah/RKPD, 2016), the coastal area of Cilamaya Wetan District is characterized by a slope of 0-2%. This slope range is considered relatively flat and sloping, encompassing both coastal and water-bordering areas. In accordance with its lowland morphology, Cilamaya Wetan District experiences an air temperature ranging from 26°C to 32°C, with an average of 27°C. Additionally, the district witnesses a yearly rainfall intensity of 1,056 mm, humidity levels of up to 80%, an average air pressure of 0.01 millibars, and a solar radiation time of 66% (Regional Government of Karawang Regency, 2009; Abadi, 2016; Central Statistics Agency, 2021). Furthermore, the wind speed in the Cilamaya Wetan District ranges from 30 to 35 km/hour (Abadi, 2016). These climatic aspects play a crucial role in ensuring the comfort of tourists during their visits (Kurnia, 2016; Wijanarko, 2016; Tuahena et al. 2019; Rukayah, 2020; Lampar, 2021) as in the *Holiday Climate Index* (HCI) (Scott et al., 2016).

2.2 Collection and Processing Data

Tourism planning involves several key steps, as outlined by Zain (2011) in the context of site landscape planning and design. These steps include data inventory, data analysis, data synthesis, and planning (refer to **Figure 2**). The data for tourism planning were gathered through Focus Group Discussions (FGD) with tourism managers and local government, as well as structured interviews conducted with tourists during field surveys. The inventory data comprises both physical and non-physical information related to TMC tourist attractions. Physical data encompasses administrative boundaries, site area, temperature, wind patterns, facilities, scenic views, accessibility, vegetation, and wildlife. Non-physical data, detailed in **Table 2**, includes visitor activities. This physical data takes into account various factors influencing a person's comfort during their activities. These factors, based on the studies by Hakim (2014), Scott et al. (2016), and Tuahena et al. (2019), encompass circulation (movement of vehicles/people between spaces), climate and natural conditions (temperature, wind, and rainfall), noise (distance from the city center/office), cleanliness (availability of garbage facilities), and aesthetics (beauty of the view).

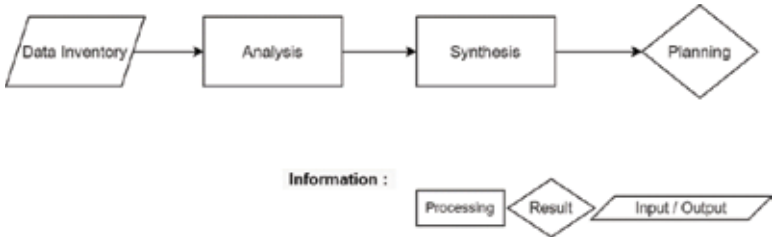

Figure 2. Step of Tourism Planning
Source: Data Summary (2022)

Table 2. Tourism Planning Tabulation

No	Data	Analysis	Synthesis
		Physical	
1	Administration		
2	Site Area		
3	Temperature		
4	Wind		
5	Facility	Potential and Constraints	Options for exploiting potential and controlling constraints
6	*View*		
7	Accessibility		
8	Vegetation		
9	Animals		
		Non-Physical	
1	Visitor Activity	Potential and Constraints	Options for exploiting potential and controlling constraints

Source: Central Statistics Agency (2021)

Afterwards, the data will undergo analysis to assess the potential and identify obstacles at the TMC tourist attraction. Following this, a data synthesis process will be executed, aiming to understand the utilization of potential, address existing obstacles or issues, and formulate zoning strategies. This involves identifying areas that require maintenance and those that need to be replanned within the TMC tourist attraction. The conclusive step involves planning, wherein detailed plans are crafted, utilizing *PlanetScope Dove-R* sensor satellite image data recordings to delineate specific zones.

During the planning phase, digitization was implemented on-site at the TMC tourist attraction, guided by FGD sessions with tourism managers and local government representatives to discuss existing tourist boundaries. The comprehensive plans formulated encompass Space Plans, Circulation Plans, Conservation Vegetation Plans, Activities and Facilities, and Green Planning Plans. The FGD served as a platform for the exchange of thoughts, opinions, and experiences, aiming to establish a shared understanding, consensus, and decision-making (Oktapia, 2019). Following the FGD, a delineation was executed on the previously digitized map based on the outcomes of the discussions. Upon acquiring the designated zones, structured interviews were conducted with tourists to gather data for the Activity and Facility Plan. The final phase in tourism planning involves the symbology process, conducted to enhance the accessibility of information or knowledge by visually representing data intended for display on the map. Subsequently, the tourism planning data undergoes processing in ArcGIS 10.4 software, utilizing insights from the FGD, structured interviews, and synthesis incorporating data from *PlanetScope* sensor *Dove-R* satellite imagery.

3. Results and Discussion

3.1 Social and Physical Condition

According to data from the Central Statistics Agency (2021) Cilamaya Wetan District has a population of approximately 85,426 people, distributed among 28,569 families. Sukakerta Village constitutes about 7.66% of the total district population, with approximately 6,544 people, comprised of 3,325 men (7.88% of the village population) and 3,219 women (7.17% of the village population). The mangrove ecosystem at the TMC tourism site covers an area of 6.5 hectares, as determined through the interpretation of *PlanetScope* sensor Dove-R satellite imagery (refer to **Table 3** and **Figure 3**). According to the research conducted by Kurniawansyah et al. (2023), the mangrove ecosystem's area in Sukakerta Village for TMC tourism in 2019 was 6.0 hectares. Consequently, there has been an increase of 0.4 hectares in the total mangrove area over the last three years. It is noteworthy that TMC West has only one designated area for tourism activities, measuring 0.27 hectares. In contrast, TMC East has two areas allocated for tourism activities, consisting of a main area spanning 0.86 hectares and a supporting area covering 0.02 hectares.

Table 3. The Area of The Sukakerta Village Mangrove Ecosystem

Village	Information		Total Area (Ha)
Sukakerta	Tourism Location	West	3,2
		East	3,3
	Non-Tourism Location		5,6

Source: Dove-R PlanetScope Sensors and Data Processing (2022)

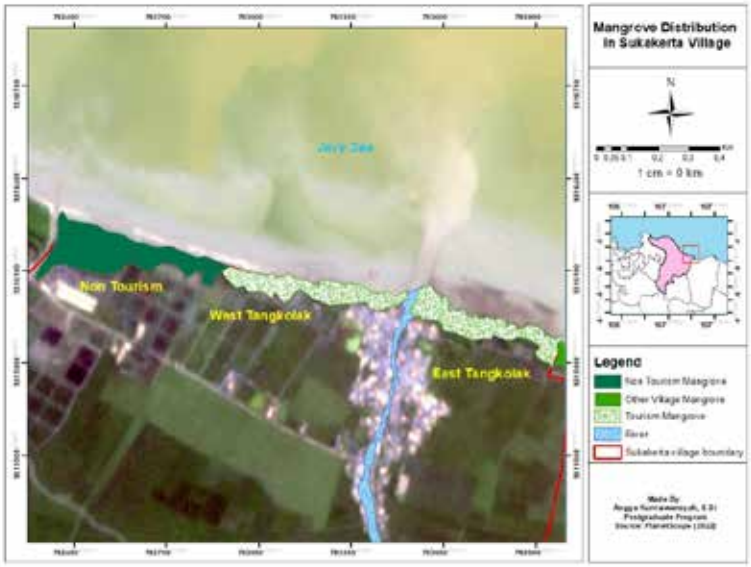

Figure 3. Mangrove Distribution of Sukakerta Village, Cilamaya Wetan District
Source: Dove-R PlanetScope sensor and Data Processing (2022)

For easy access to the primary circulation areas of TMC attractions, whether traversed on two or four wheels, the asphalt roads are quite sufficient. In the western part of TMC, visitors need to pass through local settlements to reach the tourist attractions, while in the eastern part, direct connection to the local road eliminates the need to traverse through surrounding communities. Notably, accessibility to the secondary circulation areas of TMC tourism objects differs between the west and east. In the west, footpaths are the primary means of access, complemented by roads with a casted surface. On the other hand, in the east, footpaths are the main mode of accessibility. Existing facilities at the TMC tourist attraction include food and drink stalls, souvenir shops, gazebos, bridges, wooden shipbuilding, swings, bathrooms, and a maritime gallery. The vegetation across the TMC tourist attraction is categorized into three types: *Avicennia, Rhizopora stylosa*, and *Sonneratia*. In the east, all three types of mangrove vegetation are present, while in the west, only the *Avicennia* species is found. The diversity of biota at TMC tourism sites is extensive, encompassing gobid fish, shrimp, crabs, and cranes. These animals are evenly distributed in both the western and eastern parts, with the exception of cranes, which are exclusively found in East TMC.

In TMC tourism destinations, the western and eastern areas offer distinct perspectives. The Western TMC features captivating offshore views from shipbuilding locations, towering mangrove clusters near bridges, and shipbuilding sites. Additionally, it serves as a gathering spot for cranes in the afternoon. On the other hand, the Eastern TMC presents picturesque offshore scenery and sunsets viewed from bridge structures and gazebo buildings, designed to enhance tourist experiences. It also includes areas for planting diverse types of mangroves and serves as another gathering point for cranes in the afternoon. Tourist activities at TMC tourism destinations are categorized into three aspects: nature, culinary, and conservation. The natural aspect encompasses appreciating the scenery, strolling along roads or tracks, engaging in photography/selfies, and observing wildlife. Culinary activities involve eating and drinking, while the conservation aspect focuses on planting mangrove seedlings. Community activities at TMC tourism destinations involve utilizing mangrove tree trunks for firewood and construction materials,

maintaining food and beverage stalls and souvenir shops, planting mangrove seedlings, and providing tour guide services. These community activities are guided by the local perception of the mangrove ecosystem, viewed as a protective barrier against waves, a hub for tourism, and a source of wood and non-timber products for household fuel and various processed foods and beverages.

3.2 Tourism Planning

The data analysis step involves understanding the potential and constraints of TMC tourist attractions. The objective is to enhance ecological functions by maximizing the utilization and development of existing potential while addressing and overcoming disruptive or obstructive constraints. The synthesis step is crucial for effectively harnessing the identified potential within the object and managing any obstacles or issues identified through data inventory (Zain, 2011). The result of this synthesis step is object zoning, which is defined as a form of space utilization by determining boundaries following resource potential in coastal ecosystems, as stated by (Priyanto et al., 2016) regarding Technical Guidelines for Mapping Zoning Plans for Coastal Areas and Small Islands.

The planning step constitutes a multifaceted phase, evolving through various plans derived from the sequential execution of inventory, analysis, and data synthesis activities. These encompass Space Plans, Circulation, Vegetation, Activities and Facilities, and Green Planning. These plans can be effectively presented spatially using computerized techniques, such as drawing with AutoCAD or utilizing remote sensing technologies, where data analysis is conducted with heightened efficiency and accuracy (Zain, 2011). This research leverages presentations based on *PlanetScope Dove-R* sensor satellite image recordings. These plans are denoted as zones, representing areas with natural attractions like plants, animals, or specific ecosystem formations. These areas possess ample space, ensuring the preservation of potential and energy, making them enticing for tourism and natural recreation. Additionally, the surrounding environmental conditions play a crucial role in supporting efforts towards tourism development. During this step, tracking (digitization and delineation) is executed using Avenza Maps software. Subsequently, conversion to ArcGIS software is undertaken to integrate information pertaining to Space Plans, Circulation, Vegetation, Activities and Facilities, and Green Planning. The planning outcomes gradually materialize and are distinctly presented in **Table 6**, **Figure 4**, **Figure 5**, and **Figure 6** below.

Figure 4. FGD with Tourism Managers and Local Government (left) and Interviews with Tourist (right)
Source: Documentation (2022)

Table 6. Tourism Planning

No	Planning	Space	Specification	Symbology
1	Space Plans	Zone	Main	SPm
			Support	SPs
2	Circulation Plans		Primary	CPp
			Secondary	CPs
3	Conservation Vegetation Plans		*Avicennia* Conservation	VPac
			Rhizopora stylosa Conservation	VPsc
			Sonneratia Conservation	VPss
4	Activity and Facility Plans		Nature	AFpn
			Conservation	AFpc
			culinary	AFpu
5	Green Planning Plans		Planting mangrove seedlings	GPP

Source: Processing Data (2022)

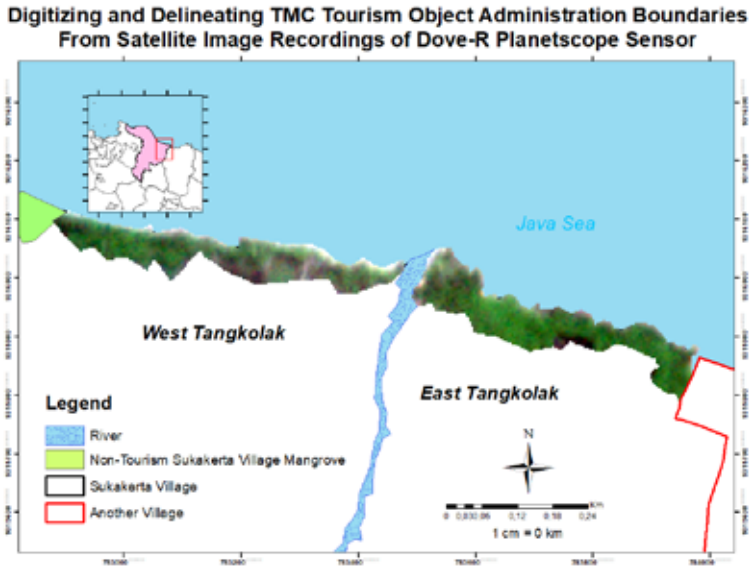

Figure 5. Results of Digitizing and Delineating TMC Tourism Object Boundaries From Satellite Image Recordings of *Dove-R PlanetScope* Sensors
Source: Processing Data (2022)

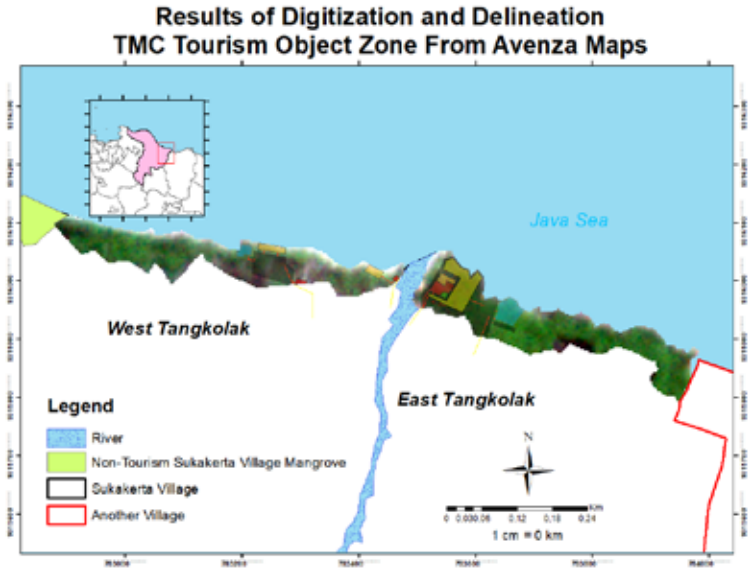

Figure 6. TMC Zone Digitization and Delineation Results From Avenza Maps
Source: Processing Data (2022)

In **Figure 5**, the TMC tourist attraction is clearly visible in the recorded imagery from the *PlanetScope* sensor *Dove-R* satellite, both in the west and east. The satellite imagery recordings are incorporated into the Avenza Maps software, generating plans through tracking processes such as digitization and delineation (refer to **Figure 6**). These plans are the outcomes of discussions with tourism managers and local government through FGD, along with structured interviews conducted with tourists (as illustrated in **Figure 4**). The resulting plans represent specific zones, distinguished by type and color, which are later integrated into the ArcGIS software. **Figure 7** depicts the visual representation of these zones within the TMC tourist attraction, with distinct layouts for both the west (top layout) and the east (bottom layout).

Figure 7. Zone Map on TMC Tourism Objects
Source: Processing Data (2022)

In West TMC, there are distinct Zones, each comprising various components. These include Main Space Plans (SPm), Primary Circulation Plans (CPp), Secondary Circulation Plans (CPs), Avicennia Conservation Vegetation Plans (VPac), Activity Plans, Natural and Culinary Facilities (AFpu), and Green Planning Plans (GPP). In East TMC, the Zone encompasses both Main and Supporting Space Plans (SPm and SPs), Primary and Secondary Circulation Plans (CPp and CPs), as well as Avicennia, Rhizophora stylosa, and Sonneratia conservation Vegetation Plans (VPac, VPsc, and VPss). Additionally, there are Plans for nature, conservation, and culinary Activities and Facilities (AFpn, AFpc, and AFpu), along with Green Planning Plans (GPP). Concerning their distribution, in West TMC, the Space Plans are situated in the western part, while the Circulation Plans are evenly distributed in both the western and eastern regions. The Vegetation Plans mirror the distribution of Circulation Plans, and the Activities and Facilities Plans are predominant in the western section. The Green Planning Plans align with the distribution of Space Plans. Meanwhile, in East TMC, the Space Plans are predominantly located in the western part, with Circulation Plans evenly spread across both western and eastern regions. The distribution of Vegetation Plans and Activities and Facilities Plans mirrors that of the Space Plans. The Green Planning Plans are centrally located in the eastern part.

Figure 8. Dense Mangrove In The Supporting Space Plan (left) and Less Dense Mangrove In The Main Space Plan (right)
Source: Documentation (2022)

There are distinctive zone characteristics between West and East TMC, with East TMC exhibiting greater diversity. This contrast is evident in the Space Plans, where the East TMC is subdivided into a primary area covering 0.86 hectares, constituting 26.06% of the total East TMC area, and a supporting area spanning 0.02 hectares, representing 0.61% of the total East TMC area. In contrast, the primary area of West TMC covers only 0.27 hectares, making up 8.44% of the total West TMC area. Based on the field survey, the Space Plans (SPs) in East TMC are designed to feature denser mangrove trees compared to West TMC SPs, catering to tourists (refer to **Figure 8**). The SPs in both locations are equipped with toilet facilities and gazebos situated on the north and east sides, fostering a conducive environment for tourist interactions. Meanwhile, the tourist-oriented Space Plans (SPm) in both West TMC and East TMC are designed to offer more comprehensive facilities than the Recreational Areas (RRp) in the two locations. For instance, in addition to gazebos, food and drink stalls, souvenirs, and toilets, these SPms also include amenities like swing facilities and a ship-shaped bridge. These additions provide tourists with opportunities to take selfies, appreciate the surrounding scenery, and capture panoramic views (see **Figure 9**).

Figiure 9. Swing Facilities (left), Wooden Bridge (right), Food and Drink Stalls and Souvenirs (bottom)
Source: Documentation (2022)

The SPm area is in proximity to the planting site of mangrove seedlings, making it an appealing destination for tourists. The mangrove seedlings, represented by dark or dense green polygons with the GPP symbology (refer to **Figure 7** for illustration), symbolize Green Planning Plans. This space is routinely utilized for planting mangrove seedlings, primarily through local government initiatives or academic grants (see **Figure 10**). In West TMC, the GPP covers an area of 0.03 hectares, constituting 0.94% of the total area, while the green open space in East TMC spans 0.15 hectares, representing 4.55% of the total area of East TMC. Notably, there is a discrepancy of 0.12 hectares or 1.85% in the TMC tourist attraction GPP area between West TMC and East TMC. This variance arises from the prevalence of programs related to planting mangrove seedlings being more pronounced in East TMC compared to West TMC. Additionally, the disparity in GPP is evident in the geographical positioning of each TMC. West TMC is situated in the northern part, near the shoreline, whereas East TMC is positioned in the west, slightly indented inland. Insights from focus group discussions with tourism managers and local governments reveal that the divergence in location between the western and eastern parts of the TMC is attributed to experimental seed-planting programs conducted in these areas.

This plan shares similarities with the Conservation Vegetation Plan, Activity Plan, and Conservation Facilities. However, a key distinction lies in the fact that the General Public and Tourists are restricted from entering this Green Plantation Project (GPP). This measure is implemented to preserve its aesthetic appeal and minimize the risk of potential damage to mangrove seedlings in the future. The execution of this plan is carried out internally by the local Tourism Awareness Group (TAG), specifically Kreasi Alam Bahari (KAB), in collaboration with the Regional Government. It should be noted that the initiatives outlined in this plan differ from the more widespread programs found in the Conservation Vegetation Plan, Activity Plans, and Conservation Facilities. In the West TMC region, the mangrove seedlings exclusively comprise the Avicennia species. Conversely, the East TMC region features a more diverse planting approach, including Avicennia, Rhizophora stylosa, and Sonneratia mangroves. The selection of mangrove species for planting is informed by the success record of previous plantings in each respective region. Notably, West TMC undergoes periodic Avicennia mangrove species planting, yielding fruitful results. Similarly, East TMC follows a periodic planting regimen, incorporating Avicennia, Rhizophora stylosa, and Sonneratia mangrove species, demonstrating success in seed growth (refer to **Figure 10**).

Figure 10. West TMC Green Planning (left) and East TMC Green Planning (right)
Source: Documentation (2022)

Based on **Table 7**, the Spatial Pattern metric (SPm) in East TMC is broader than that in West TMC, encompassing approximately 0.59 hectares or 26.06% of the total tourism area in East TMC, which amounts to 3.3 hectares. This difference is attributed to the higher frequency of visits to East TMC compared to West TMC. Consequently, the available space to accommodate tourists is more extensive by 0.1 hectares and exhibits greater diversity, encompassing both main and supporting areas. The Critical Point (CPp) of the longest tourism object in TMC is situated in West TMC, specifically in its western section, measuring a length of 131.59 meters. This length exceeds the CPp in East TMC by 59.15 meters. The rationale behind this contrast lies in the necessity for tourists to traverse residential areas to reach the tourist attraction in West TMC. Simultaneously, the longest Critical Points (CPs) are situated in East TMC, boasting a collective length of 161.56 meters, which surpasses the CPs in West TMC by 88.16 meters. This disparity is attributed to the diverse plans implemented in East TMC, enhancing accessibility between different programs.

In the VPac, it is observed that the widest area is situated in West TMC, comprising a total area of 0.09 hectares or 2.81% of the overall West TMC tourism area (3.2 hectares). This is 0.06 hectares wider than the corresponding area in Eastern TMC. The expansion in West TMC is attributed to the exclusive allocation of land in the CVP for the Avicennia mangrove species. In contrast, in East TMC, the VPsc and VPss cover 0.06 hectares and 0.01 hectares, accounting for 1.82% and 0.30% of the total East TMC tourism area, respectively. The *Avicennia* and *Rhizopora stylosa* mangrove species, locally known as *Api-Api* and *Bako-Bako* types, are predominant in the West TMC and East TMC regions, respectively. The planting of seedlings in West TMC is characterized by fires, while in East TMC, it is associated with the Bako-Bako type. The community around the TMC tourist attraction, including TAG and the local government, actively implements this Vegetation Conservation Plan. The variation in the CVP is rooted in the successful track record of previous mangrove seed planting programs, specifically Avicennia mangrove species in West TMC *and Avicennia, Rhizopora stylosa*, and *Sonneratia* mangrove species in East TMC.

Tabel 7. The Area of The Tangkolak Maritime Center Zone (TMC)

No	Zone	Spesification	Total Area	
			West	East
1	Space Plans	Main	0,27 Ha	0,86 Ha
		Support	0,0 Ha	0,02 Ha
2	Circulation Plans	Primary	131,59 m	72,44 m
		Secondary	73,40 m	161,56 m
3	Conservation Vegetation Plans	*Avicennia*	0,09 Ha	0,03 Ha
		Rhizopora stylosa	0,0 Ha	0,06 Ha
		Sonneratia	0,0 Ha	0,01 Ha
4	Activity and Facility Plans	Nature	0,06 Ha	0,37 Ha
		Conservation	0,017 Ha	0,004 Ha
		culinary	0,0 Ha	0,01 Ha
5	Green Planning Plans	Area	0,03 Ha	0,15 Ha

Source: Processing Data (2022)

The plans for Activities and Facilities (AF) at TMC tourism sites are divided into three aspects, namely nature (AFpn), culinary (AFpu), and conservation (AFpc), based on tourist interviews. The nature aspect includes activities like appreciating scenery, walking/tracking, photography/selfie-taking, and observing animals. Culinary activities involve eating and drinking, while the conservation aspect focuses on planting mangrove seedlings. Nature-related activities are consistently popular in both West TMC and East TMC, with 30.30% (10 people) and 69.70% (23 people) of encountered tourists engaging in these activities, respectively. Culinary activities are reported by 6.06% (2 people) at West TMC and 9.09% (3 people) at East TMC, facilitated by food and drink stalls around the TMC tourist attraction (refer to **Figure 9**). The conservation aspect is exclusive to East TMC, where 12.12% (four people) of tourists participate in planting mangrove seedlings through a program initiated by the local regional government, with guidance from TAG and local authorities directing tourists to contribute to managing the mangrove ecosystem. In contrast, all ten tourists encountered at West TMC reported never engaging in, nor receiving instructions to participate in, planting mangrove seedlings during their visits, resulting in no tourists being involved in conservation activities at West TMC.

According to interview data, the age range of tourists varied from 17 to 31 years old, with females comprising the majority (57.58% of total encountered tourists). Additionally, tourist origins were categorized into three regions: Bekasi, Karawang, and Subang. Notably, the Karawang region had the highest proportion of tourists, accounting for 81.82% of the total encountered. This suggests that the TMC tourist attraction has yet to capture the interest of many visitors from outside the Karawang area. Typically, tourists from Bekasi and Subang are families seeking quality time together, while those from Karawang are either individuals or small groups (twos/threes) looking to appreciate the mangrove views due to their proximity to the TMC tourist attraction. Furthermore, the field survey revealed a higher presence of tourists in East TMC (39.39% of total) compared to West TMC, resulting in a total visitation rate of 69.70%. Interviews indicated that this preference for East TMC is attributed to its better facilities, including gazebos, food and drink stalls, souvenir shops, maritime galleries, toilets, and other amenities.

Based on the findings of the field survey and map visualization, it is evident that the zones within TMC tourism sites exhibit distinct characteristics. Notably, there are areas that remain untapped and

could be optimized for greater functionality (refer to **Figure 7**). For instance, the central part of West TMC could be designated for Special Purpose (SP) utilization. Upon selecting this location for SPs, subsequent plans such as Circulation Plans, Vegetation Plans, Activities and Facilities Plans, and Green Planning Plans would naturally ensue. Furthermore, in the eastern part of East TMC, there is currently no designated zone that could be earmarked for Vegetation Plans or Activity and Facility Plans. In terms of total area, TMC tourism sites still have 4.52 hectares available for utilization. Specifically, in West TMC, this constitutes 2.73 hectares, representing 85.41% of the total area of West TMC attractions. In East TMC, 1.79 hectares are available, accounting for 54.12% of the total area of East TMC tourist attractions. It is crucial to note, however, that a meticulous and thorough assessment is necessary to gauge the potential impact of these tourism activities on the mangrove ecosystem, both in the short and long term, in order to ensure sustainability.

3.3 Discussion

The findings in this study are consistent with the research conducted by Hasanah (2019) and the book by Kurniasih & Musdinar (2020) that map visualization can provide an overview of site location and site design. The study's exploration of planning underscores an understanding that certain facets of the planning process mirror components of current mangrove ecosystem management. Alternatively, the planning activities are implemented on established tourist sites with existing ecosystem management programs. It is widely recognized that TMC tourism sites already possess management programs, such as the cultivation of mangrove seedlings. The focus of this research is to enhance and augment existing management aspects by furnishing zone information. This endeavour aims to catalyse the development of more robust management practices, considering environmental, economic, and socio-cultural perspectives.

Numerous studies have explored tourism planning through the utilization of remote sensing instruments. One noteworthy study conducted by Nugraha et al. (2015) focused on ecotourism landscapes, employing Landsat 8 OLI satellite imagery to develop key concepts, namely Space Plans, Circulation Plans, and Green Plans. This development refers to Zain (2011) in the form of inventory, analysis, synthesis, planning, and design planning. Remote sensing uses an overlay technique to visualize inventory data in location and space plan size. Ambarita (2017) employed SRTM satellite imagery and Google Earth to assess the research area's condition, delineation, and slope analysis. The development of the planning concept also refers to Zain (2011) in the form of Space Plans (reception, service, support, and ecotourism), Circulation Plans, and Green Planning Plans. Pranatha et al. (2015) in their research using Google Earth regarding the description of the research area, developed the planning concept encompassed Space Plans, Circulation Plans, and Infrastructure and Facilities Plans. Wakyudi (2016) focused on tourism planning for ecotourism landscapes in conservation areas and employing remote sensing for land cover and land use inventory through mapping. The planning concept encompassed Ecotourism Area Plans, Space and Circulation Plans, and Activity and Facilities Plans. Gultom et al. (2019) employed Google Earth for visualizing the Kaliurang tourism area. This resulted in a comprehensive tourism planning concept, including Space Plans, Circulation Plans, Green Planning Plans, Activities and Facilities Plans, and Evacuation Plans. In the current research, tourism planning development will leverage remote sensing, specifically utilizing *PlanetScope* sensor *Dove-R* satellite imagery. This sensor offers updated capabilities in the realm of remote sensing for tourism planning. Remote sensing proves valuable in tourism planning by facilitating the identification of general information, collection of regional data, and regional visualization. The gathered data will serve as a crucial reference for the formulation of effective planning strategies.

This research aims to address various gaps identified in previous studies on planning in mangrove ecosystems. Notably, Nugraha et al. (2015) encountered shortcomings in visualizing all research locations separately and failed to include an inventory of non-physical data, focusing solely on community support within the tourism framework. Similarly, Pranatha et al. (2015) omitted an explicit explanation of the data types involved in the inventory process, both physical and non-physical, connecting them directly to the results of the inventory analysis. This deficiency is echoed by Muchibi (2015) particularly in the context of educational and recreational facilities. Furthermore, Wakyudi (2016) neglected to elucidate the interview data obtained through questionnaires, which were integral to gathering primary data for formulating tourism development zone plans. Additionally, there was a lack of segmentation of respondents in Wakyudi's study. Ambarita (2017) focused narrowly on planning development, specifically in terms of an activity space plan for tourism and a circulation plan. Juhariah (2017) provided only a concise explanation

of the physical aspects during the inventory step, potentially resulting in a dearth of information on the research area's potential. Research conducted by Santos et al. (2017) primarily centers on enhancing local economies through livelihoods, neglecting the establishment of zones dedicated to community-driven ecosystem management. Brenner et al. (2018) employed Google Earth satellite imagery and ArcGIS software for environmental planning, yet the cartographic analysis of mangrove area loss lacks detailed explanation, showcasing only visible polygons. Planning by Gultom et al. (2019) lacks clarity regarding its origins, presenting a descriptive approach unsupported by field data or validation through interviews. Rakotomahazo et al. (2019) utilized participatory mapping, but fails to provide detailed numerical data for each of the 10 villages. Wijaya (2020), focuses solely on planning structures as tourist support facilities. Planning by Kasim (2021) is not specific to clearly describe the location and route of disaster evacuation. Planning by Rahayu (2021) only focuses on supporting tourist activity facilities and does not include plans for other spaces. Ramadhan (2021) limits its design focus to buildings within the mangrove zone. Villacrés (2021) states that there is no visualization of landscape planning from the results of satellite imagery workshops by community organizations. Finally, Cheris et al. (2022) introduces semi-private zones in their planning, potentially disrupting mangrove conservation research and the cultivation of snails and shellfish accessible to tourists.

The findings of this research directly support recommendations for several future studies in tourism planning. Brenner et al. (2018) emphasized the need to focus planning on spatial steps. Juhariah (2017) highlighted the importance of fostering collaboration among stakeholders, managers, and local communities in landscape arrangement to promote sustainable tourism. Basyuni et al. (2018) underscored that knowledge about mangrove tourism landscapes will enhance understanding of community-based mangrove management in the future. Additionally, Erlinda et al. (2022) suggested that developing tourism facilities and infrastructure is a key strategy for the sustainable management of mangrove ecosystems.

In the perspective of researchers, the tourism planning framework proposed by Zain (2011) is better suited for implementation in areas of the mangrove ecosystem that already host tourist attractions or have established walking tourism routes, such as TMC (e.g Muchibi, 2015; Nugraha et al., 2015; Pranatha et al., 2015; Idajati et al., 2016; Wakyudi, 2016; Ambarita, 2017; Juhariah, 2017; Wijaya, 2020; Kasim, 2021; Rahayu, 2021; Ramadhan, 2021; Santoso et al. 2021; Cheris et al., 2022). Conversely, this planning concept appears to be less suitable for areas within the mangrove ecosystem lacking tourist attractions, protected zones, or defined boundaries (such e.g., Abdullah et al. 2014; Purnomo et al. 2015; DasGupta & Shaw, 2016; Setiawan, 2016; Umilia & Asbar, 2016; Hutabarat, 2018; Damastuti & de Groot, 2019; Martínez-Espinosa et al. 2020; Miller et al. 2020; Valenzuela et al. 2020; Arumugam et al. 2021; Aulia et al. 2021; Ely et al., 2021; Handayani, 2021; Rakotomahazo et al. 2021; Suyadi et al. 2021; Wahyurini et al. 2021; Gómez-Ruiz et al. 2022: Nyangoko et al. 2022). This is because during the inventory phase, the study involves both physical and non-physical information about mangrove areas for planning purposes, serving as both supporting and primary data. Without existing tourist attractions in the mangrove area, obtaining physical and non-physical information becomes considerably challenging. For instance, physical information related to the area, mangrove density, and biota types is closely linked to administrative boundaries. Lack of knowledge about the administrative boundary of the tourist attraction hampers the collection of physical information, rendering it impossible for analysis, synthesis, and planning. Even if non-physical information can be gathered, its significance is limited when there is no existing tourist attraction, as it remains isolated data without specific meaning.

In addition, the development of this planning concept should take place at a step where more detailed information is accessible regarding the specifications of each scientific discipline. This includes both physical and non-physical data, with a predominant focus on spatial elements, intended for the utilization of remote sensing technology. For spatial data, whether dominantly spatial or not (e.g., categorization with coding), computerized techniques can be employed. This approach aligns with the perspective of Nurhayati et al. (2019), advocating for the use of information technology to optimize marine tourism through effective zoning and infrastructure enhancement. Furthermore, the development of the concept can involve zoning existing plans based on research objects as a form of standardization. For instance, in the case of coastal ecosystems, the research objects encompass Space Plans, Circulation Plans, Vegetation Plans, Activities and Facilities Plans, and Green Planning Plans. Similarly, for forest ecosystems, research objects include Space Plans, Circulation Plans, and Activities and Facilities Plans. However, the specific determinations can be adapted to the conditions of the research object in the field.

For example, if the research object is exposed to disaster risks such as tsunamis, volcanic eruptions, landslides, and others, an Evacuation Plan, as demonstrated in the research by Gultom et al. (2019) and Kasim (2021).

Conclusions

The TMC tourism objects are divided into Zones, comprising the Main Space Plan (SPm), Supporting Space Plans (SPs), Primary Circulation Plans (CPp), Secondary Circulation Plans (CPs), Avicennia (VPac), Rhizophora stylosa (VPsc), and Sonneratia (VPss) Conservation Vegetation Plans, as well as nature (AFpn), conservation (AFpc), culinary (AFpu) Activities and Facilities Plans, and Green Planning Plans (GPP). Each Zone exhibits distinct characteristics, and based on calculations, 2.73 hectares in West TMC and 1.79 hectares in East TMC remain available for utilization, with careful consideration for the sustainability of the mangrove ecosystem. This research identifies the need for future studies on tourism planning in mangrove ecosystems. Specifically, a more comprehensive examination is essential during the data inventory process, encompassing both physical and non-physical aspects, as the data is subjective. Moreover, deeper collaboration is crucial with the community, tourism managers, and local government to ensure the accuracy and depth of information. Additionally, the study underscores the importance of incorporating information on administrative boundaries at tourist attractions to effectively guide zone-based tourism planning.

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Examining Biogas Potential from Rotting Fruits for Advanced Waste Management, Environmental Conservation, and Sustainable Energy Generation

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Abstract

This research aims to analyze the efforts of Koperasi Gemah Ripah Yogyakarta in converting rotting fruits into biogas as part of waste management at Gamping Fruit Market. The methodology involved interviews, field studies, and a comprehensive literature review from various journals. The research findings are threefold. Firstly, Koperasi Gemah Ripah employs a systematic approach to waste management comprising collection, transportation, and disposal. Secondly, the biogas produced through the processing efforts made by Koperasi Gemah Ripah serves as an alternative energy source, generating electricity. Thirdly, the collaborative partnership between Koperasi Gemah Ripah and the Waste Refinery Center at Universitas Gadjah Mada has been proven to be successful in innovatively managing waste by converting it into biogas. In conclusion, the research underscores the effective waste management strategies implemented by Koperasi Gemah Ripah, showcasing the potential of biogas as a sustainable solution to mitigate environmental damage.

Keywords: Koperasi Gemah Ripah; Waste Management; Biogas.

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1. Introduction

This study explores the role of *Koperasi* (cooperative) in waste management at Gamping fruit market, in Special Region of Yogyakarta province. In general, cooperatives play a role as an organization that aims to improve the economy (Widiyanti, 1994). However, the authors see that Koperasi Gemah Ripah has a special role in waste management at Gamping fruit market environment, making it different from most cooperatives which focus only on economic activities. The authors also want to emphasize waste management, i.e., converting waste into biogas which can produce electrical energy reserves for energy needs at Gamping fruit market environment. A huge issue found at Gamping fruit market is the accumulation of fruit waste from the purchase and sale transactions at the market. In order to reduce this waste buildup, Koperasi Gemah Ripah makes efforts to minimize waste, i.e., rotting fruits.

The word “koperasi” is derived from “co” and “operation”. Cooperatives become an organization based on kinship as a people's economic movement (Anoraga & Sudantoko, 2002). In Indonesia, cooperatives are regulated in Law Number 25 of 1992; the law contains the principles of cooperatives. Overall, cooperatives are engaged in the economic sector because cooperatives are designed for economic purposes (Sitio & Tamba, 2001). In Indonesia, cooperatives are organizations that are accepted by society because cooperatives culturally represent community life based on kinship (Hadhikusuma, 2000). In 2022, in Indonesia there have been 130,354 cooperatives across various regions (Rizaty, 2023). That number shows that cooperatives are economic organizations that are accepted in Indonesian society. The authors see the uniqueness of Koperasi Gemah Ripah (KGR) in Yogyakarta, namely that KGR performs waste management at Gamping market environment. The waste management by KGR can generate a non-fossil energy source through the conversion of rotten fruits into biogas.

In Indonesia, waste has been by Law No. 18 of 2008 concerning Waste Management as the residue of human daily activities and or natural processes in solid form. Fruit waste at Gamping Market is included in a specific type, namely the type of biodegradable organic waste that can be used as compost. There are some stages in waste management including collection, transportation, and disposal (Snow, 2002). Each stage has its own system. Firstly, waste collection begins with filling a container with waste and ends with loading it to a collection vehicle (Bilitewski et al., 1997:64). Second, waste transport process is the process of unloading the waste from the collection vehicle or through a storage pit which is then brought to the final disposal site (Bilitewski et al., 1997:71). Third, the disposal process starts from collecting the waste that has previously been transferred through certain methods to be disposed of at landfills. This final process should have gone through various kinds of waste sorting, especially the selection of reusable or dangerous waste (Bilitewski et al., 1997).

The type of waste at Gamping market is biodegradable organic waste. The waste generated is rotting fruits. Unmanaged fruit waste will end up in food waste. Food waste has a negative effect on the environment. However, if managed properly, it will have an impact on reducing pollution that results from food waste (Mobaseri et al., 2021). Food waste has significant social, economic, and environmental consequences (Cosbuc et al., 2021; Stefano et al., 2021a). Most developing nations lack the technical and financial capacity to safely manage solid waste (Abdelhamid, 2014). Waste generation per capita in developed countries has nearly tripled over the last two decades, reaching a level five to six times higher than that in developing countries. Waste generation in developing countries is also rapidly increasing and may double in volume in the current decade (Katiyar, 2016). Inadequate waste management practices degrade the environment and pose health dangers (Rahman et al., 2021). Various factors influence food loss at various points of the supply chain. Wastage during processing, storage, shipping, and in the marketplace is one of these reasons (Kör et al., 2022; Żukiewicz et al., 2022). According to FAO data, food waste can amount to 1.3 billion tons per year (Devi & S, 2023). When food waste is disposed of in landfills, it decomposes and produces methane gas, which is more effective than carbon dioxide at trapping heat in the atmosphere (Sakai et al., 2012). Rotten fruits are included as food waste which can be reprocessed into useful goods. Asia Pacific accounts for 42% of fruit and vegetable waste (Tang, 2013). Based on these data, food waste, especially fruit and vegetable waste, has a large enough contribution to environmental damage. Recovery and recycling of useful components from food waste can help lessen environmental and human health problems (Ungureanu-Comanita et al., 2020).

Waste management is carried out by Koperasi Gemah Ripah to convert waste into valuable items, specifically energy reserves to supply electricity. In addition, environmental damage caused by food waste is also the focus of the SDGs, specifically number 12 with the theme "responsible consumption and production" aimed at ensuring sustainable consumption and production patterns (Hoballah & Averous, 2015a). SDGs 12 targets include reducing the amount of food waste in the world by achieving environmentally friendly management to reduce the release of hazardous chemicals such as ammonia gas into the air, water, and soil to minimize adverse impacts on the environment and human health (United Nation, 2017). SDG 12 requires fundamental adjustments in industrial processes and society as a whole (Guevara & Julián, 2019). Through green processes such as anaerobic digestion, co-digestion, composting, enzymatic treatment, ultrasonic, and hydrothermal carbonization, food waste can be used as a sustainable source of high-value energy, fuel, and nutrients (Usmani et al., 2021). Efficient waste management can reduce the cost of producing processed food (Khedkar & Singh, 2018). By implementing environmentally friendly management, the problem of food waste can be addressed better.

Koperasi Gemah Ripah at Gamping Fruit Market in Yogyakarta converts rotting fruits into biogas to produce electricity. The electricity generated adds to the supply of electricity for activities around Gamping Fruit market. Koperasi Gemah Ripah has a role in waste management at Gamping Fruit market area. Koperasi Gemah Ripah manages food waste at Gamping Fruit market to be processed into biogas. Biogas produced from the utilization of rotten fruits is a new renewable energy alternative. The electrical energy generated from the management of rotten fruits is used for the needs of the Gamping Fruit Market community. Koperasi Gemah Ripah successfully utilizes waste to be used as electric energy. This way, rotten fruits, which are included as food waste with no selling value, can become more useful after being processed into biogas which can produce electric energy for the surrounding community.

Cooperatives carry out activities to support the economy. As researched by Arifandy et al. (2020), cooperatives seek to improve the fishermen's economy in Sumenep Regency. Cooperatives in Arifandy et al. (2020) make efforts to improve the welfare of the members. Cooperatives provide savings and loan services to support fishermen's activities in Sumenep Regency (Arifandy et al., 2020). Besides, Hanafi (2020) conducted research to explore the role of cooperatives in reducing poverty in the village of Nanggela, Cirebon Regency. The cooperative in the village has a program to market products made by the local residents. This cooperative focuses on reducing poverty by becoming a trade facilitator for the local residents. The cooperative has the opportunity to distribute goods widely (Hanafi, 2020).

Waste management problems in developing countries are open dumping and open burning which result in environmental contamination and social problems. Mismanaged waste in developing countries contributes to environmental problems such as air and water pollution, as well as health issues (Ferronato & Torretta, 2019). An article written by Spadaro et al. (2021) focuses on the issue of waste management in the European Union region by highlighting the need for new policies for port cities. Spadaro et al. (2021) emphasize the importance of sustainable waste management, especially in port cities. They also mention that waste in port cities has the potential to generate waste for coastal communities and urban waste can pollute the oceans (Spadaro et al., 2021).

The concept of Sustainable Development is a framework for the researchers to see the efforts made by Koperasi Gemah Ripah. Through this conception, the researchers see that the efforts made by this cooperative are based on the concept of sustainable development where cooperatives carry out waste management as a sustainability effort. The concept of Sustainable Development in the world of International Relations has become the basis for analyzing the problems that occur (Morán-Blanco, 2022). The definition of this concept itself is development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brindtland Commission, 1987). Sustainability is the basis of many of today's international cooperations. There are three things that underlie the concept of sustainable development, namely economic, environmental, and social factors (Coghlan, 2019). With the sustainability of the three sectors in this concept, the goal is to create better conditions for the survival of human life. Sustainability is defined as providing the demands of the current generation without jeopardizing future generations' ability to meet their own needs (Church et al., 2022).

The essence of the concept of sustainable development is revolutionary, meaning that this concept makes a complete and fundamental change (Amacker, 2011). However, there are challenges to carrying out the concept, namely not only to educate a concept but also to be able to define and understand it. In its development, sustainable development is now the basis for Agenda 21. Where this agenda is a comprehensive plan of action to be taken globally, nationally, and locally by the United Nations system

organizations, Governments, and Major Groups in every field where humans impact the environment (United Nation, 1992). Now many countries have been making efforts to be aware of and understand the concept of sustainable development and make changes domestically or internationally. This regards the fact that the goals of Agenda 21 are to achieve sustainable global development as well as combat environmental degradation and poverty (Deka & Neog, 2020). These goals can be achieved by enhancing international cooperation and national policies.

2. Method

In examining the role of Koperasi Gemah Ripah at Gamping Fruit Market in Yogyakarta in terms of its effort to reduce environmental damage in the midst of technological advances, this paper uses two methods, namely the qualitative method and the library research method. Qualitative methods are used to gain in-depth understanding of the role of Koperasi Gemah Ripah in its waste management efforts, i.e., converting waste into renewable energy. The data analysis was carried out inductively from specific themes to general themes and the researchers interpreted the meaning of the collected data (Cresswell, 2009). The collected data were in the form of information related to the role of Koperasi Gemah Ripah at Gamping Fruit Market, particularly in terms of waste management and the conversion of waste into renewable energy. The data collection was conducted through interview methods with Bambang Rahardjo, the manager of Koperasi Gemah Ripah, to obtain direct insights. Additionally, the researchers also conducted a literature review to gather additional information from various relevant sources. The data validity was maintained by using qualitative methods involving direct interviews with relevant parties, carefully designing questions, focusing on the research objectives, and ensuring the data validity.

2.1 Analysis

The qualitative methodology was implemented through a comprehensive approach involving interviews with the management of Koperasi Gemah Ripah. In addition, the researchers undertook on-site observations and field studies at Gamping Fruit Market in Yogyakarta, allowing for directly observing the activities related to the management of biogas for its conversion into electric energy. This study also used thematic analysis, employing an analytical approach that involves identifying, analyzing, and recording recurring patterns within existing data (Braun & Clark, 2006 in Kiger & Varpio, 2020:2). This analytical method was used to describe the collected data, providing the researchers with a foundation for interpretation. The interpreted data comprised insights gathered from the field observations at Gamping market and interviews with the management of Koperasi Gemah Ripah. Subsequently, the researchers meticulously analyzed the data to generate meaningful discussions. The analytical process followed an inductive approach, starting with specific thematic elements and progressing towards more general themes, aligning with the methodology outlined by Cresswell (2009). The data, sourced from the interviews and literature research, were systematically categorized based on themes associated with the role of Koperasi Gemah Ripah in waste management. This categorization helped summarize information and identify relevant patterns. In the final step, the researchers interpreted the collected data, followed by drawing conclusions pertaining to the role of Koperasi Gemah Ripah in waste management at Gamping Fruit Market. This thorough and systematic approach resulted in a comprehensive understanding of the involvement of the cooperative in addressing environmental challenges within the context of the market's technological advancements.

3. Results and Discussions

Koperasi Konsumen Pasar Induk "Gemah Ripah" or Koperasi Gemah Ripah was established in 1995. Currently there are 215 members of the cooperative, consisting of 116 traders, 41 employees, and 58 staff. This cooperative has various types of businesses including vehicle entry fees, savings and loans, procurement of crates, and waste management. In this study, the researchers focus on the waste management by Koperasi Gemah Ripah at Gamping Fruit Market in Yogyakarta. This cooperative has made efforts to manage fruit waste to be used as biogas. In the processing of biogas, the cooperative is supervised by the Waste Refinery Center of Universitas Gadjah Mada.

3.1 Waste Management by Koperasi Gemah Ripah

The problem of waste accumulation at Gamping Fruit Market in Yogyakarta was the reason for making innovations in the form of processing rotten fruits into biogas energy. In fact, the accumulation of rotten fruits have brought negative effects on the environment and social community around Gamping Fruit Market. Rotten fruits release ammonia gas, thus causing air pollution in the surrounding area which disturbs the cleanliness of the market. In addition, ammonia gas can cause respiratory problems (Utami, 2022). Thus, waste accumulation can reduce the public health index.

Based on Law No. 18 of 2008 issued by the government, waste management aims at improving public health and environmental quality as well as making waste a resource that can be utilized. Koperasi Gemah Ripah Yogyakarta strives to carry out these activities to create better conditions for the community and the environment, especially at Gamping Fruit Market in Yogyakarta. In fact, the rotten fruit waste accumulation at the market can reach 4-10 tons per day. With such a large amount, processing rotten fruits into biogas energy is seen as a great potential as a waste management measure to reduce environmental damage. The development of a biogas production pilot project managed by Koperasi Gemah Ripah is in collaboration with several domestic and international institutions, including the Sleman Regional Government, Universitas Gajah Mada, University College of Boras (Sweden), and the Boras City Government.

3.1.1 Collection, Transportation, and Disposal System

The main role of Koperasi Gemah Ripah in making biogas energy from rotting fruits is to provide raw materials, provide a site for the biogas plant, and manage the operation of the biogas pilot project. The cooperative collects waste on a daily basis. The cooperative manages waste in three stages around the market, namely first, collecting waste from market stalls; second, transporting the waste by truck to a designated location; third, sorting waste, whether it should be disposed of at landfills or processed into biogas.

The waste management process carried out by Koperasi Gemah Ripah involves the collection, transportation, and disposal of fruit waste at Gamping Fruit Market. The cooperative plays a key role in providing raw materials and a location for the biogas production as well as overseeing the operation of the biogas pilot project. The waste management process is conducted in three stages, namely waste collection from the market stalls, waste transportation to designated locations, and waste disposal, including the conversion of rotting fruits into biogas.

In the first stage, waste is collected daily from the market stalls, with cleaning crews deployed early in the morning. Sellers sort waste into non-organic and organic categories to ease later disposal. Some waste from rotting fruits is managed by the cooperative to be used for biogas production. The waste collection process involves transporting the waste from the market stalls to the final disposal site (landfill) or the biogas processing location.

"Every day starting at 6 am, the cooperative deploys cleaning crews to sweep and collect rubbish from the stalls. The cooperative also has a waste collection truck that patrols arround the market stalls" (Interview: manager of Koperasi Gemah Ripah, September 4, 2023)

Sellers sort non-organic waste from organic waste. This aims to make it easier for the cooperative to classify the types of waste because waste has two disposal methods in the final stage. The cooperative collects waste from the sellers' stalls in the morning. This waste collection is carried out by transporting the waste from the stalls to either the final disposal site or biogas processing site. Some waste from rotting fruits is managed by the cooperative to be converted into biogas. The cooperative has 11 employees who manage waste at Gamping Fruit market. First, the waste at Gamping market is sorted to determine where it should be disposed of. Waste such as plastic and wood is transported by the cooperative to the landfill, while rotting fruits are converted by the cooperative into biogas.

In the second stage, the cooperative transports waste by a garbage truck. Non-organic waste will be transported to a landfill as determined by the government. There are two destinations where the waste can be transported, namely the landfill by a truck and the biogas processing site, especially for

rotting fruits (*Figure 1*).

"The cooperative transports fruit waste using a vehicle which is a grant from Universitas Gadjah Mada. There are two people whose job is to transport certain fruit waste to be converted into biogas. The fruit waste to be converted into biogas is not collected every day, but three times a week. (Interview: manager of Koperasi Gemah Ripah, September 4, 2023)

Figure 1. Vehicle to transport rotten fruits (photographed by the author)

In the third stage, the cooperative determines the disposal site for the waste generated around the market. Non-organic waste is disposed of to the landfills determined by the government, while some of the rotting fruits is processed into biogas. The waste, specifically for processing into biogas, is collected three times a week, not every day, preventing the biogas processing site from being overloaded.

A specific problem with the waste at Gamping market is fruit waste because there is too much fruit waste. Certain fruits will be processed into biogas. (Interview: manager of Koperasi Gemah Ripah, September 4, 2023)

The biogas plant is located right inside Gamping Fruit Market, making it possible for the market community to supervise the process. The operational activity carried out by the cooperative is to put rotten fruits into the biogas plant, then regulate the use of the resulting electric energy. Before carrying out the process, the cooperative first conducts a feasibility study to review the aspects of needs, technology, raw materials, and support. The first aspect is need, i.e., the basis for this activity is to minimize the impact of landfilling on public health due to an increase in the number of diseases, air pollution, and soil pollution. The second aspect is technology, i.e., in practice the technology used to convert rotting fruits into biogas energy has been standardized according to the local needs and conditions. The third aspect is raw materials, i.e., most of the waste generated at Gamping Fruit Market in Yogyakarta is rotten fruits, so instead of transporting it to *Tempat Pembuangan Sementara* (TPS) or *Tempat Pembuangan Akhir* (TPA), the waste can become a recyclable resource to create biogas energy to produce electric energy. The last aspect is support, i.e., by collaborating with many parties and improving the quality of the existing human resources, this program can be carried out properly to increase the understanding of the surrounding community about the importance of being responsible for consumption and production activities.

In the first stage, Koperasi Gemah Ripah collects waste from the market stalls at Gamping Fruit Market. Sellers typically leave their waste in front of their stalls to be picked up by the cooperative. The waste is sorted into non-organic and organic waste to ease proper disposal. Every morning, the

cooperative collects waste from the market stalls and transports it to either the landfill or the biogas processing site. Some fruit waste is processed into biogas. In the second stage, the cooperative transports non-organic waste by a garbage truck to a government-designated landfill. Some fruit waste, however, is transported to the biogas processing site. In the third stage, the cooperative continues its waste management efforts by transporting non-organic waste to government-designated landfills. In addition, the cooperative also transports fruit waste for biogas processing, typically three times a week, to prevent the biogas plant from being overloaded.

The processing rotten fruits into biogas energy that produces electricity has given a positive impact and received positive responses from the community of Gamping Fruit Market. Based on the field survey conducted by the authors, the market community greatly benefits from this activity. Reducing waste accumulation and making market conditions more comfortable are some of the positive impacts perceived by the community. The collection of rotten fruits by the cooperative also benefits the community, especially in relation to the management of waste generated from the production and consumption activities in the market. In addition to the problem of waste, electric energy produced from biogas energy also provides many benefits to the market community. This is very useful when the market experiences a power outage. With the existence of electric energy from the biogas processing, the market community still has electricity reserves and can carry out activities as usual without experiencing problems caused by power outage. The community hopes that Koperasi Gemah Ripah can continue the activities of producing biogas from rotting fruits and continue to improve the quality of its activities. The biogas plant is located within Gamping Fruit Market, enabling the community to oversee the process. Before initiating the process, the cooperative first conducts a feasibility study which covers several aspects such as needs, technology, raw materials, and support. This initiative aims to mitigate the negative impact of landfilling on public health and promote responsible consumption and production practices within the community.

3.2 Conversion of Fruit Waste into Biogas

The biogas plant is managed by Koperasi Gemah Ripah under the supervision of the Waste Refinery Center of Universitas Gadjah Mada (WRC UGM), where the installation was designed through a research scheme by UGM and Boras University (Marendra et al., 2020:2). The cooperative hires employees to manage the biogas production at the biogas plant. The cooperative handles the management of waste collection, transportation, and sorting before processed at the biogas plant. The rotten fruits produced by Gamping Fruit Market are very large in amount, with cumulative waste generation above 10 tons per day. This waste is then reprocessed to be converted into biogas which can be used as energy in the form of electricity. The fruit waste processed in the biogas plant consists of various fruits such as melons, watermelons, and bananas, excluding oranges, which make up only 1-10% of the total fruit waste processed in the biogas plant (Cahyono et al., 2018).

With the help of several sources of organic materials, rotting fruits can be used as biogas. A large amount of fruit waste is reprocessed by Koperasi Gemah Ripah to produce electric energy by utilizing gas from the rotting fruits. The rotting fruits are collected from every market stall at Gamping Fruit Market to be processed into biogas as a source of electric energy.

There are several stages of converting the rotting fruits into biogas. First, the rotting fruits will be collected from every fruit stall at Gamping Fruit Market. The cooperative is responsible for this task, followed by transporting them to a location where the rotting fruits will be ground using a grinding machine (*Figure 2*), generating liquid. The results will be channeled to a reservoir called a digester. The digester is in the form of a tube which is placed 8 meters below the ground surface, while the diameter of the digester is 8 meters (*Figure 3*). Third, the digester will store the liquid from the grinding of the rotten fruits, allowing for organism process to occur, which then results in the formation of gas. In fact, the gas that evaporates in the digester has been in the form of biogas which can be processed into electric energy. Fourth, the biogas will then be channeled to the generator (*Figure 4*), generating electric energy. Finally, the biogas becomes the power to turn on an electric generator (Marendra et al., 2018).

Figure 2. Grinding Machine (Photographed by the authors)

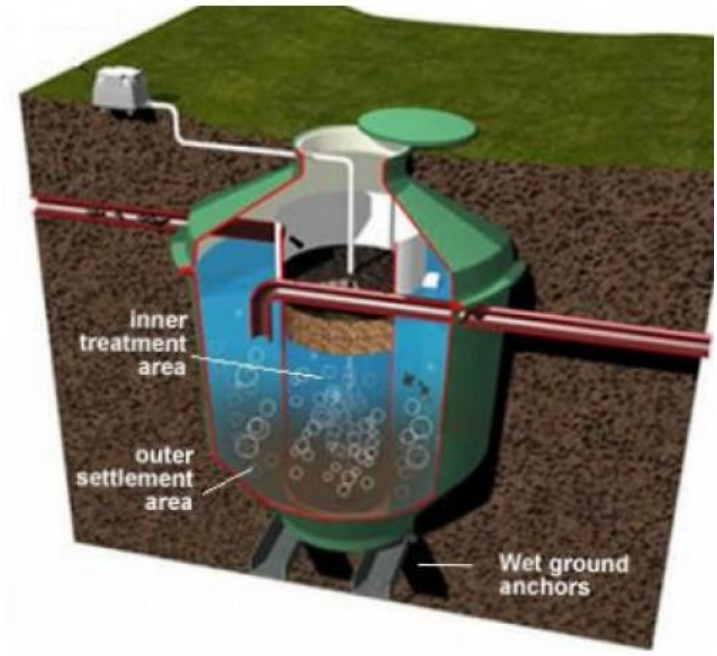

Figure 3. Example of Digester (Kencana Online, 2022)

Biogas energy from the processing of rotten fruits at Gamping Fruit Market in Yogyakarta is a breakthrough and at the same time solves the problem of many rotten fruits. The biogas plant potentially generates up to 162 Nm3 biogas, which can generate electricity up to 150 kWh/day (Marendra et al., 2018:87). The electric energy generated can meet the needs of 500 families. In addition to being a breakthrough for electric energy, converting rotten fruits into biogas serves as alternative energy to fossil energy that is not environmentally friendly. Koperasi Gemah Ripah, supervised by WRC UGM, can convert rotten fruits, which initially have no value, into electric energy that can benefit the Gamping market community. Apart from converting rotting fruits into biogas to generate electric energy, the end products of rotten fruits at this market are also in the form of fertilizer and gas for the cooking needs of the Gamping Fruit Market community (Marendra et al., 2020:3).

Figure 4. Generator (Photopgraphed by the authors)

Fertilizer is generated from the liquid that remains in the digester, while gas is generated from the vapor in the digester. This way, all rotten fruits are processed by Koperasi Gemah Ripah into products with benefits, instead of wasted. Environmental damage can be reduced by not using fossils as the main source of power generation; alternative energy can be used to reduce environmental damage. Rotten fruits processed into biogas can be a source of energy that is more environmentally friendly compared to the use of fossil energy which can have negative effects on the atmosphere.

Koperasi Gemah Ripah has successfully reduced its waste after converting it into biogas. There are at least two problems solved by this cooperative, including (1) the conversion of rotting fruits into biogas can reduce food waste problems, (2) energy reserves generated from biogas can be alternative electric energy supply. The activities of Koperasi Gemah Ripah are regularly monitored by the Waste Refinery Center of Universitas Gadjah Mada (WRC UGM). Universitas Gadjah Mada created the concept for the biogas system as technically supervised by Sweden. Universitas Gadjah Mada, the Sleman Regional Government, and Koperasi Gemah Ripah Market make a collaboration to build the Biogas Power Plant Gamping (BPG). The University of Boras, Boras Municipality, and Boras Energy and Environment also work together to develop this project (Marendra et al., 2018:87).

Koperasi Gemah Ripah at Gamping Fruit Market in Yogyakarta has shown the potential for sustainable development as an innovative concept at the local level, so it is possible to encourage the government to take similar actions at the national and international levels. The breakthrough demonstrated by Koperasi Gemah Ripah in converting rotting fruits into biogas energy that can generate electricity is the result of combining the three aspects as outlined in the concept of sustainable development. Each of these aspects is a form of sustainable development efforts.

The implication of waste management carried out by Koperasi Gemah Ripah is to convert rotten fruits into electric energy. The electric energy generated from the renewable energy at Gamping Market provides benefits for the surrounding community. The energy can be used as gas for cooking and electricity to power up electronic devices. The community should play a role in collecting rotten fruits as the raw materials to generate renewable energy.

The effort made by Koperasi Gemah Ripah is to create a community that can contribute to renewable energy. This effort is important because people must also be prepared for the transition from fossil energy to fulfill their daily needs towards renewable energy. Koperasi Gemah Ripah acts as a

facilitator, allowing the community at Gamping market to utilize rotten fruits as the raw material to produce biogas to generate electric energy.

The important role of the community in the energy transition is to familiarize people with the use of renewable energy. Local communities play an essential role in promoting localized renewable energy (Yamamoto, 2016). National commitment to energy transition will be more easily achieved when there are interventions that consider the psychological, social, cultural, and organizational factors that influence energy choices. In addition, there are also efforts to involve the community to see how social and community behavior are important to reduce consumption of fossil fuels (Stern et al., 2016). The program created by Koperasi Gemah Ripah at Gamping market at least serves as an intervention to the surrounding community to utilize rotten fruits to be processed into renewable energy. The communities can gain better understanding of how to use renewable energy in their daily life, especially around the market, such as using electricity and gas for cooking resulting from the conversion of rotten fruits.

3.3 Cooperatives and the Sustainable Development Goals (SDGs)

The SDGs are global goals aiming at eradicating poverty and inequality, protecting the environment, and guaranteeing that all people have access to health, justice, and prosperity (Howard-Grenville et al., 2019). It is vital to set integrated targets for food, energy, and ecological services (Griggs et al., 2014). Koperasi Gemah Ripah carries out waste management efforts related to SDG 12 "Responsible Consumption and Production". Goal 12 aims at maintaining long-term consumption and production trends (Hoballah & Averous, 2015b). SDG 12 has a target to reduce food waste at the retail and consumer level throughout the world (Gasper et al., 2019:86). Koperasi Gemah Ripah is re-processing the remaining fruit waste. This cooperative does not allow fruit waste to be disposed of, but it makes effort to make use of the food waste. Every day, Gamping market has the potential to produce significant amounts of food waste. Every year, Indonesia contributes 20.93 million tons of food waste, accounting for 8-10% of global greenhouse gas emissions (Naurah, 2022). Gamping market is a specialized fruit market that generates 4-10 tons of fruit waste every day. As a consequence, Koperasi Gemah Ripah, as a market business unit, tries to manage the fruit waste generated by market activity. The cooperative's management has reduced food waste in the retail sector by re-processing food waste, instead of disposing it at the landfill.

The cooperative manages fruit waste, which generates biogas that can be used as a reserve of electric energy for the market community. The cooperative's efforts to use biogas as a material to generate electric energy are part of the company's efforts to encourage sustainable energy. The contribution made by Koperasi Gemah Ripah in generating electric energy from biogas is related to the Sustainable Development Goal (SDG) 7. SDG7 aims to prepare affordable energy and clean energy (Miskiewicz, 2022). Improvements in energy efficiency are made to accelerate the climate goal of reducing greenhouse gas emissions (Puig et al., 2018; United Nation, 2022). Gamping Market possesses a valuable resource in the form of biogas generated from food waste processing. This biogas is harnessed by the cooperative to generate electric energy, thus contributing to the utilization of renewable energy sources. Effforts made by Koperasi Gemah Ripah that is in line with clean energy are to generate electric energy from biogas. Koperasi Gemah Ripah executes energy transition by innovatively managing fruit waste at Gamping Fruit Market. Through daily collection and sorting, the cooperative utilizes a garbage truck for the waste transportation to transport non-organic waste to a landfill and certain fruit waste to a biogas plant. The biogas production involves grinding the rotting fruits that results in liquid, channeling the liquid to a digester for gas formation, and subsequently channeling the biogas to a generator to generate electric energy. This energy is crucial for powering up activities in the market, emphasizing a sustainable energy source. The cooperative conducts feasibility studies by collaborating with some institutions like Universitas Gadjah Mada and actively involves the community in waste management. This initiative not only addresses waste issues but it also in line with Sustainable Development Goals, offering multiple benefits such as reduced food waste, fertilizer production, and cooking gas utilization.

Furthermore, the effort made by Koperasi Gemah Ripah of converting fruit waste into biogas, followed by the utilization of biogas as a source of electric energy meets SDG 7, which seeks to ensure affordable and clean energy (Miskiewicz, 2022). By improving energy efficiency and transitioning away from fossil fuels, the cooperative contributes to the broader climate objective of reducing greenhouse gas

emissions. The biogas produced from food waste at Gamping Market represents a valuable resource that is useful for the promotion of renewable energy sources.

Conclusions

The research introduces an innovative waste-to-energy model implemented by the cooperative, shedding light on sustainable practices that can contribute to renewable energy generation. Additionally, it emphasizes the active engagement of the local community in waste management and energy transition, fostering awareness and a collaborative approach to addressing environmental challenges. The study illustrates how the biogas generated from fruit waste aligns with Sustainable Development Goal 7, emphasizing affordable and clean energy. The findings present a potential blueprint for addressing waste management challenges in other markets or communities, serving as a case study for sustainable practices and promoting environmental responsibility and clean energy adoption. The research provides valuable academic insights into sustainable practices and waste-to-energy models while offering practical guidance for policymakers, environmentalists, and community leaders interested in implementing similar initiatives. By emphasizing the alignment of the cooperative's actions with Sustainable Development Goals, the research underscores the broader implications of local initiatives in contributing to global sustainability objectives.

The waste management carried out by Koperasi Gemah Ripah is an important contribution to reducing food waste. Koperasi Gemah Ripah has successfully turned waste into more valuable goods. The application of renewable energy technology carried out at Gamping Fruit Market in Yogyakarta by Koperasi Gemah Ripah is to convert rotting fruits into biogas energy that can generate electricity. This activity is in line with the concept of sustainable development about clean energy. Waste management is carried out by Koperasi Gemah Ripah in three stages, including collection, transportation, and disposal. The cooperative carries out waste management from start to finish. In the final stage, the cooperative sorts fruit waste to be converted into biogas. These efforts are indirectly related to Sustainable Development Goals 7 and 12. Koperasi Gemah Ripah is in partnership with the Waste Refinery Center in waste processing around Gamping market. In this case, the fruit waste processing efforts are not solely the responsibility of the cooperative; there is also a contribution from WRC UGM in managing waste in the Gamping market area.

The Sustainable Development Goals (SDGs) represent a global commitment to combat poverty, inequality, and environmental degradation, as well as ensure access to essential resources and services for all (Moyo, 2016). To achieve these goals effectively, it is imperative to establish integrated targets for food, energy, and ecological services (Griggs et al., 2014). Koperasi Gemah Ripah plays a crucial role in waste management aligned with SDG 12, which focuses on Responsible Consumption and Production (Hoballah & Averous, 2015a). Specifically, Goal 12 aims to maintain sustainable consumption and production patterns, including reducing food waste at the retail and consumer levels worldwide (Gasper et al., 2019:86). The waste management efforts by Koperasi Gemah Ripah within the Gamping market environment are fully in line with SDG 7 and 12. These endeavors include reducing food waste and transitioning to renewable energy sources, indirectly supporting the broader SDGs in achieving their objectives. The commitment of the cooperative to responsible consumption, waste reduction, and clean energy demonstrates a significant contribution to the global pursuit of sustainable development.

The inclusion of three aspects, namely economic, environmental, and social aspects, makes the processing of rotten fruits an activity that makes fundamental and comprehensive changes. The role of Koperasi Gemah Ripah in the management of rotten fruits shows that there is awareness in the community of the importance of preserving the environment for the common good. The good impact of the processing of rotting fruits has been felt by the market community and its surrounding. The reduced waste and the availability of electricity reserves are benefits that greatly affect the social environment of the market. Koperasi Gemah Ripah in Yogyakarta continues to improve its quality in the development of biogas energy generated from rotting fruits to generate electric energy.

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Regulation on the Utilization of Carbon Service as a Forest Protection Effort in Indonesia

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Abstract

Reducing Emissions from Deforestation and Forest Degradation (REDD+) is a strategy to reduce greenhouse gas emissions from deforestation and forest degradation. Through this scheme, Indonesia is vital in implementing ratified commitments through national legislation. The methodology used in the research employed normative juridical techniques characterized by descriptive research parameters and underwent analysis through comprehensive literature exploration. The results found that Indonesia has supported sustainable development by issuing REDD+ arrangements to realize climate change mitigation. Through the REDD+ scheme, Indonesia is expected to provide answers to global warming problems that occur throughout the world by providing protection, preventing degradation, and providing an increase in the quality of forest cover and carbon stocks.

Keywords: Reducing Emissions from Deforestation and Forest Degradation (REDD+); Carbon Services; climate change; Protection and management of the environment

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1. Introduction

As a logical consequence of the development of human life in this universe, the concept of development thinks about the protection of nature (Siagian & Alghazali, 2023). Various instruments and mechanisms for protecting nature are presented solely to create control for humans in utilizing existing land. Commencing with environmental preservation and governance regulations, this initiates the discussion of an ecologically conscious constitution and democratic framework (Asshiddiqie, 2017). In Indonesia, how the notion of human rights influence and the idea of economic democracy are put into action is enshrined in the country's Constitution as stipulated in the Constitution of Indonesia as established in 1945. This operational approach is subsequently clarified in Article 28 H subsection (1) of the Constitution of Indonesia as established in 1945, which affirms the inherent right of every individual to lead a life marked by affluence and well-being, the acquisition of an appropriate and salubrious habitat, and access to health services. Subsequently, the integration of sustainable and eco-conscious development principles is demonstrated in Article 33 (4) of the Constitution of Indonesia as established in 1945. This section states: "The national economy shall be structured based on economic democracy with the principles of unity, equitable efficiency, durability, environmental consciousness, self-reliance, and the maintenance of balanced development and national economic cohesion".

The arrangements made by this constitution emphasize that environment and development should be implemented by sustainable principles and illustrate the Indonesian Constitution, the Green Constitution (Asshiddiqie, 2017). Nonetheless, the integrity of this constitution is jeopardized by the challenge of climate change, leading to worldwide temperature rises. Consequently, Indonesia has enacted a range of measures to address the pressing matter of climate change, imperiling the tenets of the environmentally-conscious constitution. The presence of climate change, leading to consequences for the environment and living beings, should be the state's responsibility in its management (Zuhir, 2017). The state is responsible for decision-making and policies, both international legal instruments and national law.

Climate change can occur naturally and be brought about by human action. This action takes the form of deforestation, which is carried out on a massive scale and causes the earth's temperature to rise (Noordwijk, 2014). The inability of forests or the environment to perform their functions properly requires government action. Such actions are known as doctrines Parens Patriae (Koening, 2011), where the state acts as a parent or guardian for the vulnerable. This doctrine can also be applied to the environment because, in certain circumstances, the environment becomes a vulnerable entity and needs protection. The preservation and administration of the environment amidst climate change in Indonesia are catered to via Article 3 letter J Legislation with the identifier Law Number 32 of 2009, which focuses on the safeguarding and administration of the environment, also known as the UUPPLH, which is intended to foresee global environmental problems such as climate change. Subsequently, the Preamble of the UUPPLH underscores the need to exert endeavors to safeguard the environment from the impacts of global warming (Husin, 2016).

In the effort to oversee initiatives aimed at mitigating climate change impacts within Indonesia, the Indonesian government, with the facilitation of The Department of Environmental Affairs and Forestry or *Kementerian Lingkungan Hidup dan Kehutanan* (KLHK), which oversees matters related to environmental conservation and forestry, carries out the designated roles outlined in Regulation issued by the President Number 16 of 2015 regarding the functions of the Department of Environmental Affairs and Forestry. This Regulation was subsequently replaced by a Regulation issued by President Number 92 of 2020, which addresses matters concerning the Department of Environmental Affairs and Forestry. As articulated in Regulation issued by President 92/2020, Article 29 delineates that the Department of Environmental Affairs and Forestry, under the guidance of the Directorate General of Climate Change Control, is entrusted with formulating and implementing strategies related to climate change management. Conversely, when addressing the intricacies of climate change management in Indonesia, the Department of Environmental Affairs and Forestry assumes a crucial role in overseeing and directing the trajectory of climate-related initiatives within the nation (Kaisa et al., 2017).

Overcoming the problem of climate change will require two lines of action to be taken to reduce it, namely the path of mitigation and adaptation. The mitigation pathway is an action to slow down the pace of climate change, whereas adaptation involves taking measures to align with the threats posed by the consequences of climate change that have either taken place or are anticipated to happen (National

Council on Climate Change, 2013b). Concrete activities in climate change mitigation are to reduce and/or prevent GHG emissions released as a result of human activities (Hermawan et al., 2023). Various activities can be classified as climate change mitigation, one is increasing agroforestry to improve and maintain forest management. The forest, a component of natural resources, holds significant significance and plays crucial functions across various facets of social existence and environmental advancement. This is explicated in Article 1 section (1) of the Forestry Law, which defines a forest as an ecological entity encompassing tracts of land harboring biological natural resources, primarily composed of interconnected trees within the natural setting.

The Forestry Act regulates "forest areas" rather than "forests". Regardless of whether the area has trees or not, forest area measurement relies on the dimensions of the administrative region or the demarcated forest zone, potentially resulting in instances where areas designated as forests may not actually contain trees (CIFOR, 2013). Indonesia holds the distinction of being the world's largest archipelagic nation, setting aside approximately 64 percent or 120.5 million hectares of its total landmass for forested regions (Department of Environmental Affairs and Forestry of the Republic of Indonesia, 2020). A designated forest area is an allocated region defined and identified by the government to ensure its perpetual preservation as a forested space.

Forests are classified into three main functions: conserving, protecting, and producing. The conservation forest is a woodland with distinctive traits, primarily intended for safeguarding the variety of flora, fauna, and their environments (Hermawan et al., 2023). On the other hand, the protective forest serves as a shield for life-sustaining systems, overseeing water resources, averting floods, managing erosion, warding off saltwater intrusion, and preserving soil richness. Lastly, the production forest is a forest area whose chief purpose revolves around generating forest-based commodities. Production forest is further classified into “permanent production forest” (where the entire area is reserved for producing forest products), “limited production forest” (where only a portion of the area is reserved for producing forest products), and “conversion production forest” (which is reserved for other land uses) (Central Bureau of Statistics, 2022b).

From a regulatory perspective, empowered by Government Regulation 23 of 2021 concerning Forest Management, the Ministry of Forestry holds the jurisdiction to designate state forest zones for non-forestry undertakings, a concept counter to the previously outlined approach in Government Regulation 24 of 2010 regarding Forest Area Usage. This regulation aims to contribute to the escalation of forest depletion and decline within Indonesia. Deforestation, connoting the irreversible shift from a forested expanse to a non-forested expanse, is elucidated. Similarly, forest degradation denotes the decrement in the extent of forest cover and carbon reservoirs over a specific span. Indonesia's deforestation rate has exhibited an annual upsurge, with the solitary year of 2020 observing a deforestation rate of 115,459.8 million hectares (Central Bureau of Statistics, 2022a).

The surge in deforestation within Indonesia's diverse circumstances is intricately tied to alterations in the utilization of forested lands, unlawful timber extraction, and occurrences of forest fires. The fundamental root of deforestation and the deterioration of forests can be attributed to the management of forest resources (Jepson, 2001). Many things lead to weak forest governance, namely in the form of inconsistent and conflicting laws and regulations; forestry decentralization that deviates from its designation; unfinished forest area boundaries; the licensing process is closed and laden with corruption (Meehan & Tacconi, 2017), collusion and nepotism; weak government capacity to supervise licensing; at the localized level, the absence of a distinct forest overseer, feeble implementation of regulations, and instances of misconduct, coupled with a limited engagement of local communities in the decision-making process, particularly in matters related to forestry, are prevailing concerns (Moeliono et al., 2020).

Amidst the challenges surrounding forest management within nations marked by elevated deforestation and forest deterioration, an international framework termed educating emissions from deforestation and forest degradation, or simply REDD+, was developed. This system is envisioned to curtail climate change instigated by deforestation and forest degradation. Consequently, should Indonesia effectively implement the REDD+ framework, positive outcomes are anticipated. This fact is substantiated by information derived from the Central Bureau of Statistics, revealing that the extent of land and water covered by forest zones (Ha) reached 125,817,021.96 million (Ha) (Central Bureau of Statistics, 2022a). REDD+ incentivizes countries that can maintain their forests through carbon credits as an emission reduction measure. The results of these emission reductions are then sold to developed countries as a

form of commitment to the contribution of developed nations to fulfill their obligations for lowering carbon emissions.

REDD+ presents a strategy to curtail greenhouse gas discharges arising from deforestation, forest deterioration, preservation, sustainable forest management (SFM), afforestation, and reforestation. REDD+ aims to provide credit to parties involved in reducing GHG emissions (Angelsen, 2008) by trading on the international carbon market or submitting to funding agencies, which then compensate countries that carry out forest conservation. Regarding this, the presence of the REDD+ scheme is actually a scheme carried out by various parties and the state to secure recompense for endeavors to mitigate deforestation and the decline of forest (Pirard et al., 2023).

The concept of REDD+ surfaced within the framework of the Bali Action Plan during COP-13 in Bali, Indonesia, back in 2007 (Maryani et al., 2012). This initiative establishes a mechanism to lessen greenhouse gas discharges by rewarding entities that deter deforestation and the deterioration of forests (Siagian, 2023). At COP-14 in Poznan, Poland, in 2008, a consensus was obtained stating that REDD activities were expanded by establishing three strategic areas from the two previous provisions, namely: (Siagian, 2023)

a. Initial determination of REDD
    1) Mitigating emissions arising from deforestation;
    2) Alleviating emissions originating from forest degradation.
b. Strategic Area Determination (REDD+)
    1) The function of preserving nature;
    2) Ensuring the sustainable utilization of forests;
    3) Enhanced accumulation of carbon within forested areas.

REDD+ is the second scheme after the Clean Development Mechanism (CDM) which links the main tasks of developed countries for climate change mitigation. The central focus of this strategy revolves around endeavors aimed at curbing deforestation and the deterioration of forests, recognized as the leading factors driving global warming (Sheng et al., 2018). In general, it can be said that REDD+ is an effort to help countries that have forests by protecting their forests (Laurens & Fristikawati, 2014). REDD+ stands as a program strategically devised to provide recompense to developing nations in recognition of their actions towards curbing carbon emissions from deforested areas (Forest Climate Center, 2022). As set in Bali Road Map which states that:

> "*Enhanced national/international action on mitigation of climate change, including, inter alia, consideration of: (iii) Policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests, and enhancement of forest carbon stocks in developing countries*".

The mechanism of the REDD+ initiative functions through emission reduction or the prevention of deforestation, subsequently quantifying this effort as a form of credit (Boer, 2020). These credits accumulated across a time frame can be traded within the carbon market (Astuti & Mcgregor, 2015). Alternatively, they can be presented to a designated funding institution established to financially support countries engaged in forest preservation. Effectively, the REDD+ program creates an economic avenue for forest conservation to vie on equal terms with various other economic ventures responsible for deforestation (Laurens & Fristikawati, 2014) . However, until now there is still debate about how carbon is calculated and payments made, whether in the form of technical assistance, capacity building, or other forms. A step taken by Indonesia in this regard authorizes the KLHK to carry out the climate change control function as described in Article 5 letter of the regulation issued by the President as Number 92 of 2020 regarding the Department of Environmental Affairs and Forestry. Against this, the Department of Environmental Affairs and Forestry can formulate a policy for controlling climate change by producing a regulation to support the climate change control scheme, with the REDD+ scheme in Indonesia.

2. Methods

The investigative technique applied in this study is normative legal analysis, utilizing a juridical normative approach. This study uses a focus on normative legal research methods. Hartono (2006) stated, in normative legal research one can search for legal principles, legal theory and the formation of new legal principles. Meanwhile, as Bagir Manan's perspective, normative investigation entails the study of established legal principles and principles that focus on research on library data or what is called secondary data (Soekanto, 2001). The application of the normative legal approach in this study is pursued with the aim of delving into the clauses of domestic statutes and regulations pertaining to the utilization of carbon services. This approach entails scrutinizing and dissecting legal tenets, probing into the systematics of law, and delving into legal harmonization. Moreover, this investigation employs qualitative scrutiny within a literature review framework, tracing through primary, secondary, and tertiary legal sources. The legal materials will be analysed using descriptive, comparative, evaluation, and argumentation techniques to answer the research results regarding the use of carbon services as an effort to protect forests in Indonesia.

3. Results and Discussion

3.1 Indonesia's Commitment to Tackle Climate Change

Indonesia is explicitly bound to the Climate Change Convention and Kyoto Protocol, this is because Indonesia has ratified the Climate Change Convention, Kyoto Protocol, and Paris Agreement (Ekawati et al., 2019). Climate change is occurring and becoming an environmental challenge in many countries. These changes stem from shifts triggered directly or indirectly by human endeavours, which impact the composition of the Earth's atmosphere on a global scale, in addition to natural climate fluctuations that continue over long timescales (Dessler & Parson, 2010). Climate change is one of humanity's serious, complex, and dilemmatic multidimensional challenges. This makes it difficult for countries and groups to avoid the threat of climate change (Hadad, 2019). According to data released by the World Resources Institute (WRI), they made a map of the countries that have contributed the most carbon dioxide in the last 160 years and Indonesia is included in the list of countries that contribute the largest CO2 emissions (Siagian et all., 2022).

The increase in carbon dioxide has been detrimental to human life in all parts of the world (Chasek et al., 2010). These impacts range from changes in weather patterns to more frequent droughts and floods that disrupt agricultural activities. Another impact can be felt is the rising sea level that makes islands and coastal areas sink (Prijadikusuma, 2012). This situation triggered ideas and programs to reduce GHG emissions internationally, which began in 1979. This idea resulted in the Global Compact on Climate Alteration, commonly known as the UNFCCC (Rahmadi, 2019).

The aim of the Climate Convention centers on steadying greenhouse gas accumulations in the air at a threshold that poses no risk to the climate. This equilibrium must be attained within a timeframe allowing ample opportunity for the ecosystem to naturally adjust to climatic shifts, thus safeguarding both food production and sustainable development endeavors (Directorate General of Climate Change Control Department of Environmental Affairs and Forestry, 2016). Operative from March 21, 1994, this Convention is categorized into two factions: Annex I nations and non-Annex I nations. Those within Annex I have historically emitted greenhouse gases since the industrial era commenced. Conversely, non-Annex I nations are yet to be incorporated into this category. Their impact on greenhouse gas emissions is comparatively minimal, coinciding with their more modest economic expansion (Directorate General of Climate Change Control Department of Environmental Affairs and Forestry, 2016).

Through Law No. 6 of 1994 on the Ratification of the United Nations Framework Convention on Climate Change, Indonesia has effectively demonstrated its dedication to upholding the Climate Change Convention. As one of the Non-Annex I countries, Indonesia has direct obligations. This status gives Indonesia access to various opportunities and support the UNFCCC provides to empower its initiatives. One part of the effort to achieve the UNFCCC goals is participating in the highest meeting, the Conference of the Parties (COP).

A consensus decision was made at the implementation of COP-3 held in Kyoto, Japan, in 1997 which resulted in a consensus to adopt the Kyoto Protocol to the United Nations Framework Convention on Climate Change (Directorate General of Climate Change Control Ministry of Environment and Forestry,

2016). The Kyoto Protocol is the basis for industrialised countries to industrialised countries to reduce their combined GHG emissions by at least 5% from 1990 levels with targets for 2008-2012. The Kyoto Protocol places a heavier burden on developed countries because it adheres to the principle of common but differentiated responsibilities, meaning all countries share a common passion for preserving and protecting human life and the integrity of the earth's ecosystems. However, all countries have an equal obligation to reduce their greenhouse gas emissions. Protecting human life and the integrity of the earth's ecosystems, but with different contributions according to their capabilities.

One of the objectives of the existence of the Protocol of Kyoto as an effort to reduce emissions is to increase legally, with a commitment period, using emission allowances from each Annex 1 party, and including six types of GHG (Supriadi, 2006). The Protocol of Kyoto regulates the GHG emission reduction mechanism implemented in developed countries by providing several mechanisms, namely (Directorate General of Climate Change Control Department of Environmental Affairs and Forestry, 2016): a) Joint Implementation (JI) serves as a mechanism for curbing emissions, allowing Annex I nations to collaboratively channel emission reductions through joint initiatives aimed at diminishing greenhouse gas discharges. b) Emissions Trading (ET) constitutes a framework for exchanging emissions among developed countries. Those with greenhouse gas emissions below the acceptable threshold can vend surplus emissions to other developed nations grappling to fulfill their commitments. c) The Clean Development Mechanism (CDM) operates by shrinking GHG emissions through a partnership between developed and developing nations. This approach aspires to enable Annex I nations to attain their emission reduction goals by engaging in greenhouse gas reduction initiatives within developing nations.

CDM is one type of carbon market mechanism that has been regulated in the Kyoto Protocol under the crediting category. CDM is a mechanism that provides carbon credits that can be used to meet the needs of developing countries by involving low GHG emission projects in developing countries, including Indonesia. Indonesia has strengthened the CDM by ratifying the Kyoto Protocol through Law No. 17/2004 on the Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change. By ratifying the Kyoto Protocol, Indonesia can participate through one of the Kyoto Protocol mechanisms, namely the Clean Development Mechanism.

The concept of carbon trading has become an interesting study because it is considered a "win-win solution," this is reinforced by the jargon "when profit and ethics come together, solving problems with the thinking that created them". The strength of this concept is its success in combining two interests that have been considered conflicting, namely environmental and economic interests (Naibaho, 2011). As a non-Annex I country, as affirmed in the UNFCCC, Indonesia has officially ratified the Kyoto Protocol by enacting Law No. 17 of 2004 on the Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change. Nations Framework Convention on Climate Change. This essentially allows Indonesia to utilize the potential of the CDM to incentivize clean development initiatives (National Council on Climate Change, 2013a). This ratification also affects Indonesia's participation in the CDM and the sale of Certified Emission Reduction (CER) to Annex I countries in need.

Furthermore, the CDM has provisions stating that every project should make a positive contribution the sustainable development of the project's host country (Di Gregorio et al., 2017). However, this needs to be approved by the agency authorized by the state, namely Designed National Authority (DNA). In the context of Indonesia, this issue is governed by the Directive issued by the Head of Environmental Affairs under the title Decree Number 206 of 2005, which pertains to the Domestic Committee for Sustainable Development Approaches. Establishment of the National Committee for MPB as DNA of Indonesia, whose role is to assess the project's benefits for sustainable development in Indonesia against established criteria and approve its development as a CDM project in Indonesia.

Indonesia, being a significant player in global climate changes, aligns its stance with the Paris Agreement, supported by the presence of Law Number 16 of 2016 concerning the Endorsement of the Paris Agreement to The Global Compact on Climate Alteration (Hein et al., 2018). The presence of this legislation intricately interconnects with the repercussions of climate alterations on human existence. It encompasses both those involved in activities generating greenhouse gas emissions and those affected by them, underscoring climate change as a universally pertinent concern. The global stage provided by the Global Compact on Climate Alteration serves as a common ground for nations worldwide, where they participate in dialogues to devise ideal strategies and come to consensus on the distribution of duties and obligations concerning climate change mitigation and the management of its consequences.

3.2 REDD+ Scheme Regulations in Indonesia

REDD+ is a scheme to reduce GHG emissions based on deforestation, forest degradation, conservation, sustainable forest management, afforestation and reforestation. REDD+ aims to provide credits to parties involved in efforts to reduce GHG emissions, by trading on the international carbon market or submitted to funding institutions which then compensate countries that conserve forests (Angelsen, 2008). Against this, the presence of the REDD+ scheme is actually a scheme that is carried out by various parties and also countries to get a compensation for efforts to reduce deforestation and degradation of forest. The Indonesian government welcomes the presence of the REDD+ scheme.

This is evidenced by the presence of various regulations that accommodate the REDD+ scheme. Regulations related to the REDD+ scheme in Indonesia are: Minister of Forestry Regulation No. P.68/Menhut-II/2008 on the Implementation of Pilot Activities for Reducing Carbon Emissions from Deforestation and Forest Degradation; Minister of Forestry Regulation No. 30/Menhut-II/2009 on Procedures for Reducing Emissions from Deforestation and Forest Degradation (REDD); and Minister of Forestry Regulation No. 36/Menhut-II/2009 on REDD+.

3.2.1 Regulation of the Minister of Forestry No. P.68/Menhut-II/2008 concerning Implementation of Pilot Activities for Reducing Carbon Emissions from Deforestation and Forest Degradation

This Ministry of Forestry arrangement is here to explain the implementation of REDD+ demonstration activities in Indonesia. The purpose of organizing demonstration activities to reduce carbon emissions from deforestation and forest degradation is to test and develop methodologies, technologies, and institutions for sustainable forest management that seek to reduce carbon emissions through controlling deforestation and forest degradation (Enrici & Hubacek, 2016). The demonstration activities aim to reduce carbon emissions from deforestation and forest degradation by testing and developing methodologies, technologies, and institutions for sustainable forest management that aim to reduce carbon emissions by controlling deforestation and forest degradation (Implementation of Pilot Activities for Reducing Carbon Emissions from Deforestation and Forest Degradation, 2008).

This regulation outlines the procedure for applying. The first thing that is regulated is the stages in the application process, as stated in Chapter IV, Application and Approval Procedures. This application includes a map of the location of the prospective area, the form and period of cooperation, an estimate of the value of the activity, risk management, and a revenue distribution allocation plan. Furthermore, this regulation requires all applications to carry out pilot activities assessed by the Ministry of Forestry's Climate Change Control Working Group (Casse, 2019). The assessment results, which the Climate Change Control Working Group estimates, are then given to the minister to recommend the planned activities. However, this regulation does not accommodate the rights of communities concerning implementing demonstration activities and does not explain the context. Therefore, there is a possibility of disputes between the project proponent and the community related to the social and cultural conditions of the local community in the designation of areas as demonstration activities.

3.2.2 Regulation of the Minister of Forestry No. P.30/ Menhut-II/2009 concerning Procedures for Reducing Emissions from Deforestation and Forest Degradation (REDD)

Encompassed within this Regulation by the Ministry of Forestry is a broad aspiration that guides the implementation of REDD endeavors, aiming to thwart and curtail emissions stemming from deforestation and forest deterioration, all with the intention of fortifying forest administration. Essentially, the objective of REDD activities revolves around stifling deforestation and forest degradation, with the ultimate goal of fostering sustainable forest management and enhancing the well-being of communities (Rochmayanto, 2023). This directive takes on a distinctive role by ensuring clarity concerning the designated forest regions earmarked for REDD purposes within Indonesia. This clarity is presented in Article 3, section (1), where it outlines the subsequent classifications: a) Zones allocated for the application of timber forest products within natural forests (IUPHHK-HA); b) Zones designated for the utilization of timber forest products in plantation forests (IUPHHK-HT); c) Zones set aside for the purpose of community-based forest product utilization (IUPHH-HKM); d) Zones specified for timber forest product utilization in community plantation forests (IUPHHK-HTR); e) Zones marked for the establishment of businesses focusing on ecosystem restoration timber forest product utilization (IUPHHK-RE); f) Zones supervised by Production Forest

Management Units (KPHP); g) Zones monitored by Protected Forest Management Units (KPLH); h) Zones managed as Conservation Forest Management Units (KPHK); i) Designated Conservation Forests; j) Indigenous Forests; k) Privately-Owned Forests; and l) Village Forests.

This regulation also regulates REDD actors who are divided into two entities that play a role, namely national entities, and international entities. National entity actors are managers of twelve (12) forest area statuses, as explained in Article 3 paragraph (1), Meanwhile, international entity actors can be: governments, business entities, and international organizations, foundations, individuals who have funds for the implementation of REDD. The financial resources for the execution of the REDD program, procured through contributions from entities engaged in the UN climate change convention and validated funding channels, were initially utilized for REDD implementation before the international-level decision on the REDD mechanism by the parties to the UN Climate Change Convention. During this period, the REDD initiative's actualization encompassed REDD demonstration activities, skill enhancement, technology exchange, and voluntary transactions of carbon credits. This regulation stipulates the requirements for applying for the implementation of REDD activities as stated in Articles 5, 6, 7, 8, 9 and 10. This regulation regulates requests for REDD+ activities, in which the initiator must apply to carry out REDD activities to the minister, by completing the requirements set out in Articles 5, 6, 7, 8, 9 and 10. This application is then submitted to the REDD Commission for review taking into account the REDD site selection criteria.

Ministers are obliged to make a decision on the REDD application within a span of 14 days upon receipt of the pertinent documents. If the application is verified upon reception, it is mandated that the REDD commission must issue a certification for carbon emission reduction within 30 business days at the latest. This certification, pertaining to carbon emission reduction, holds the potential for trade. However, as outlined in the Minister of Forestry Regulation No. P.30/Menhut-II/2009 governing the Procedures for Reducing Emissions from Deforestation and Forest Degradation (REDD), the entity referred to as the "REDD Commission" is not accommodated. This Regulation doesn't specify the nature of this commission or working group, whether it is an independent commission or a collective working group, and its inclusion is not mirrored in the Minister of Forestry Regulation No. P.68/Menhut-II/2008 which outlines the Implementation of Pilot Activities for Reducing Carbon Emissions from Deforestation and Forest Degradation.

Through the enactment of Minister of Forestry Regulation No. 30/ Menhut-II/2009 which addresses the Procedures for Reducing Emissions from Deforestation and Forest Degradation (REDD), the framework is broken down into six appended segments that accompany the regulation. These attachments elaborate on the technical execution of REDD, encapsulated in the following facets: a) Directives for Formulating Local Government Recommendations for REDD Implementation; b) Criteria for Selecting Sites; c) Blueprint for Compiling REDD Implementation Plans; d) Process for Assessing REDD Applications; e) Procedure for Establishing Reference Emission Levels (REL), Carrying out Monitoring, and Reporting REDD undertakings; and f) Instructions for Verifying REDD Initiatives.

The issue of carbon credits has actually been accommodated as explained in Chapter VII concerning Rights and Obligations. The rights of REDD actors are stated as follows:

a) Obtaining compensations for enacting REDD+ on a nationwide scale (national entities);
b) Possessing and utilizing REDD+ certificates (carbon credits) as evidence of emission reductions and;
c) Engaging in the trade of REDD+ certificates within the post-2012 REDD+ carbon trading system.

The presence of this directive underscores the alignment of REDD implementation in Indonesia with the stipulations set forth in Minister of Forestry Regulation No. 30/ Menhut-II/2009, delineating the Protocols for Curbing Emissions from Deforestation and Forest Degradation (REDD), by providing clarity on market mechanisms and certificates as proof of REDD activities that can be traded.

The results of the distribution of funds received by the government will be treated as Non-Tax State Revenue (PNBP), then the distribution of funds for the community will be channeled into the form of trust fund whose management is jointly managed by the community and village government, as well as the project developer. Trust fund This is used to finance the activities of securing the forest area of the RAP-KARBON and/or PAN-KARBON Development project in order to prevent leakage (leakage) (Article 17 paragraph 4)". In contrast to REDD as stipulated in Permenhut P30/2009 which links the proceeds from REDD to poverty alleviation, the funds received from the carbon project are actually also used for community empowerment but with the aim of preventing leakage (leakage) of the project area.

3.2.3 Regulation of the Minister of Forestry No. 36/ Menhut-II/2009 concerning Procedures for Licensing Businesses for Utilization of Carbon Sequestration and/or Storage in Production Forests and Protected Forests

Business absorption and utilization carbon business storage carbon (UP RAP-Karbon and UP PAN-Carbon) is a type of business that utilises the service environment for forest production and forest protection. Rules this concerns REDD+ as explained in article 4, which explains implementation activity storage carbon in the schematic reduction emission from Deforestation and Degradation Forest (REDD) and absorption carbon of down mechanism development clean. Own rules alone of level minister. However, provision this no explains more carry-on about the mechanism of REDD.

This regulation places more emphasis on businesses that provide environmental services and not on reducing emissions. This regulation divides the business activities of Utilization of Carbon Sequestration (RAP-Karbon) and Carbon Storage (PAN-Karbon). Article 3 explains the division of RAP-Karbon and PAN-Karbon business activities for Sustainable Management of Production Forests and Protected Forests.

Although it mentioned that activity RAP and PAN could be done in forest production and forest protection, it gives limitations on which detail about activity RAP and PAN, except state that the activity is shaping utilization service environment in forest production and forest protection. Definition this no can understand appropriately what RAP and PAN do. However, there is a description activity which can be done, like operation RAP and NAP. Activity PAN between another postpone logging, expand area conservation, and apply harvest take turns It means activity PAN is intended to guard so that forest is still in front and prepare it for absorption of carbon. Activity RAP covers planting stands and enhancement of area forest. Because although activity RAP and PAN rule their speciality activity, which is different in forest production and forest protection, differences are found between the second type of activity.

Activity RAP and PAN can be done of region with or without permission. Precondition and procedure to file applications are different for the second region. Authority above the area given permission (HTI, area restoration ecosystem, forest society) is at the hand of the Minister, Governor, and Regent/Mayor, whereas authority above the area which not yet once permitted by Minister. Although meaning carbon RAP and PAN seems different from REDD+, Article 4 rules them with a clear state that:

> Implementation of activities storage carbon in the REDD scheme and absorption carbon of down Mechanism Development Clean arranged by Ministerial regulations.

Nonetheless, the processes of RAP and PAN activities bear striking resemblance to REDD+. In essence, these activities undergo independent verification by a verifier, resulting in the issuance of emission reduction certificates that can be traded on the carbon market. The core differentiator lies in the fact that while RAP and PAN activities are limited to forest production and safeguarding, REDD+ encompasses a broader spectrum of forest types.

We other, activity REDD+ of Indonesia, face lots of conflicts, no only from public civil but also from institutional government, which no feel involved in process regulation. On 29 April 2010, the Ministry of Finance objected to decision No. 36/Menhut-II/2009 because the Ministry of Finance must be involved in formulating rules for results between country, city, and business person.

The pivotal concern emerges when the Ministry of Forestry surpasses its jurisdictional boundaries. Referencing Law No. 17 of 2003 pertaining to the Financial Matters of the State for the year 2003, the Ministry of Finance, spearheaded by the Finance Minister, holds the authoritative reins (Chapter 6(2)) responsible for answering the above management finance country. The legal context defines "state finances" as encompassing all entities stemming from a nation's rights and obligations, which can be assigned a monetary value, alongside any monetary or tangible assets that the State may possess in relation to fulfilling these responsibilities. Although ministers and other governing bodies, such as the Ministry of Forestry, possess influence over state finances, their control is positioned as that of users rather than managers (Article 6, paragraph (3)). According to the guidelines of Law No. 17 of 2003, the Ministry of Forestry lacks the authorization to regulate the allocation of profits derived from REDD+ and/or carbon storage endeavors. This provides integration and alignment between sectors which is still a major challenge in Indonesia. However, particularly in the implementation of REDD+, there have been many overlapping regulation.

Table 1: Profit Sharing

License Holder/ Developer	IUPHHK-HA	IUPHHK-HT	IUPHHK-RE	IUPHHK-HTR	People's Forest	Community Forest
Government	20%	20%	20%	20%	10%	20%
Public	20%	20%	20%	50%	70%	50%
Developer	60%	60%	60%	30%	20%	30%
License Holder/ Developer	Indigenous Forest	Village Forest	KPH	KHDTK	Protected forest	
Government	10%	20%	30%	50%	50%	
Public	70%	50%	20%	20%	20%	
Developer	20%	30%	50%	30%	30%	

Source: Regulation of the Head of Environmental Affairs and Forestry No. 8 of 2015 concerning the Second Amendment to the Regulation of the Minister of Forestry Number P.36 / MENHUT-II / 2009

Based on explanations from various arrangements regarding carbon service mechanisms specifically for the schemes of REDD and REDD+ policies in Indonesia, these have been accommodated, among others, through: Minister of Forestry Directive No. P.68/Menhut-II/2008 outlining the Execution of Demonstration Initiatives for Diminishing Carbon Emissions due to Deforestation and Forest Degradation; Minister of Forestry Edict No. P.30/Menhut-II/2009 addressing the Protocols for Curtailing Emissions Arising from Deforestation and Forest Degradation (REDD); and Minister of Forestry Regulation No. 36/Menhut-II/2009 addressing the Protocols for Granting Permits for Ventures Engaged in Carbon Sequestration and/or Storage within Production Forests and Protection Forests.

In fact, the presence of Minister of Forestry No. P.68/Menhut-II/2008 is an explanation to outline procedures for requesting and validating REDD activities, so that the application of methods, technology, and institutions from the REDD scheme can be implemented and evaluated. However, the challenge of this regulation is that the activities to implement the REDD scheme can be transferred to the expected REDD projects for the future. Then, Minister of Forestry No. P.30/Menhut-II/2009 contains procedures for implementing REDD, in which there are requirements that must be met, whether in the form of verification, certification, rights and obligations of the REDD actor (Giessen et al., 2016). However, there has been no determination of emission levels to be a reference for the REDD scheme. Meanwhile, within Minister of Forestry Regulation No. 36/Menhut-II/2009, provisions are established for granting licenses for enterprises engaged in REDD operations involving carbon sequestration and storage. This directive also elucidates the equilibrium in financial matters, delineating the protocols for enforcing, amassing, placing, and disbursing state income through the application of the REDD framework. Moreover, this regulation outlines distinctions between carbon sequestration and storage activities across diverse forest categories and corporate entities.

3.3 Analysis of the Application of Carbon Service Utilization in Overcoming Forestry Problems in Indonesia

The transformation of native forests into yearly plantations, the alteration of native forests into agricultural and plantation zones, the engagement in extractive activities within forest domains (coal, oil, gas, geothermal), the igniting of forests and land (blazes), and the conversion for transmigration and additional infrastructure necessities encompass a multitude of factors that propel forest deterioration and deforestation across Indonesia (Panabulu Foundation, 2017). Through REDD+, which is forest management with efforts to prevent, reduce and protect as well as increase the quality of forest cover and, most importantly, carbon stocks with the ultimate goal of supporting sustainable development (Implementation of the National Registry System for Climate Change Control., 2017). REDD+ is poised to serve as the primary mechanism through which the Indonesian Government endeavors to uphold its responsibility in diminishing greenhouse gas discharges by 26% from the Business-as-Usual (BAU) projection in 2020 autonomously, or by 41% with global support. This commitment from Indonesia was subsequently reaffirmed within the 2015 Paris Accord and was integrated into the contents of the Nationally Determined Contribution (NDC). This cements Indonesia's determination to cut national emissions by 29% in 2030 compared to the BAU reference (National Energy Council, 2020).

Since 2014, the implementation of the REDD+ scheme in Indonesia has entered its third phase with a focus on developing a results-based financing model and market-based mechanisms (Laurens &

Fristikawati, 2014). Commencing from 2010 and extending through 2013, the rollout of the REDD+ initiative embarked on two sequential phases: the inauguration of the 1st phase, recognized as the preparatory stage, followed by the second phase, known as the transformative stage. This involved the crafting of the National REDD+ Strategy, the institution of the REDD+ agency, the establishment of an autonomous MRV (Monitoring, Reporting, and Verification) entity, the identification of financial mechanisms, the founding of a Pilot province, the operationalization of financial mechanisms, the imposition of a moratorium on new permits for forest and peat conversion, the creation of a repository for degraded forests, the reinforcement of regulations pertaining to logging, timber trade, and the resolution of land and tenure disputes. In phase 3, it is hoped that developing a results-based financing model and market-based mechanisms will foster a carbon trading model that will benefit REDD+ program actors, both financially and non-financially (Panabulu Foundation, 2017).

Facilities are needed for countries implementing REDD+ (Fay & Denduangrudee, 2018), particularly within the context of Indonesia, where preparations are underway for the comprehensive enactment phase of REDD+, significant strides are being made through the formulation of an endeavor via the Forest Carbon Partnership Facility (FCPF), overseen in collaboration with the World Bank. The FCPF is an initiative tailored to aid developing nations in curtailing emissions arising from deforestation and forest degradation, while concurrently amplifying efforts in carbon storage, preservation, and the sustainable administration of forested domains. Initially unveiled during COP 13 held in Bali in December 2007, the FCPF initiated its operations in June 2008, signaling a pivotal turning point in its journey. The FCPF provides financial support through the Carbon Fund (FCPF-Carbon Fund), namely performance-based funding support intended as piloting/trial payments for reduced emissions from a forest landscape with a results-based approach (Archipelago Nature Conservation, 2022).

In the Indonesian context, FCPF funding will encourage capacity building in preparing infrastructure for REDD+ implementation. FCPF support includes national research activities and capacity building at the national and subnational level.

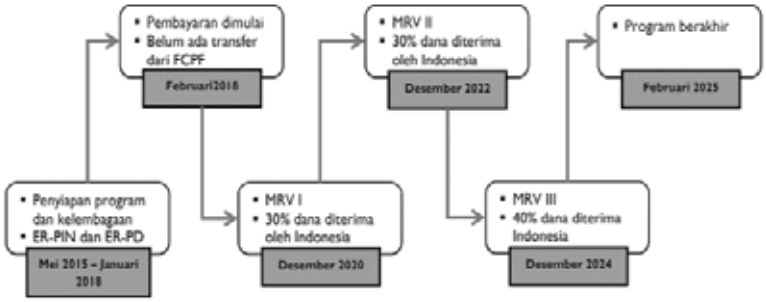

***Figure 1**. Flow and Timeline of FCPF Carbon Found Indonesia (The Research and Development and Innovation Agency of the Department of Environmental Affairs and Forestry and the Climate Change Regional Council of East Kalimantan Province)*

To be able to implement the FCPF Program Carbon Fund, the Indonesian government is obliged to compile Emission Reduction – Program Idea Note (ER-PIN) on a national scale proposed to the World Bank (Department of Environmental Affairs and Forestry Research and Development Agency and East Kalimantan Province Climate Change Council, 2016). The next stage after the ER-PIN has been approved is the preparation of Emission Reduction Project Development (ER-PD) on a pilot area scale. The FCPF program scheme has stages that must be passed to obtain a funding scheme, Carbon Fund. Preparation of proposals Emission Reductions – Program Idea Note (ER-PIN) is the beginning of the program bidding process submitted by Indonesia to the World Bank as a fund management institution Carbon Fund After the initial proposal (ER-PIN) has been approved, it is followed up with the preparation of a full proposal for the implementation of the FCPF program through documents mission Reduction–Project Development (ER-PD), this document will then be followed by the preparation of an agreement scheme mission Reduction–Purchase Agreement (ER-PA) (Department of Environmental Affairs and Forestry Research and Development Agency and East Kalimantan Province Climate Change Council, 2016).

Based on the ER-PIN document, Indonesia proposed East Kalimantan Province as a pilot area in the FCPF Program Carbon Fund so that the ER-PD will be prepared based on the local context of East

Kalimantan Province (East Kalimantan Provincial Government, 2019). This determination was strengthened by the presence of the Letter of the Head of the Development and Innovation Research Agency of the Department of Environmental Affairs and Forestry No. 5.92/Litbang-P3SEKPI/2015 on 30 September 2015 concerning the Carbon Fund. This letter was followed by a statement signed by Dr H. Awang Faroek Ishak as Governor of East Kalimantan on 5 October 2015 (The Research and Development and Innovation Agency of the Ministry of Environment and Forestry and the Climate Change Regional Council of East Kalimantan Province, 2016). East Kalimantan Province has an area of approximately 12,726,752 ha consisting of 12,533,681 ha of land and 193,071 ha of in land waters (East Kalimantan Portal, 2022).

The choice of East Kalimantan Province was based on existing criteria Carbon Funds, including : (Forest Carbon Partnership Facility (FCPF) Carbon Fund, 2014)

a) Cohesive with broader REDD+ objectives. The Carbon Program Fund lends its backing to the nationwide REDD+ initiative, while contributing provinces will hold a pivotal role in executing localized REDD+ strategies.
b) Preceding REDD+ investments have paved the way. East Kalimantan has previously embraced a substantial interconnected REDD+ program, which serves as the propelling force for the ongoing momentum of the Carbon Fund.
c) Robust involvement of civil society. This engagement stands as a pivotal facet, facilitating the program's ability to tackle issues at the grassroots level and to seamlessly incorporate local communities into the comprehensive program planning and execution.
d) Dedication from local government bodies. Local administrations assume a crucial function in orchestrating district-level undertakings, with their unwavering commitment to REDD+ and the Carbon Program Fund standing as the linchpin to the viability and enduring success of the proposed endeavors. Local entities within each district are identified as the focal juncture for program execution, augmented by budgetary allocations earmarked for REDD+-related activities.
e) Aligning with spatial blueprints and local decrees.
f) A structured mechanism for information dissemination and stakeholder involvement exists, incorporating avenues to engage local communities and address concerns raised by stakeholders.
g) Advancements in shaping a REDD+ framework. This encapsulates the headway in formulating Reference Emission Levels, enhancing proficiency in cultivating Forest Monitoring Systems, and refining expertise in emissions quantification, encompassing issues like leakage and returns.
h) Headway pertaining to safeguards. This encompasses the assimilation of PRISAI or SES, disseminating information about REDD+, and garnering support from non-governmental organizations and academia for REDD+ pursuits.
i) Advancements in spatial strategy and the operationalization of FMUs. This involves the formulation of community-driven forestry strategies.
j) Advancements in mechanisms for sharing benefits. This encompasses insights gleaned from community-driven developmental initiatives and localized statutes that bolster the mechanisms for distributing benefits.

ER-PD prepared for the FCPF Program Carbon Fund will have the following main components: managing institutional arrangements, location, intervention strategy, stakeholder engagement, operational and funding plans, carbon types and categories, reference levels, monitoring, measurement, reporting and verification (MRV) methodologies, leakage and return risks, social and environmental safeguards, data management and registration systems and institutional and benefit-sharing mechanisms (Panabulu Foundation, 2017).

Benefit sharing in the REDD+ Program must take into account several important aspects in a comprehensive manner, namely: identification of who should receive the benefits, determination of the most appropriate type of benefits, and arrangements regarding the distribution of practical benefits (Luttrell et al., 2014). This means that the arrangements for distributing REDD+ will be closely linked to the types of benefits distributed and to whom these benefits will be distributed (Panabulu Foundation, 2017).

Differences in benefit distribution arrangements are based on the type of carbon assistance or market finance, which comprises a compliance market and a voluntary market. The compliance market is

a carbon market that operates under the rules of international agreements to set emission reduction targets in developed countries, and is compensated with emission reduction credits from emission reduction projects carried out in developing countries. A voluntary market is a carbon market that uses an emissions trading mechanism but operates outside international agreements (SEKPI-RePort, 2022).

Involuntary market, international entities can directly conduct transactions with the developers/actors of the REDD+ Program, namely land owners or business license holders for forest utilization with or without the involvement of supporting third parties. For forest areas, the government, as the land owner, can impose various levy instruments on economic rents resulting from efforts to sequester or store carbon (Abraham, 2016). Meanwhile, in the compliance market, the role of the government plays a central role because bilateral and multilateral funds will be managed centrally and then distributed to the parties involved in implementing the REDD+ Program (SEKPI-RePort, 2022).

On the voluntary schematic market, international entities as buyers can directly make payments based on carbon reduction emission certificates (Certificate of REDD/Certified Emission Reduction/CER) generated. As for the schema compliance market, revenue from the CER that is sold goes to the central government before finally being channelled back to the manager after deducting the business license fees and fees on the sold REDD Certificates. Revenue derived from the sale of REDD certificates is the manager's right (SEKPI-RePort, 2022).

Suppose the REDD+ location is in a forest area. In that case, the manager should pay economic rent to the state through fees for REDD+ activity permits and fees for selling REDD+ certificates. This REDD+ activity permit fee is paid once within the management period. While levies on CERs are based on the volume of carbon sold (per tonne of equivalent) (Panabulu Foundation, 2017). The mechanism for the distribution and proportion of profit sharing from the REDD+ permit fee follows Government Regulation no. 55 of 2005 concerning Balancing Funds. The allocation of Revenue Sharing Funds from REDD+ permit fees is divided between the central and regional governments, with the central government receiving 20% and local governments receiving 80%. This distribution entails 16% for the corresponding provincial government and 64% for the district government responsible for production.

The share for the central government is allocated to the National REDD+ Guarantee Fund. Meanwhile, the distribution mechanism and the proportion of profit sharing for the levy on sold REDD certificates is proposed to follow the proportion of profit-sharing Funds from the Reforestation Fund, amounting to 60% for the central government and 40% for regional governments. This proportion is proposed because the implementation of REDD+ is based on a national approach involving complex institutions because it involves cross-sectors (Panabulu Foundation, 2017). The REDD+ manager should also contribute to the community around the REDD+ site, so benefits should be allocated to the community.

Part of the REDD+ revenue for the community can be given in the form of alternative sources of livelihood, such as assistance with plant nurseries, fisheries, animal husbandry, handicrafts and so on. In addition, assistance can also be in the form of infrastructure development, education and health. Local governments also should contribute to the community from DBH REDD+ revenues. Assistance is provided through financing programs allocated in the budget of each work unit within the local government. These programs are directed at empowering the community around the REDD+ location. Performance-based payment mechanisms can be implemented at different levels of the REDD+ Program, ranging from programs focused on land users to programs managed by specific local governments (Rahayu et all., 2016).

The performance-based REDD+ payment mechanism or results-based payment is an incentive expected to help facilitate initial support from stakeholders and build the necessary conditions to encourage positive behaviour changes of the parties in achieving the ultimate goal of the REDD+ Program. The distribution of benefits from the REDD+ programme is also expected to help overcome some of the risks and costs faced by more powerless and marginalized stakeholders by providing cash payments for the results of performance that have been carried out.

3.3.1 Benefits Obtained for the Community in Implementing FCPF Activities Carbon Fund

FCPF support Carbon Fund will encourage the strengthening of REDD+ implementation in East Kalimantan Province, as a pilot area at the sub-national level, through a performance-based payment mechanism. In carrying out FCPF program activities Carbon Fund, then beneficiaries are classified as:

Communities (indigenous peoples and local communities), Government (central, provincial, district and village), and Business groups and developers (Forest Carbon Partnership Facility (FCPF) Carbon Fund, 2015).

REDD+ efforts, supported by international carbon funds, to reduce deforestation and forest degradation are intended as an incentive so that developing countries that have large areas of tropical forests can receive significant benefits from efforts to reduce emissions. As mentioned above, the REDD+ scheme will provide incentives and compensation in the form of sharing benefits/benefits with a performance-based payment mechanism for emission reduction actors. FCPF program Carbon Fund has identified that apart from the government (both central, provincial, district and village governments) and business groups and developers; The community should also get the main benefits from emission reduction programs. Community groups include indigenous peoples and local communities (ER-PIN) (Forest Carbon Partnership Facility (FCPF) Carbon Fund, 2015).

In the REDD+ Program scheme, communities are key stakeholders in managing forest areas. Community groups at a certain level will be able to play a role as program managers, be the ones most likely to be affected by the program, and on the other hand have the greatest potential to be able to enjoy non-carbon program benefits (Forest Carbon Partnership Facility (FCPF) Carbon Fund, 2015).

3.3.1.1 Community Benefit Sharing Plan in the FCPF Carbon Fund Program

FCPF program Carbon Fund has positioned indigenous peoples and local communities as the program's primary beneficiaries in addition to the government (central, provincial, district and village governments), business groups and developers. FCPF Carbon Fund has potential to deliver both carbon and non-carbon programme benefits. Non-carbon advantages are directly obtained and enjoyed by the community (McDermott et al., 2012). Meanwhile, the benefits of the REDD+ Program in the form of carbon will be measured using the MRV method (Chhatre, 2012), which is the basis for payment for emission reduction performance (Panabulu Foundation, 2017). The receipt of the payment will be distributed in the form of monetary and non-monetary benefits to administrators, including community groups.

FCPF funding Carbon Fund will provide incentives based on a jurisdiction-based performance approach, and incentive mechanisms can be provided to parties within a particular jurisdiction, either at the district or village level, to change the behaviour of actors in that jurisdiction. Budget allocation Carbon Fund is based on performance determined at each jurisdiction level. The performance will be measured using indicators outcome, i.e. reduced deforestation or emissions or indicators output/ process, namely, benefits are given based on the implementation of a particular policy or activity.

As it has been explained, the FCPF carbon fund has focused on the sharing plan utilization for the public. These funds will be specialised in the distribution of the benefits of the REDD+ programme as divided into several forms, including : Non-carbon benefits for society; Carbon benefits in the form of monetary and non-monetary based performance outcomes for community groups that act as managers (HKm, HTR, Village Forests, Customary Forests); and Carbon benefits in monetary and non-monetary forms are based on Village/Customary Village/Rural Area jurisdictions and are measured based on output performance.

During the phase of disbursing advantages from the Provincial/District Administration to local Villages/community entities, these community groups have the opportunity to access grants offered by the provincial/district administration through the Village channel. Furthermore, these community associations are eligible to directly acquire Social Welfare Allocations from the provincial, district, and village levels. Social welfare allocations denote the supply of financial support or commodities by the regional administration to individuals, families, collectives, or communities. This assistance is non-continuous and discerning, aiming to provide a safeguard against potential social hazards.

One of the fundamental challenges in implementing options for sharing carbon benefits in monetary and non-monetary forms based on Village/Customary Village/Rural Area jurisdictions and which are measured based on output performance is to ensure that output-based performance measures have a significant portion of the distribution plan. Benefits to be used by the FCPF Carbon Fund. Concern that performance measurement is based on the outcome will take up a much more significant portion of the allocation of benefits, now coupled with the unpreparedness and maturity of the MRV measurement

system and mechanism itself so that the measurement of emission reduction performance by managers cannot be ascertained in a transparent and accountable manner.

Preliminary strides towards ascertaining the division of profit allocation have been initiated, elucidated in the Head of Environmental Affairs and Forestry Regulation No. 8 of 2015, detailing the Second Revision to Minister of Forestry Regulation No. P.36/MENHUT-II/2009, which pertains to the Protocols for Licensing Enterprises Engaged in Carbon Sequestration and Storage within Production Forests and Protection Forests. This regulation systematically outlines the distribution ratio of earnings stemming from the trade of Verified Emission Reductions (VER) that should be apportioned to the local community, governmental entities, and project developers.

Conclusions

The protection and management of the environment must be carried out on the basis of the principles of state responsibility, sustainability and benefit in order to realise environmentally sound development, as well as protection from the effects of global warming. Global warming occurs due to the increasing deforestation and degradation of forest functions to absorb carbon emissions. Against this, the REDD+ scheme is a climate change mitigation program. It emphasizes forest management to prevent degradation, protection, and to improve the quality of the forest cover and the carbon stocks in support of sustainable development. On the other hand, the REDD+ scheme has a focus on providing incentives for pressure speed deforestation, and this is in line with the Polluter Pays Principle doctrine, which polluters need to be responsible for their actions that hurt the environment.

The implementation of the REDD+ scheme in Indonesia has been accommodated through Permen LHK 70/2017, whose aim is to achieve the implementation of REDD+ by the requirements of the UNFCCC COP decision on REDD+. REDD+ is implemented nationally by the responsible government for the environment and forestry sector. At the sub-national level, it is carried out by Regional Governments, the private sector, Forest Management Units and Community Groups managers. The implementation of this sub-national has appointed East Kalimantan Province as a pilot area for REDD+ with funding from the World Bank in the FCPF program. In fulfilling this implementation, Indonesia has issued various implementation instruments from REDD+, namely: “National Strategy, Forest Reference Emission Level (FREL)/Forest Reference Level (FRL), Measuring, Reporting, Verifying (MRV), National Forest Monitoring Systems (NFMS), Funding Instruments, Safeguards, and the REDD+ Safeguard Information System, the National Registry System (SRN).”

Recommendation

REDD+ emerges as an effective strategy in curbing the pace of deforestation and forest degradation due to its capacity to offer mutual benefits in this challenge. However, the statistics concerning deforestation and degradation within Indonesia's forest realms have shown no marked shift since the inception of the nationwide REDD+ strategy. Thus, there arises a necessity to bolster policies that can harmonize the alignment of REDD+ initiatives both at the broader national level and the localized sub-national tiers, all essential for securing the triumphant execution of the REDD+ blueprint within Indonesia. Furthermore, heightened transparency in the endeavors enacted at the sub-national echelons becomes pivotal, considering that the REDD+ program's essence underscores the distribution of advantages among the forest-adjacent communities as part of the REDD+ undertaking.

The Government of Indonesia needs to strengthen the policies for what schemes are used in financing REDD+ in Indonesia due to the various schemes that appear in carbon trading, creating susceptibilities for engaging in corrupt behaviors, both on a national and sub-national scale, in the establishment of REDD+ initiatives within Indonesia. In terms of financial allocations for climate change mitigation within the country, the essential approach lies in seamlessly integrating climate control measures into developmental strategies at both the national and local levels. Vital planning will be reflected in proper budget allocations and a continuous monitoring and evaluation system to ensure budget efficiency and effectiveness. Strong coordination between key institutions as regulators and implementing institutions as implementers is needed to accelerate and synergize various climate change control programs.

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Overview of Informal Sector Workers Viewed from Education Variables

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Abstract

The Special Region of Yogyakarta has a significant population engaged in the informal sector. This study aims to explore the relationship between educational level and participation in the informal sector. The data used in this study is from the August 2022 Sakernas (National Labor Force Survey) data. Descriptive analysis was employed to address the research objectives. The research findings reveal that over half of the population is employed in the informal sector. Workers with higher levels of education tend to transition to the formal sector, while less educated individuals dominate the informal sector. Education not only influences sectoral choices but also has an impact on conditions within the informal sector. Workers with higher education experience better conditions, regardless of the field of business, working hours, or income level. They engage in businesses that require capital, demonstrating organization, efficiency, and higher earnings. Some educated informal workers take part-time jobs while waiting for other opportunities.

Keywords: Education; Informal; Workers; Yogyakarta.

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1. Introduction

The Province of the Special Region of Yogyakarta, commonly referred to as DIY, is a province with numerous accolades. One of the well-known designations is the City of Students, which alludes to the high number of students studying there daily. From elementary schools to universities, educational institutions are abundantly available. There are 5,142 schools in total, with 422 of them being SMA/SMK or equivalent. Additionally, Yogyakarta is home to 117 universities. According to data from the DI Yogyakarta Education, Youth and Sports Office in 2021, the people of DIY generally have access to quality education. Consequently, it is not surprising that the Human Development Index (HDI) in DIY reached 80.64 in 2022, ranking second in Indonesia after DKI Jakarta. The superior quality of human resources resulting from education serves as a promising asset when entering the workforce (Bento et al., 2018; BPS Provinsi D.I. Yogyakarta, 2022a; Dellas et al., 2017).

On the other hand, in the world of work, two sectors can be entered, namely the formal sector and the informal sector. The informal sector is often referred to as an area where workers who are not accommodated in the formal sector engage in alternative jobs (Khuong et al., 2021). Formal jobs, which are synonymous with clear legality and regularity, cannot be fully accessed by the entire workforce. Generally, job vacancies in the formal sector require a minimum educational background. In DIY, the availability of complete educational institutions from elementary to high levels provides the population with a good educational background. Therefore, most residents of DIY are expected to enter the formal sector. As expressed by Gumbo & Moyo (2022) through their research in Albania, they found that the higher a person's education, the less likely they are to enter the informal sector Jacolin et al. (2019) also stated that the informal sector is predominantly comprised of lower-class individuals with low incomes. They indirectly assumed that the lower class also has lower levels of education (Darbi et al., 2018).

The relationship between education and the informal sector will be explored in this article. As a province that provides comprehensive and adequate education for its citizens, DIY can demonstrate this relationship. Is it true that many individuals with low educational backgrounds enter the informal sector? Furthermore, does a higher educational background in workers from DIY result in fewer individuals entering the informal sector? In addition to examining the composition of the employment sector in DIY based on workers' educational backgrounds, exploring the relationship between educational background and the informal sector will also unveil distinctions in the characteristics of informal workers with low education and those with higher education backgrounds. If the level of education is higher, individuals are more likely to opt for the formal sector, which is generally perceived as better. Consequently, if they eventually end up in the informal sector, individuals with higher education should have better conditions or at the very least experience notable differences compared to informal workers with lower education

2. Methods

The data source for this research is secondary data in the form of raw data from the National Labor Force Survey (Sakernas) at the provincial level of the Special Region of Yogyakarta in August 2022. The utilized Sakernas data consists of educational background components and the economic sectors entered by individuals. The educational background variables are separated according to their levels, ranging from the lowest to the highest. There are 7 groups, including "No Primary Education/Equivalent," "Primary Education/Equivalent," "Junior Secondary Education/Equivalent," "Senior Secondary Education/Vocational School/Equivalent," "Diploma I/II/III," "Diploma IV/Bachelor's Degree," and "Postgraduate". These seven levels are simplifications of the 16 levels present in Sakernas. The second variable is the economic sector in which workers are employed, divided into formal and informal sectors. Indicators for this variable are based on the respondent's status/position in their main occupation during the past week.

The data used in this study employs the individual level as the unit of research analysis, which includes the working-age population (10 years and above) who are employed or have a job but temporarily not working in the informal sector. The data is processed using the Statistical Package for the Social Sciences (SPSS) Version 23. To address the research objectives, descriptive analysis in the form of tables, graphs, or diagrams is used to provide an overview of the relationship between education and the informal sector through the variables utilized in the study.

3. Results and Discussion

The Special Region of Yogyakarta is rightfully called the centre of the informal sector, as one can find various forms of informal workers everywhere. There are satay sellers with seating on the ground, tented angkringan food stalls, becak drivers, andong drivers, street vendors selling individual shirts, roaming cigarette sellers, and so on. As participants in the informal sector, they offer small-scale goods or services using their labour, facing unregulated competition (Mustapha et al., 2022).

Sperling et al. (2020) state that the informal sector usually manifests itself in six main forms, namely retail, small food stalls, transportation, service/repair, small manufacturing, and construction workers. It is underlined that the scale of the informal sector is limited and small. This is also agreed upon by Adom et al. (2020), who state that informal sector actors operate independently, employ themselves, work temporarily, or only help relatives. He also reveals that this sector usually emerges in developing countries due to the transition from agriculture to non-agriculture. Not all of them can enter industrial areas; as a result, some are still scattered as agricultural labourers or work independently informally outside of these fields. Other jobs included in the informal sector are voluntary or unpaid jobs. This was mentioned by Knox et al. (2019), who highlighted that the informal sector in Europe is closely related to activities such as volunteering or non-profit organizations.

These theories underlie the selection of indicators from variables in the economic sector that workers are engaged in. This article carries out the separation of the formal-informal sector by examining the status/position of respondents in their primary jobs during the past week. In the BPS Sakernas questionnaire, the status/position is divided into seven categories, which include: 1) Self-employed, 2) Business assisted by temporary workers/family workers/unpaid, 3) Business assisted by permanent/paid workers, 4) Laborers/employees/employees, 5) Casual workers in agriculture, 6) Freelance workers in non-agriculture, and 7) Family/unpaid workers. These seven indicators align with the aforementioned theoretical foundations, with those falling under categories 1, 2, 5, 6, and 7 being considered part of the informal sector, while those falling under categories 3 and 4 are classified as formal workers (BPS Provinsi D.I. Yogyakarta, 2022b).

Looking at it as a whole, in the 2022 Sakernas survey, there was a population of 2,960,204 people in DIY. Out of them, 2,053,168 had a working status, while 907,036 others did not work. Interestingly, when considering the working population, 69% of them were employed in the informal sector, whereas the formal sector had fewer individuals. This information is presented in Table 1 below.

Table 1: Economic Sectors Entered by People Working in DIY

	Formal	informal	Total
Working Residents	892,163	1,161,005	2,053,168
(%)	43.45	56.55	100

Source: August 2022 Sakernas, processed

After examining the composition of the formal and informal sectors, the subsequent discussion will focus on the results of the data processing. By employing cross-tabulation, the intersection between the educational background variable and the economic sector can be observed. To conduct a more detailed analysis, the absolute number of formal and informal workers in each educational background group is converted into percentages for better comparison. Furthermore, changes in the number of workers, whether an increase or decrease, will be observed across various educational backgrounds.

Table 2: Educational Background in the Economic Sectors Entered by People Working in DIY

No	Educational background	Working			
		Formal	F (%)	informal	I (%)
1	No Elementary School Diploma/Equivalent	33783	11,19	268036	88,81
2	SD/Equivalent	69371	20,21	273880	79,79
3	Middle School/Equivalent	121507	35.05	225192	64.95
4	SMA/SMK/Equivalent	428044	57.99	310124	42.01
5	Diploma I/II/III	62080	64.98	33455	35.02
6	D IV/Bachelor	154225	75.97	48777	24.03
7	Postgraduate	23153	93.76	1541	6,24

Source: August 2022 Sakernas, processed

Table 2 above shows that workers in the do-it-yourself (DIY) sector are predominantly high school (SMA/SMK/equivalent) graduates in terms of absolute proportion, both in the formal and informal sectors. Following that, in the second highest order, we find workers with different educational backgrounds in each sector. In the formal sector, there are workers with a Diploma IV/Bachelor's degree education background, while in the informal sector, there are those who have graduated from elementary school or its equivalent. This indicates that individuals with higher educational backgrounds tend to prefer the formal sector over the informal one (Daru & Naura, 2018). To further clarify this, a comparison of percentages between sectors at each educational level can be observed in Figure 1.

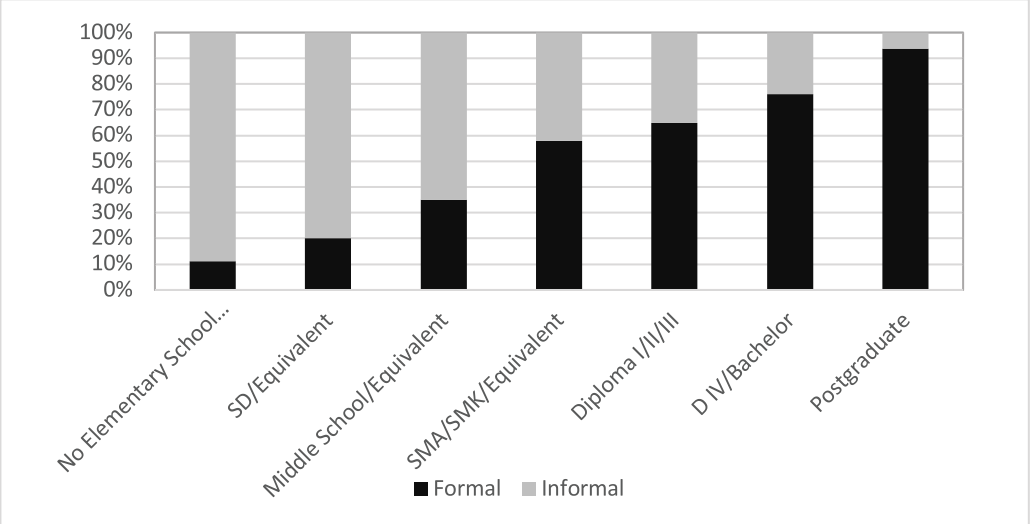

***Figure 1**. Percentage of the Formal – Informal Sector for Each Educational Background of the Population Working in DIY*

Source: August 2022 Sakernas, processed

It can be observed from the figure that as the level of educational background increases, there is a consistent change in the percentage ratio of the two economic sectors. Starting from the lowest educational background, which is the absence of an elementary school diploma or its equivalent, nearly 90% of individuals enter the informal sector. Moving on to the next educational background, which is elementary school graduates or its equivalent, the percentage of informal sector workers is lower compared to the formal sector. This reduction in the percentage of the informal sector persists until the highest level of education, which is postgraduate graduates (S2 and S3). Among this group with the highest educational background, the informal sector is the least prevalent, with almost all individuals being in the formal sector. From the lowest to the highest educational background, the percentage in the

formal sector consistently increases. This aligns with the theory proposed by Uzondu (2021), which suggests that individuals with more advanced educational backgrounds are less inclined to enter the informal sector.

Gerxhani & van de Werhorst's theory is based on their research in Albania, a country in Eastern Europe that opened its state system to become democratic in the early 1990s after 40 years of adhering to a communist system. This transition made the economic system unstable and submerged the various formal institutions that had previously existed. The informal sector then grew to fill the void, eventually accounting for 33.4% of all national economic activity in 1999/2000. Over time, development in Albania has continued, particularly in the education sector. The boost in education has had an impact on mindsets and decision-making, leading to a decreased inclination to participate in the informal economy sector. This influence of education is closely tied to the human capital theory. According to Son Early & Peksen (2019), individuals with higher levels of education have better job opportunities because they possess superior human capital, making them more competitive in the job market. In developing countries, where opportunities are often limited, competition in the formal sector is fierce. Moreover, there are minimum requirements for entry into the formal sector. Therefore, with higher education, individuals can meet or even exceed these requirements, increasing their chances of securing formal employment (Bagus Panglipur & Amijaya, 2018).

Educational background is also said by Tayyaba et al. (2022) to influence the job opportunities that a person gets. It was revealed that a low educational background would limit someone from entering the company because they were considered to have low productivity, in terms of their knowledge and skills. People who have limited opportunities then tend to enter the informal sector or work independently because this sector does not need special qualifications. This concept was also expressed by Inanna et al. (2020) who also agreed that the informal sector is very open to people who do not have an adequate formal educational background. Requirements to enter the informal sector are very low and it is common for the skills used to be not from a particular educational background. In contrast to those who have a higher educational background and are qualified, there are specific knowledge and skills that can be used in formal jobs with suitable specializations. They are also close to order by working regularly. This explains why workers in DIY, with higher educational backgrounds, will be more likely to enter formal jobs than informal jobs (Prayitno, 2017).

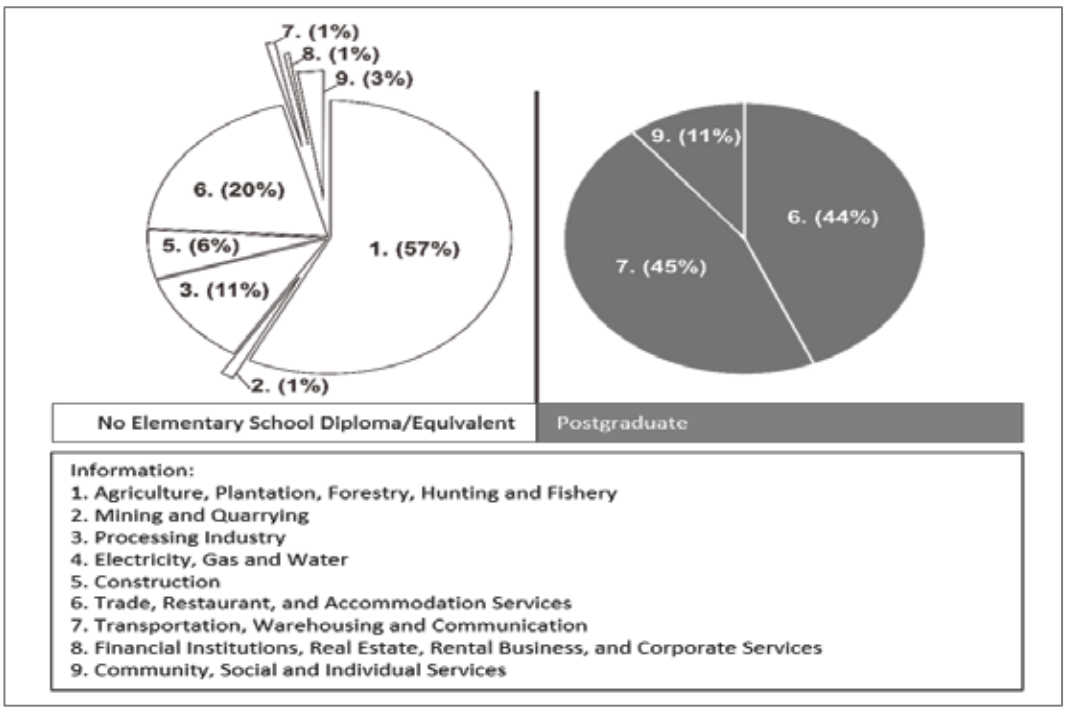

***Figure 2**. Comparison of Types of Business Fields between Informal Workers with Low and High Education in DIY*

Source: August 2022 Sakernas, processed

After understanding that it is true that the higher the level of education of workers, the more likely they are to enter the formal sector rather than the informal sector, in line with human capital theory, their working conditions are generally better than those of workers with low educational backgrounds due to their superior knowledge and skills. Therefore, it is necessary to compare the characteristics of the informal sector between individuals with higher education and those with lower education. Figure 2, depicting the types of business sectors, provides a sharp comparison between the lowest point, representing informal workers without elementary school/equivalent degrees, and the highest point, representing informal workers with postgraduate education levels. Examining the disparities between these two points will reveal specific business sectors within the informal sector that are chosen by workers with different levels of education (Purnama Putra et al., 2018).

What can be inferred from the figure above is the discovery that informal workers with low education are more involved in agricultural businesses. More than half, or 57%, are engaged in agriculture, plantation, forestry, hunting, and fisheries. Informal businesses in this field are completely absent among informal workers with the highest educational background. A noticeable portion of informal workers with low education is occupied by manual labour jobs, such as in the construction and processing industries (Dahles & Prabawa, 2013). Considering that this sector lacks a formal job structure, one can envision construction jobs being performed by construction workers, wall painters, and other similar rough project work. The processing industry is also distinct from mass-production factories or companies but rather involves independent work converting raw materials into semi-finished or finished products. For instance, carpentry work with wood, wicker, and pottery falls into this category. Such jobs are not observed among informal workers with postgraduate education (Igwe et al., 2020).

The contrast between informal workers with the highest educational background and the strong capital-based business sector is evident. Three types of business fields can be observed, with the largest portion, accounting for 45%, being the transportation, warehousing, and communication sectors. Engaging in this field not only necessitates economic capital for acquiring vehicles, premises/buildings, and technology but also demands a well-established knowledge base and skill set. Similarly, the community, social, and individual service business field, comprising 9%, requires specific knowledge for its operation (Rochman et al., 2017). For instance, managing a business consulting service necessitates economic capital as support. The two types of business fields, coded 7 and 9, are rarely found among informal workers with the lowest education, accounting for only 1% and 3% respectively. Conversely, among informal workers with the highest education, the percentage engaged in trading, restaurant, and accommodation services is higher compared to those with the lowest education, standing at 44% and 20% respectively. Despite ranking as the second most common business field across both the highest and lowest education levels, they still exhibit distinguishing characteristics (Çakmak & Çenesiz, 2020).

Other characteristics that differentiate informal jobs from those of workers with higher and lower levels of education can be observed in terms of hours worked and income. Higher levels of education typically result in greater reliance on mental rather than physical abilities. Additionally, individuals with higher education tend to work more efficiently. In terms of income, those with higher education generally have more opportunities to earn higher incomes. Regarding working hours, among informal workers with the highest education level, namely postgraduates, there are only two types of working hours. Firstly, some work work full-time for a week, which amounts to six days, or those who work very briefly for a week. Approximately 11% of these workers put in 57 hours per week, which equates to 8 hours per day. Meanwhile, 44% of them work 46 hours per week, which is around 7 and a half hours per day across six working days. Surprisingly, 46% of informal workers with the highest education level only work for 5 hours per week, which is quite astonishing.

This extremely short working time, when related to the earlier mentioned type of business field, could imply that they work as capital-intensive business owners or service providers with specialized skills. As a result, they only need to work occasionally to oversee or handle limited orders with high value. When examining informal workers with the lowest education level, different conditions can be observed as their working hours vary greatly, ranging from working only a few hours to exceeding 98 hours per week (Damayanti et al., 2018). The most contrasting situation involves those who work for 90-98 hours a week, equivalent to 12-14 hours per day. Among all informal workers from the lowest educational background, approximately 1%, or 2,490 individuals, work for half a full day or even more, continuously working for 7 days. Undoubtedly, this is physically exhausting and inefficient. A significant amount of time is spent waiting for passengers, as is the case for pedicab drivers or motorcycle taxi drivers who frequently halt at

intersections. Despite spending half a day waiting for passengers, their income remains limited (Webb et al., 2020).

Moving on to the issue of income, according to the Sakernas 2022 records in DIY, the highest income for workers in the informal sector ranges from IDR 10,000,000 to IDR 15,000,000 per month. This level of income is only achieved by individuals belonging to the higher education class. Specifically, 2.5% of all Diploma I/II/III graduates, totalling 606 people, and 4.2% of D IV/Bachelor graduates, totalling 2,081 people, can earn such high incomes. Apart from these two educational background groups, no one else in the informal sector earns such substantial income. Table 3 provides a clearer overview of the high-income levels earned by informal workers based on their educational backgrounds. The high income mentioned is determined by the UMK (City/Regency Minimum Wage) in DIY for 2022, which, when averaged and rounded up, amounts to approximately IDR 1.5 million. An income is considered high if it is a multiple of that nominal amount. Therefore, table 3 below presents individuals whose income has multiplied by that amount, starting from double (Rp. 3 million and above) and going up to fourfold (Rp. 6 million and beyond).

Table 3: High-Income Informal Sector Workers by Education

No	Education	Group Size	(%)	High Income			
				IDR 3 million - IDR 5.99 million	(%)	> IDR 6 million	(%)
1	No Elementary School Diploma/Equivalent	268036	100	717	0.27	0	0.00
2	SD/Equivalent	273880	100	2932	1.07	453	0.17
3	Middle School/Equivalent	225192	100	4102	1.82	1382	0.61
4	SMA/SMK/Equivalent	310124	100	16276	5,25	577	0.19
5	Diploma I/II/III	33455	100	2528	7.56	606	1.81
6	D IV/Bachelor	48777	100	6971	14,29	2602	5,33
7	Postgraduate	1541	100	164	10.64	674	43,74

Source: August 2022 Sakernas, processed

The table above demonstrates that as the education level of workers in the informal sector increases, the number of individuals earning high incomes also increases. This is evident from the percentages associated with each education level. For instance, only a small percentage of individuals with the lowest level of education earn incomes of IDR 3 million or IDR 6 million and above. However, as the education level rises, the percentage of individuals earning such incomes also increases at each level. The highest percentage is observed in the group of informal workers with D IV/Bachelor and Postgraduate education. Among the informal workers with a D IV/Bachelor degree, 14.29% earn incomes ranging from IDR 3 million to IDR 5.99 million, making this group the highest among other education groups. Additionally, 5.33% of informal workers from this group earn above Rp. 6 million. The majority of individuals with postgraduate education achieve the highest nominal income, with 43.74% of this group earning that amount every month.

In addition to the aforementioned characteristics that explain the differences in the conditions of the informal sector for groups with low and high levels of education, there are other noteworthy findings. Another characteristic is the decision of informal workers to either stay in the informal sector or work in it temporarily. Based on their educational background, it was found that some individuals with higher education only temporarily stopped in the informal sector as they were searching for other jobs or utilized it as part-time work while continuing their studies. Among informal workers, 12.6% with Diploma I/II/III education and 8.6% with Diploma IV/Bachelor's degree were actively seeking other employment in the past month. They would abandon their current informal jobs if they secured other opportunities. When asked about their reasons for seeking other employment, 675 workers from all educational backgrounds

mentioned that their current job was not suitable. This reason was expressed by 77.6% of informal workers with Diploma I/II/III and Diploma IV/Bachelor's education. Additionally, 16,503 individuals in DIY engage in informal work as a side job while pursuing higher education. Among them, 32.5% are recent high school graduates continuing their diploma/undergraduate education, and 11.7% are students who further their studies after completing a Diploma IV/undergraduate degree. This finding aligns with Sethuraman's statement (1985) that the informal sector serves as a temporary employment option for individuals, possibly as they await opportunities in the formal sector (Knox et al., 2019).

Conclusions and Policy Implication

Of the working population in the Province of DIY, more than half, or 69%, are engaged in the informal sector. The informal sector outperforms the formal sector by a margin of 13.1%. When considering the educational background of workers, those with a high school diploma (SMA/SMK/equivalent) dominate both sectors in terms of absolute numbers. However, upon examining the ranking of the next highest absolute number, it becomes apparent that workers with higher education tend to gravitate towards the formal sector, while those with lower education fill the informal sector. The relationship between educational background and the informal sector in the Province of DIY becomes clearer through cross-tabulation and the presentation of percentage figures. This relationship suggests that individuals with higher educational backgrounds are less likely to enter the informal sector, as they are more inclined to join the formal sector due to their higher qualifications.

In addition to influencing the choice to enter the formal or informal sector, education also differentiates the characteristics and conditions of workers in the informal sector. Different levels of education entail distinct conditions. Generally, the higher the level of education, the better the conditions in terms of business field, working hours, and income. Informal workers with higher education predominantly engage in business fields that require capital, whether in terms of materials or skills. On the other hand, those with low education are primarily involved in menial business fields. Highly educated individuals tend to have more organized and efficient working hours, leading to higher incomes. It has also been observed that some informal workers with higher education in DIY (Do-It-Yourself) only work temporarily while awaiting other job opportunities or engage in part-time jobs.

Recommendation

DIY has provided numerous educational institutions that cover all levels from elementary to high school. If the population has a higher education level, job opportunities will be widely available. Individuals also tend to prefer entering structured and specialized formal jobs based on the knowledge and skills they acquire during their education. However, the percentage of the formal sector in DIY is still lower than that of the informal sector. The current suggestion is for the government to make educational and economic policy choices. Should residents in DIY be encouraged to pursue higher education and subsequently create new formal sectors? Alternatively, is it sufficient to limit education to the high school level and then enhance the informal sector through guidance, skills training, and supportive regulations. Other options can be explored if this issue is further studied.

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Friend or Foe: Internet to Indigenous People in Indonesia

Lesson Learned from Inner Baduy Request for Internet Blackout

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"*The existence of phones/smartphones that can be owned by everyone, including Baduy people, is considered to result in declining morals of our generation that can access non-educating applications and contents*."

The above-mentioned declaration was written in a letter by a member of the Baduy Dalam tribe. This indigenous community deliberately avoids using money, modern advancements, and formal schooling, thereby preventing tourists from documenting their unique existence. The letter was initially directed to the Lebak Official and later forwarded to the Ministry of Communication and Informatics, bearing the date of June 2023 (Syakriah, 2023).

"*This request is a part of our efforts to minimize the negative impact of smartphones on our people*."

Additionally, the assertion above is from a representative from the Baduy community, who argued that the presence of telecommunication towers nearby could pose a threat to their traditional way of life and the inclination of the younger generation towards internet usage (AFP, 2023) In light of this request,

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the Ministry of Communication and Informatics has officially granted the Inner Baduy's appeal to cease internet services. The Inner Baduy community firmly believes that the internet has a detrimental impact on the younger generation. As a result, they have implemented measures to protect their community from the influence of the online world (Loasana, 2023).

The Baduy community, frequently associated with the Sunda Kingdom or Padjajaran Kingdom in the 15th and 16th centuries, is divided into Outer Baduy and Inner Baduy. While Outer Baduy embraces modernity, they also maintain the principles and teachings of the Baduy. Conversely, Inner Baduy remains resolute in preserving its genuine culture, free from external influences. They prioritize the traditions of their forefathers and actively work towards safeguarding them, as well as the natural environment surrounding them. (Amaliyah, 2018) On July 6th, 2020, the Baduy community made an official appeal to the President of the Republic of Indonesia, urging for the exclusion of their village from the roster of tourist attractions. Instead, they put forth a suggestion to include the esteemed Saba Budaya Baduy. This endeavor emphasized sustainable tourism approaches, intending to limit the number of visitors to the village. The primary objective of the Baduy community was to uphold a harmonious equilibrium between preserving their cultural legacy and protecting their pristine natural environment. (Abidin, 2020) Baduy received the prestigious 2022 Indonesia Tourism Village Award for outstanding performance, securing a place among the top 50 Best Villages. (Malikh, 2022) Due to its unwavering commitment to traditional values, the Baduy community has exhibited exceptional cultural and economic resilience amidst the COVID-19 pandemic. Despite being a community of approximately 26,000 people, the Baduy economy has remained unaffected by the current crisis. The tribe places great importance on its value: a mountain should not be destroyed, a valley should not be damaged, and a prohibition should not be violated (Amalia, et al., 2023).

Baduy Dalam is undeniably recognized as one of the indigenous peoples of Indonesia. Even though the interpretation of the term "indigenous people" is a matter of contention and can occasionally be construed in various ways. Convention No. 169, also known as the Indigenous and Tribal Peoples Convention of 1989, has been implemented by the International Labour Organization (ILO) to provide explicit guidelines for identifying indigenous and tribal communities. (International Labour Organziation (ILO), n.d.) The concept of the rights of indigenous peoples is universally recognized in global legal norms, irrespective of the terminology employed at the national level to define them. These individuals are entitled to a comprehensive range of rights that aim to address and rectify discriminatory practices that impact them. In the case of Indonesia, the term "*masyarakat adat*" is frequently used to refer to native communities, which comprise more than 700 ethnic groups and around 20-29% of the country's population. (Errico, 2017) Amnesty International has documented that the worldwide population of Indigenous individuals surpasses 476 million, inhabiting more than 90 countries across the globe. (Amnesty International, 2023) Around two-thirds of the worldwide indigenous population is located in the Asian continent (World Bank, 2011). On September 13, 2007, the international community pledged to endorse a resolution known as the United Nations Declaration on the Rights of Indigenous Peoples. This declaration recognizes that indigenous individuals are entitled to the same rights and privileges as any other individuals while also emphasizing the importance of respecting and embracing the diversity of all people. Moreover, the United Nations firmly asserts that when indigenous peoples have authority over decisions that affect them and their lands, territories, and resources, they are better equipped to safeguard and strengthen their institutions, cultures, and traditions. This empowerment enables indigenous communities to develop in alignment with their aspirations and needs (General Assembly, 2007).

Like many other countries, Indonesia has made significant efforts to integrate indigenous communities into the world of technology and development. A recent research study has explored the cultural dynamics between the adat community and modernity, highlighting the crucial role of government support for both aspects. Adat villages, such as Inner Baduy, have transformed into popular tourist destinations but have encountered difficulties adjusting to the market-driven economy and embracing modernization. Economic progress and the influence of external customs from beyond their community have instigated this cultural shift. (Fadli, Cahyandari, Liemanto, Sholehudin, & Hadiyantina, 2023) Indonesia has also emerged as one of the rapidly growing digital economies in the region. However, it grapples with a significant digital divide between urban and rural areas and among different socio-economic groups. To narrow this divide and guarantee a more inclusive future for every Indonesian citizen, the government has taken various steps to improve digital connectivity and accessibility to a wide

range of digital technologies and services. These measures include creating a national broadband plan to ensure that high-speed internet is available to all individuals by 2024. The Palapa Ring project is also being expanded to enhance digital connectivity further. The government has also established community-based internet networks in rural areas, as demonstrated by the "*Digital Village*" program. Furthermore, efforts are being made to promote digital literacy and skills among the population while also improving public service delivery and citizen engagement through digital platforms.

In result, the digital landscape in Indonesia has experienced remarkable growth in recent years. From 2015 to 2022, the number of internet users actively participating online has tripled. Additionally, there has been a consistent increase in active social media accounts, which has risen from 72 million in 2015 to 191.4 million in 2022. The table below illustrates the continuous expansion of Indonesia's digital realm during this period.

Table 1: Sum up of Indonesia's Digital Landscape Overview from 2015 – 2022
(Data released in January of the respected year, in millions)

	2015	2016	2017	2018	2019	2020	2021	2022
Total Population	255.5	259.1	262	265.4	268.2	272.1	274.9	277.7
Active Internet User	72.7	88.1	132.7	132.7	150	175.4	202.6	204.7
Active Social Media Accounts	72	79.0	106	130	150	160	170	191.4
Mobile Connections	308.2	326.3	371.4	177.9	355.5	338.2	345.3	370.1

Source: Reports from Digital Indonesia: The Essential Guide to the Latest Connected Behaviors, We Are Social, Kepios, from 2015 – 2022.

The data presented in the table highlights the continuous growth of Indonesia's digital ecosystem. This is evident when comparing the number of mobile connections to the total population, with the former surpassing the latter. Although the data does not provide insights into the gap between individuals with and without mobile connections, the increasing number still carries significance. In the IMD World Digital Competitiveness (WDC) assessment, Indonesia is 53rd out of 64 countries. The WDC evaluates and ranks countries based on their adoption and utilization of digital technologies, which can bring about significant changes in government practices, business models, and society. The accompanying figure further supports this information (The IMD World Digital Competitiveness Center 2021).

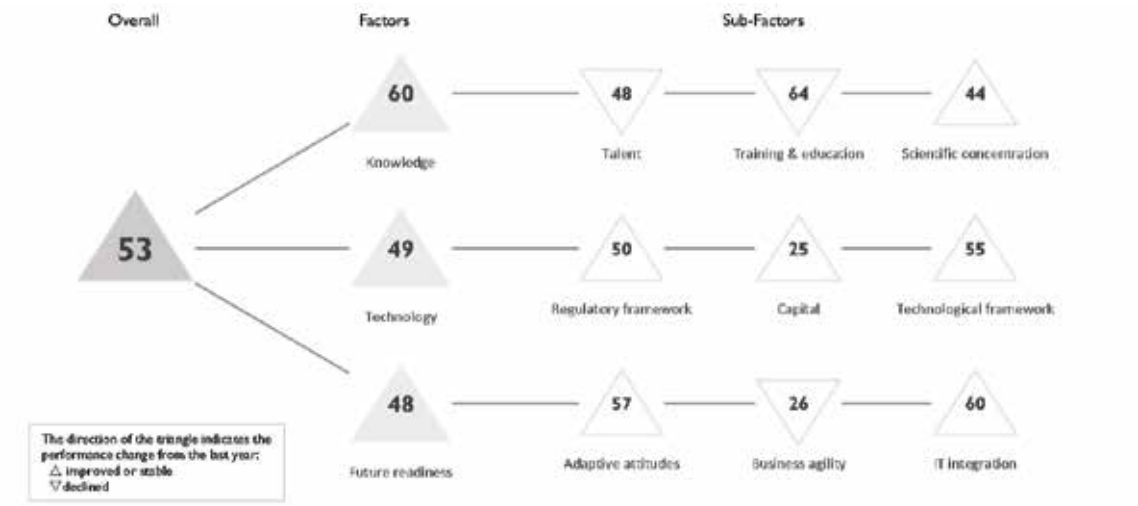

Figure 1. *Indonesia's Overall Performance on World Digital Competitiveness Ranking from 64 countries (The IMD World Competitiveness Center, 2021)*

Indonesia has witnessed a remarkable and noteworthy advancement in its digital landscape during the pandemic period from 2020 to 2021. The outcomes have consistently shown significant progress. The unexpected catalyst for this accelerated digital transformation in Indonesia has been the COVID-19 pandemic. In recent years, Indonesia has actively nurtured innovation, inclusivity, and efficiency in the realm of technology development.

OVERALL & FACTORS - 5 years	2017	2018	2019	2020	2021
OVERALL	59	62	56	56	53
Knowledge	58	61	56	63	60
Technology	56	59	47	54	49
Future readiness	62	62	58	48	48

***Figure 2**. Indonesia Overall and Factors Ranking Year by Year from 2017 - 2021 on World Digital Competitiveness Ranking from 64 countries (The IMD World Competitiveness Center, 2021)*

The Ministry of Communication and Informatics in Indonesia has underscored that the progress of ICT infrastructure in the nation has been hastened by at least a decade compared to the initial timeline. This expeditious development can be attributed to the swift population expansion and the obstacles presented by the COVID-19 pandemic. Consequently, every sector of the country has been compelled to adjust and advance to address the pandemic effectively. As a result, the ministry's budget reallocation and refocusing policy has been greatly influenced by the pandemic's impact on numerous plans and programs (Ministry of Communication and Informatics of the Republic of Indonesia, 2020).

In 2022, Indonesia achieved a significant milestone by assuming the Presidency of the G20, adopting the motto 'recover together, recover stronger.' Due to its substantial population and economy, Indonesia has been bestowed the privilege of being the sole representative country for Southeast Asia in the G20 since 1999 (Salim, 2010). Digital Economy Transformation is one of the three critical issues chosen by the forum. The ongoing discussions surrounding Covid-19 and digital transformation have been intense. It is widely acknowledged that effectively dealing with economic and health crises necessitates embracing rapid technological advancements. Interestingly, this pandemic has played a pivotal role in compelling the government of Indonesia to take significant strides towards enhancing its digital transformation endeavors. This includes advocating for the inclusion of this agenda on the G20 platform.

The G20 has had a notable impact on the formation of global governance, particularly on advancing development and economic strategies that strive to enhance the well-being of individuals worldwide. Comprising 19 prominent nations and the European Union, the G20 serves as a platform for multilateral cooperation, encompassing countries ranging from middle-income to high-income economies. The composition of the G20 reflects the evolving dynamics of global economic power, with its members collectively accounting for over 80% of the global financial income. Consequently, the economic state of these 20 nations significantly influences the global economy as a whole (Hermawan, Sriyuliani, Hardjowijono, & Tanaga, 2011). The G20 is dedicated to harmonizing its endeavors with the 2030 Agenda for Sustainable Development to guarantee that everyone is included in the efforts to eliminate poverty, attain sustainable development, and construct an all-encompassing and sustainable future for everyone. These endeavors will be carried out through multilateral and unilateral domestic and international actions, utilizing the G20's comparative advantage as a global economic forum. (G20 Official, 2016) During the Hangzhou summit in 2016, the G20 expressed its political dedication to assume a leading role in attaining sustainable global development and supporting the implementation of the 2030 Agenda for Sustainable Development. This commitment was solidified by adopting the G20 Action Plan on the 2030 Agenda for Sustainable Development. The sectors outlined in this plan, known as the Sustainable Development Sectors, are intricately connected to the well-being of individuals, the preservation of our planet, the promotion of prosperity, and the cultivation of peace and partnership. These sectors are also referred to as the 2030 Agenda's 5Ps (G20 Official, 2017). The G20 countries have made concrete endeavors to implement the Sustainable Development Goals (SDGs). These efforts have been evaluated, and it has been revealed that the G20 countries that submitted Voluntary National Reviews (VNRs) from 2016 to 2018 have reported significant progress. Nevertheless, critics have raised concerns regarding the inadequate reporting of SDG-related policies and budgets (Elder & Bartalini, 2019). The government has consistently prioritized the Sustainable Development Goals (SDGs) as the foundation of all development initiatives in Indonesia's global framework.

The principle of not leaving anyone behind is a fundamental aspect of the Sustainable Development Goals (SDGs), which aim to eradicate poverty, safeguard the environment, and promote peace and prosperity for all by 2030. We must uphold this principle while developing our nation, as it is ethically

correct and strategically advantageous. Ensuring that all individuals have access to essential services, opportunities, and human rights is the government's duty to establish a more inclusive, resilient, and sustainable society capable of addressing the challenges of the 21st century.

However, it is crucial to acknowledge that the principle of leaving no one behind does not imply neglecting the indigenous people's need to preserve their culture. While granting the request to disconnect from the internet may seem contradictory to the Sustainable Development Goals (SDGs) values, it shows respect for the tribe's way of life. In today's modern society, the internet is widely considered an essential tool, prompting some to question why certain tribes choose to live without it. Nevertheless, it is important to understand that not all tribes residing in remote areas share the same perspective. These tribes have unique cultures and traditions, shaping their values and priorities. Consequently, the internet is not seen as a necessity by these tribes but rather as a potential distraction. They have alternative means of communication, learning, work, and entertainment with greater significance and fulfillment. Their deep connection with nature, community, and ancestors outweighs any desire for online connectivity. Embracing the internet would mean risking the erosion of their distinct identity and way of life, which they are unwilling to compromise. These tribes find contentment and happiness in their current circumstances without feeling compelled to adopt the Internet. The government should address the digital divide by employing socio-cultural approaches. It is crucial to ensure that each person reaps the advantages of technological advancements while also being protected from any negative repercussions they may bring.

While the Baduy community has the potential to bring numerous benefits to the tourism industry, it is important to acknowledge that it may also have detrimental effects on the indigenous people. Tourism is an industry that generates significant economic advantages for various destinations. The intrusion of tourism in such cases can disrupt the tribe's way of life and traditions by causing a lack of respect for their customs, beliefs, and privacy. These actions include taking unauthorized photographs or videos, touching or removing sacred objects, or interfering with important rituals and ceremonies. Additionally, tourism can jeopardize the very survival and independence of these tribes. The presence of tourists may attract the attention of other outsiders who may exploit the tribe's land, resources, or cultural heritage. Moreover, tourists may pressure the tribe to conform to mainstream societal norms or abandon their traditional lifestyle and culture. This can lead to the erosion of the tribe's identity and autonomy, ultimately threatening their long-term existence. Ideally, it may be more appropriate to leave these tribes undisturbed and preserve their unique way of life.

Tribe rights play a significant role in attaining the Sustainable Development Goals (SDGs) as they are crucial in reducing inequality and advancing the SDGs. These rights encompass the collective human rights of indigenous peoples, protecting important aspects such as their cultural identity, self-governance, control over their lands and natural resources, and meaningful participation in decision-making processes. International instruments, including the UN Declaration on the Rights of Indigenous Peoples (UNDRIP) and the ILO Convention 169 on Indigenous and Tribal Peoples, recognize and safeguard these rights. However, effective implementation of tribe rights at national and local levels still faces numerous challenges and gaps. These barriers include a lack of political commitment, inadequate legal recognition, insufficient data and indicators, limited consultation and consent mechanisms, and limited access to justice and remedies. As a result, indigenous peoples cannot fully exercise their rights and contribute to achieving the SDGs. To address this, it is crucial to involve indigenous peoples in designing, monitoring, and evaluating the SDGs, considering their specific needs and priorities when formulating indicators and targets. The recent decision by the Indonesian government to grant the request of the indigenous Baduy Dalam community to disconnect themselves from the internet is an example of commitment and respect towards indigenous peoples. Additionally, providing indigenous communities with the necessary resources and support for capacity-building is vital in enabling them to realize their rights and pursue their development aspirations.

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Poverty and Freedom: Case Studies on Global Economic Development

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Introduction

The book, ***'Poverty & Freedom: Case Studies on Global Economic Development'***, is penned by Matt Warner in 2019, an American practitioner and researcher actively engaged in international writing, speaking, and consulting on economics, institution building, nonprofit management, and philanthropic impact. As the President of Atlas Network, Warner extensively details a global case study showcasing the triumph of think tanks employing local-first strategies for change. Drawing on diverse insights, the book directs philanthropic aid to high-performing think tanks aiming to eradicate poverty and enhance well-being.

Structured with an introduction, seven main sections, and a conclusion, it delves into three crucial facets of poverty and freedom issues in economic and institutional development: (1) highlighting the inefficacy of foreign aid and development interventions from regional to international levels, (2) emphasizing the dedication of local institutions, such as think tanks, to eliminating institutional barriers, and (3) showcasing numerous global case studies illustrating the accomplishments of local institutions, particularly think tanks, in combatting poverty.

In this book, there are several innovations. First, it prominently showcases the effectiveness of think tanks in leading local strategies for change, emphasizing a more locally focused approach. Also, it

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highlights global case studies, providing deeper insights into issues and solutions across various regions. However, there are shortcomings in presenting non-Western perspectives or broader views in the context of global poverty reduction. While presenting a fresh perspective on poverty alleviation strategies, the book may require more in-depth analysis that involves broader perspectives from non-Western outlooks.

Poverty, Freedom, and Sustainable Development Planning

Poverty and freedom play crucial roles in sustainable development planning. Poverty often stands as a primary obstacle to achieving sustainable development goals, making efforts to alleviate poverty commonly take center stage (Cobbinah, 2011; Oyeshola, 2007). Similarly, greater societal and individual freedoms like access to education, healthcare, and gender equality support sustainable development (Indro, 2013). It is important to note that community involvement in sustainable development planning considers societal needs, including poverty and freedom aspects. Thus, active engagement in planning ensures programs' sustainability and relevance to local needs (Ipinnaiye & Olaniyan, 2023). Poverty, freedom, and sustainable planning are interconnected in striving for sustainable global development goals.

Poverty, Freedom, and Economic Development

Talking about poverty and freedom, we must align perceptions and definitions. Poverty exceeds a mere lack of income and resources for sustainable livelihoods. Examples include hunger, malnutrition, limited access to education, discrimination, social exclusion, and a lack of decision-making participation (United Nations). Causes encompass disparities in resource ownership patterns, human resource quality, and access to capital (Sharp et al., 2005). Meanwhile, freedom embodies meaningful choice in line with determinism's teachings, focusing on internally motivated actions. It bears a normative connotation—doing what's necessary.

This book encompasses several crucial points in each section. In parts I and II, key elements include (1) the development of contextual aspects (at various levels—local, national, or international), avoiding prescription, and striving to enhance human dignity and (2) the establishment and fortification of local independent institutions (such as think tanks) or grassroots organizations. Additionally, (3) while local think tank freedom in strategy and implementation is necessary, defining targets and indicators for MEAL (Monitoring, Evaluation, Accountability, and Learning) remains imperative. Meanwhile, chapters III to VII delve into numerous worldwide case studies serving as learning experiences, fostering open dialogue, and founded on the Coach-Compete-Celebrate principles.

“Poverty and Freedom” is captivating with its excellent writing and comprehensive literary references. It offers a chance to endorse a novel economic development model. It fosters a robust, expanding middle class and diminishes inequality. This book illustrates the imperative for global countries to strengthen local endeavors, empowering communities by dismantling restricting institutional barriers. Through its case studies, the book highlights the commendable efforts of local thinkers dedicated to expanding freedom among vulnerable populations worldwide.

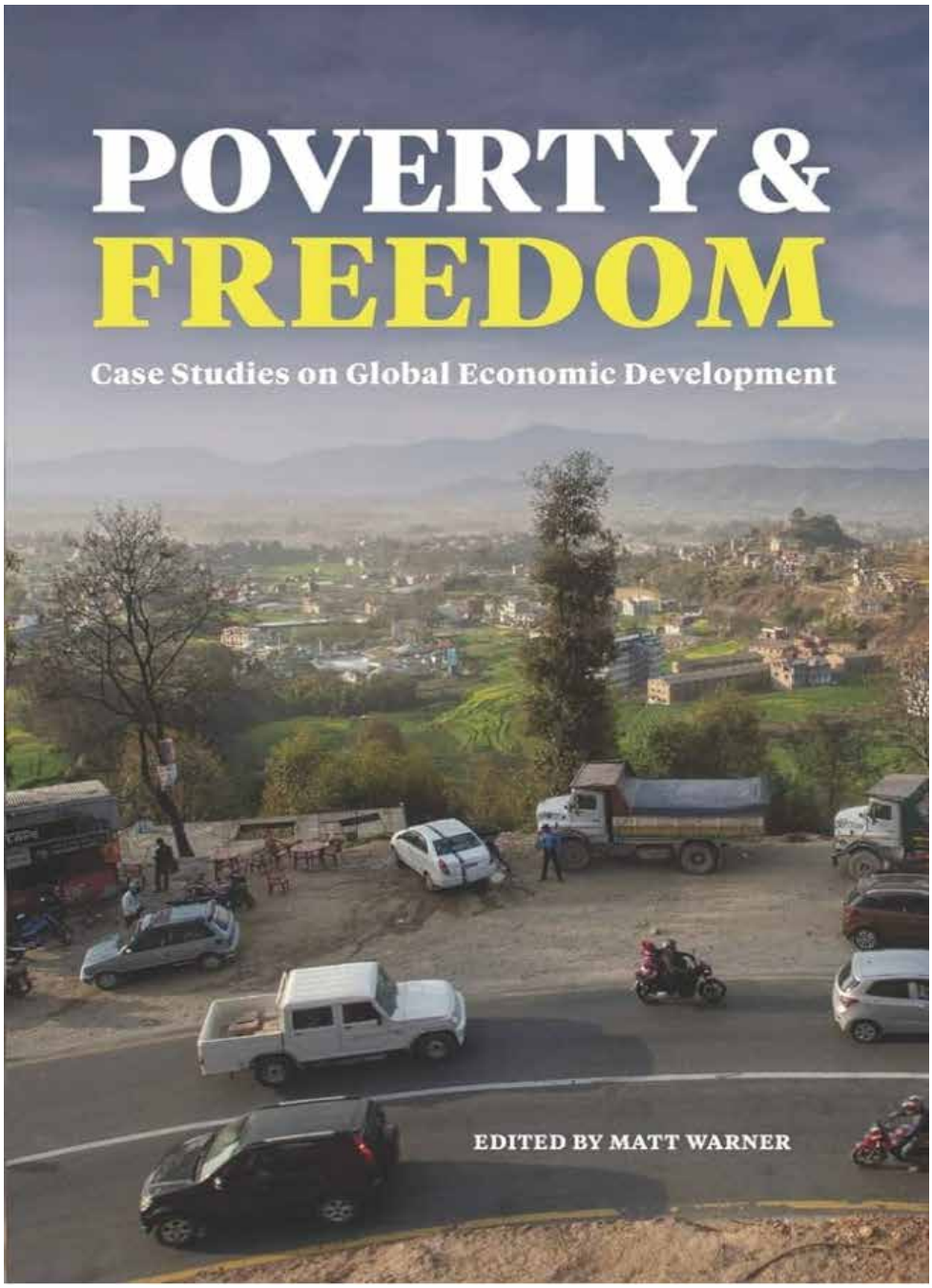
Poverty Alleviation and Freedom

This book offers insights into poverty alleviation by (1) strengthening local and national bureaucratic ecosystems, emphasizing coordination and collaboration while avoiding unproductive competition and repetition. It promotes a productive business community and economy and (2) maximizes knowledge transfer to address needs and areas of ignorance. Moreover, to tackle poverty, it advocates freedom in (a) managing natural resources through land tenure and agrarian reform, (b) enhancing human resources' quality, and (c) accessing capital by using financial institutions, creating MFIs, and fostering cooperatives. However, it requires enhancements, such as the integration into the global development agenda (SGDs 2030) and the elaboration and detailing within the MEAL framework (Monitoring, Evaluation, Accountability, and Learning).

Conclusion and Rating

In short, this 200-page book is highly recommended. The book is packed with both theoretical and practical knowledge and presented through concise and engaging case studies. It resonates with institutions or individuals engaged in poverty alleviation and development studies. It serves as a valuable resource for those currently involved in such work. Moreover, it can guide development planners and local institutions to reassess policies favoring the disadvantaged, amplifying community aspirations at a broader level. Overall, with the mentioned flaws, the book deserves an A-rating.

Cover Book



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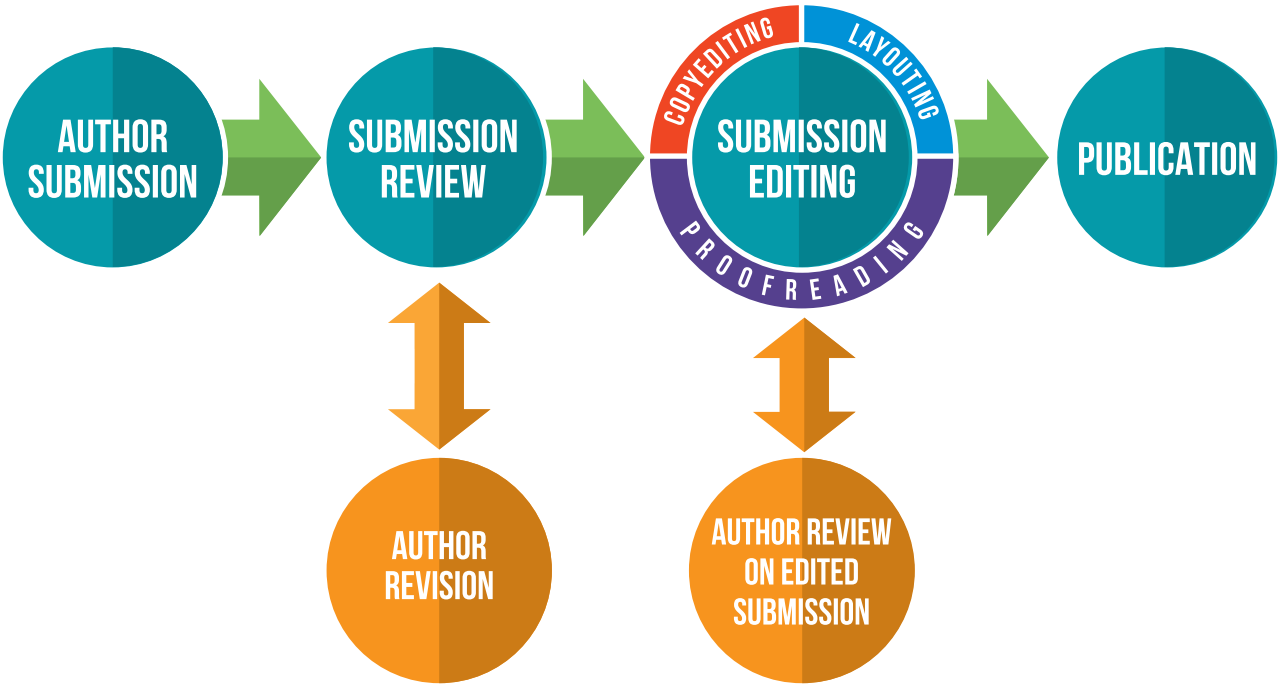

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