Effectiveness of Using Organic and Liquid Fertilizers Based on Palm Oil Mill Waste

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ABSTRACT

This study aimed to assess the effectiveness of organic and liquid fertilizers derived from palm oil mill waste as an alternative to improve soil quality and control Ganoderma in PT Padasa Enam Utama plantations. This study used the DEA model, one of three model approaches, to evaluate how effectively processing palm oil waste into organic fertilizer is. The results showed that using organic fertilizers from palm oil mill waste significantly improved soil quality, as indicated by increased organic matter content and soil microorganism activity. Compared to conventional methods, this treatment also reduced the level of Ganoderma attacks by 40% and increased production yields by 15%. This success was supported by policies that focused on the ease of use of technology, employee encouragement to use it properly, and synergy of encouragement.

Keyword : *Effectiveness, Using Organic, Liquid Fertilizers Based, Palm Oil Mill Waste*

INTRODUCTION

Because oil palm farmers use large amounts of artificial fertilizers in their planting areas, the dependence of oil palm plantations on artificial fertilizers has become a problem (Adrinoviarini, 2022; Nuro et al., 2016). In general, fertilization is carried out to improve the physical and biological properties of the soil (Harahap et al., 2020). This ganoderma attack threatens the survival of oil palm plantations. The Ganoderma boninense fungus causes this attack, which is the main pathogen of diseases that attack oil palms. As a result, the lower trunk of oil palm plants is damaged, causing many oil palm plantations to suffer losses (Syahputra & Purba, 2015). Various health problems and dependence on artificial fertilizers could threaten the sustainability of oil palm plantations in Indonesia.

Synthetic fungicides used to control Ganoderma are considered inefficient and can cause environmental pollution (Widiastuti & Eris, 2016; Susanto, 2013). Maintaining or conditioning the environment so that fungal growth can be suppressed and does not damage the environment by using natural materials such as liquid fertilizers is an approach that is now starting to be used. One type of liquid fertilizer that has many benefits, including preventing the spread of Ganoderma fungi in plants, is liquid waste produced from palm oil mills (Mulia Raja et al., 2021; Yacob et al., 2005). This is because many minerals in liquid waste are produced from palm oil mills that function as plant nutrients. In other words, liquid waste can be a natural fertilizer to increase plant growth. Liquid waste can continue when Ganoderma fungi are in the soil (Ideriah et al., 2007).

Although the growth of the palm oil industry has benefited many areas, the sustainability of oil palm plantations is an important issue that must be addressed. The spread of Ganoderma is one of the main challenges in achieving sustainable oil palm plantations. In such a situation, using mill effluent can be a possible solution for Ganoderma control, with many benefits for the environment and institutions. However, there is no comprehensive approach that combines all elements to implement the utilization of mill effluent for Ganoderma control. Therefore, this study aims to develop a model that can optimize the utilization of mill effluent for Ganoderma control while considering the impact of mill effluent on the institutions and environment of sustainable oil palm plantations. In addition, by involving relevant stakeholders, this study aims to develop a model that can optimize the utilization of mill effluent for Ganoderma control.

LITERATURE REVIEW

Plantation Company Management

There is an urgent need to promote sustainable oil palm plantation management. Smallholder plantations must achieve sustainable management by 2025. After that, compliance with ISPO principles and criteria becomes mandatory. ISPO certification requires the implementation of five principles and thirty indicators. However, ISPO implementation is difficult because plantations still have a low level of readiness to receive certification. As a result, efforts to obtain ISPO certification without assistance and improvements in oil palm plantation management can exclude oil palm farmers who are not ready and face obstacles in meeting the assessment aspects.

Oil palms have high economic value because their fruit can be processed into semi-finished products such as crude coconut oil (CPO) and coconut kernel oil (PKO). However, oil palm plantations also face major environmental problems. About half of the eight million hectares of productive plantations today have been established through previous deforestation. The Indonesian government created a palm oil certification standard known as ISPO to maintain the quality, quantity, and competitiveness of products in the international market (Imansari, 2015).

Palm Oil Farming Business Income

Because more than 55% of Indonesia's population works as farmers, such as palm oil farmers (Pranoto, 2002; Setyamidjaja & Djoehana, 1991), the agricultural sector plays an important role in national economic development. According to research by Pratiwi et al. (2020), palm oil farming in Waru District generates an average income of 19 million rupiah per year per ha -1. Based on the R/C ratio value of 4.44, or greater than 1, this means that for every additional cost of IDR 1,000.00, business actors will generate income of IDR 4,440.00. In addition, the area of land of the Cattle and Oil Palm Integration System in War District explains that oil palm cultivation has the potential to improve the standard of living and income for both small farmers and large companies (Chrisendo et al., 2022).

Plantation production per hectare affects oil palm plantations' income. The performance of plants in the field, characterized by the variable fruit per plant, determines production. The parent's genes influence the quality and quantity of oil palm fruit. Only from high-quality seed sources can types with high genetic quality be obtained. The final results of the expected oil palm products will also be influenced by the very diverse variables of field management. Production decreases, especially when plants are attacked by Ganoderma agar disease.

Various mechanical and chemical techniques have been used to overcome Ganoderma disease, but they have not succeeded in significantly stopping the growth of the fungus. According to the principles of sustainable agriculture, the use of chemical drugs can have a negative impact on plants and the environment in the long term. To suppress the growth of these root diseases, a method that combines organic fertilizers can be a new approach (Mulia Raja et al., 2021; Ideriah et al., 2007).

Ganoderma Boninense

Stem rot disease in oil palm remains a problem that must be watched out for today, especially in oil palm plantations undergoing rejuvenation. Ganoderma boninense is a pathogen that causes this disease in oil palm plants (Widiastuti & Eris, 2016). Symptoms occur before the formation of the mushroom fruit body, with rot at the base of the stem causing dry rot in the inner tissue (Semangun, 2000).

Since Ganoderma boninense is a soil-borne pathogen with high saprophytic ability and a wide range of plant hosts, control with technical, mechanical, and chemical cultures has not successfully suppressed the disease's development. Leaf spot disease is another disease that attacks oil palms. It is caused by the pathogenic fungus Curvularia sp., which lives on various plants in tropical and subtropical regions. This fungus can cause the death of oil palm plants at the prenursery stage.

Oil palm farmers in several Asian countries, especially Malaysia and Indonesia, which produce 85 to 90% of the world's palm oil, are still experiencing basal stem rot (BPB) disease caused by the fungus Ganoderma boninense (Ishaq et al., 2014; Kurniawan and Pinem, 20117). To stop Ganoderma disease in oil palm, various techniques have been used, including the use of conventional fungicides, such as improving sanitation and destroying infected plants, and the use of chemicals such as carboxin and quintozene (Sahebi et al., 2015).

Palm Oil Mill Liquid Waste

One uses liquid waste from palm oil mills as a fungicide to combat pathogens that cause basal stem rot and leaf spot diseases in oil palms (Retno, 2014). One type of organic waste is liquid waste produced when fresh fruit bunches (FFB) are processed into crude palm oil (CPO) or crude palm oil (CPO) from palm oil mills (PKS). Each ton of FFB processed can produce between 0.5 and 0.7 tons of liquid waste (Yacob, S., M.A. Hassan, Y. Shirai, M. Wakisaka, 2005).

The remaining oil palm plants not included in the main products or by-products of the palm oil processing process are called palm oil liquid waste. Processing: Liquid waste from palm oil mills can be used as a source of nutrients because it contains many nutrients, such as N, P, K, Mg, and Ca. Therefore, liquid waste can be processed in fat pits, cooling ponds, bacterial breeding ponds, acidification, anaerobic decomposition ponds, aerobic sedimentation ponds, and land use (Hanim et al., 2020). Liquid waste from factories Because plants can use the nutrient content contained in it as a source of nutrients, this palm oil can be used as fertilizer.

RESEARCH METHOD

The use of oil palm waste for Ganoderma control was studied through quantitative and qualitative research methods. Data were collected through a case study method. The purpose of the case study was to improve our understanding of the issue and provide an overview of the oil palm plantation development method (Creswell, 2010). The qualitative research method was chosen because it can produce more in-depth data and prioritizes face-to-face

interviews with several informants to gain an accurate and in-depth understanding of various perspectives and situations, such as the types of institutions used to build oil palm plantations. This study involved informants from PT. Padasa Enam Utama and parties related to the problem. Oil palm samples were taken in stages based on oil palm plantation business actors on the land they control. Sample business actors and place them in the PT. Padasa Enam Utama Plantation in North Sumatra. These quantitative data were analyzed using structural equation models (SEM), especially Partial Least Square (PLSSEM), using the SmartPLS tool.

Data Analysis Method

Quantitative Data Analysis (Data Envelopment Analysis/ DEA)

Quantitative research in this study uses the DEA model to evaluate the efficiency value of liquid waste use as economic added value. The data processing program is STATA 13.

Technology Acceptance Model (TAM)

To determine the perception of oil palm plantations towards the use of liquid waste to control Ganoderma boninense fungus, the Technology Acceptance Model (TAM) was used, which is used for descriptive analysis with a Likert scale. Perceived ease of use (perceived ease of use), perceived usefulness (perceived usefulness), and user attitudes towards technology acceptance (technology acceptance) were measured using a Likert scale. In a Likert scale, four or more different questions are combined to create a score or value that describes a person's characteristics, such as knowledge, attitudes, and behavior. The composite score of each question item, usually in the form of a sum or average, can be used during the data analysis process. Since each question item indicates the variable it represents, the sum of each question item can be used.

RESULT AND DISCUSSION

Efficiency Level of PT Padasa Enam Utama Oil Palm Plantation.

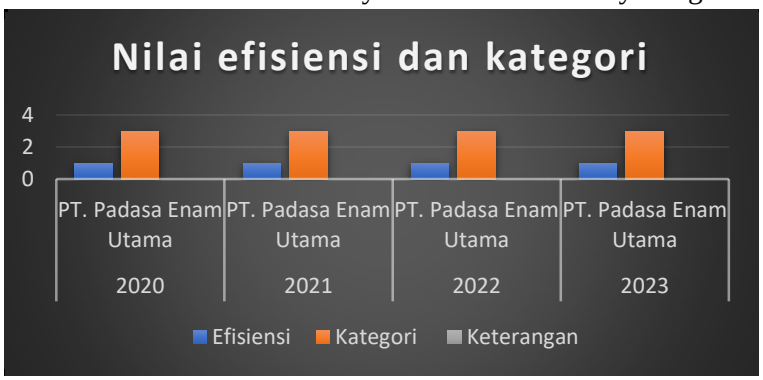
The processing results of PT Padasa Enam Utama Oil Palm Plantation from 2020–2023 were carried out using the DEA model and Stata 13 software. The results are as follows:

Table 1. Efficiency Value of PT Enam Utama Oil Palm Plantation

No	Year	Plantation Name	Efficiency	Category	Information
1	2020	PT. Padasa Enam Utama	1	3	High Efficiency
2	2021	PT. Padasa Enam Utama	1	3	High Efficiency
3	2022	PT. Padasa Enam Utama	1	3	High Efficiency
4	2023	PT. Padasa Enam Utama	1	3	High Efficiency

Source: Data Processing with STATA 13 Application

Chart 1. Overview of efficiency values and efficiency categories



Source: Data processed using STATA 13 application.

PT. Padasa Enam Utama has shown an efficiency value of 1 for four consecutive years (2020–2023). This value indicates that the company operates at the highest level of technical efficiency (Sembiring & Novita, 2018). In other words, this business can optimize the use of its resources to achieve optimal output without producing waste or inefficiency in the production process (Lutsenko et al., 2022). Consistency in achieving this technical efficiency indicates that the company has implemented best practices in operational management and technology utilization, which align with modern and sustainable management principles. This efficiency indicates good internal performance and the company's commitment to sustainable agribusiness practices.

In addition, the efficiency of PT. Padasa Enam Utama can be attributed to the company's compliance with the Indonesian Sustainable Palm Oil (ISPO) standard. ISPO is a certification the Indonesian government gives to ensure that palm oil production in Indonesia is carried out sustainably from an environmental, social, and economic perspective. PT. Padasa Enam Utama, which has a high-efficiency value, shows compliance with the ISPO standard for coconut production. This expertise enhances the company's reputation as a leader.

In addition, the "High Efficiency" category found in the data supports the idea that PT. Padasa Enam Utama may be more technically efficient than allocative efficiency, where resources are allocated appropriately according to market input and output prices (Lestari et al., 2023). This indicates that the business can maintain performance and stability in the long term, which is strong evidence of good management and the ability to adapt to market changes. According to Mario de Carvalho Filho (2018), the ISPO standard requires companies to ensure that resource allocation is carried out to minimize negative impacts on the environment and society. Ultimately, this will increase allocation efficiency. Therefore, PT. Padasa Enam Utama can balance social responsibility and economic efficiency, which is very important.

This efficiency achievement is supported by the management of Palm Oil Mill (PKS) waste at PT. Padasa Enam Utama. Sustainable waste management is one of ISPO's primary needs. PT. Padasa Enam Utama can convert PKS waste into organic fertilizer, which reduces environmental impact and makes inputs more efficient. This waste processing is an important component of the company's strategy to reduce waste and maximize the added value of by-products. The company increases technical efficiency by utilizing waste as a productive resource. They are also firmly committed to the circular economy (Tang et al., 2023).

In addition, using PKS waste to make organic fertilizer has also proven effective in preventing Ganoderma disease, one of the main diseases in oil palm plants. This disease is caused by pathogenic fungi that can cause significant losses in oil palm production. Therefore, using organic fertilizers derived from PKS waste improves soil health and plant resistance to Ganoderma attacks. As a result, the soil and plants become healthier. Therefore, the waste management strategy of PT is to help Padasa Enam Utama improve operational efficiency and keep oil palm production alive through disease control.

The use of organic fertilizers obtained from PKS waste has significant ecological benefits. In addition to plant health, organic fertilizers improve soil structure, water retention capacity, and soil biodiversity (Manurung et al., 2023). Plantations increase productivity in the long term and support the sustainability of the surrounding ecosystem. In the context of ISPO, these environmental benefits align to balance effective palm oil production with environmental protection. Consequently, this inventive waste management method confirms PT. Padasa Enam Utama's commitment as a company dedicated to responsible and sustainable agribusiness practices.

Proper management and technology implementation and compliance with sustainability standards such as ISPO can help agribusiness companies achieve optimal efficiency levels. Empirical findings show this (Maity et al., 2023; Liudmyla Berezina & Bahan, 2023). This is very important when facing increasingly complex economic and environmental challenges. The efficiency achieved shows the company's internal performance and helps broader sustainability goals, such as controlling diseases such as Ganoderma, which can affect plantation productivity. Therefore, businesses have proven that sustainable agribusiness practices correlate with higher operational efficiency.

Overall, PT. Padasa Enam Utama has demonstrated how operational efficiency, compliance with ISPO standards, and innovation in PKS waste management can work together to achieve sustainable agribusiness goals (Rahmawati & Novani, 2024). Responsible agribusiness practices can generate economic, social, and ecological benefits, evidenced by the consistent high efficiency and effective control of Ganoderma disease (Sengupta et al., 2024).

Perception of Acceptance of Palm Oil Mill Waste with Technology Acceptance Model (TAM)

This study aimed to evaluate respondents' responses to the technology of processing palm oil mill waste into organic fertilizer. The Technology Acceptance Model (TAM) and the Structural Equation Modeling-Partial Least Squares (SEM-PLS) testing method were used to do this. The TAM model was chosen because of its ability to explain factors that influence the acceptance and use of new technologies (Handayani & Prahartiwi, 2019), primarily related to the use of new technologies. In the initial stage, a questionnaire was used to collect data to measure respondents' perceptions of usefulness and ease of use. Furthermore, the collected data were processed using SEM-PLS to test the reliability and validity of the constructs. In addition, the measurement and structural models were also evaluated.

Pilot Test

A trial or pilot test was conducted as an initial stage of the research before being used in the main research. The questionnaire was tested on a small group of respondents to assess its accuracy and effectiveness. In this process, 70 samples of respondents were tested. In addition, the Average Variance Extracted (AVE) and Composite Reliability values were used to test the validity and reliability of the questionnaire. SmartPLS 3 software was used to conduct this analysis. The table below shows the results of the pilot test.

Table 2. Results of the Pilot Test Questionnaire

Variables	Average Variance Extracted (AVE)	Composite Reliability	Information
Intensity	0.697	0.920	Valid and Reliable
Ease of Use	0.720	0.927	Valid and Reliable
Experience	0.676	0.912	Valid and Reliable
Real Users	0.691	0.918	Valid and Reliable
Perception of Usefulness	0.673	0.925	Valid and Reliable

Source: Data Processing Results, using the SmartPLS.3 application. 2024

Measurement Model Test Results (Outer Model) for PT Padasa Enam Utama

Validity testing is carried out to ensure that the research tool used really has the ability to measure the intended variables accurately. In the Partial Least Squares (PLS) approach with reflective indicators, convergent validity is measured through the loading factor; the loading factor value that is considered adequate is usually 0.7 or more. An AVE value greater than 0.5 is considered valid (Muhson, 2022).

Figure 1 shows the results of the outer model test, which is used to evaluate the validity of each research variable. Two main stages are used to test this outer model: validity test and reliability test. Convergent Validity and Discriminant Validity are tested in the validity test, and composite reliability is tested.

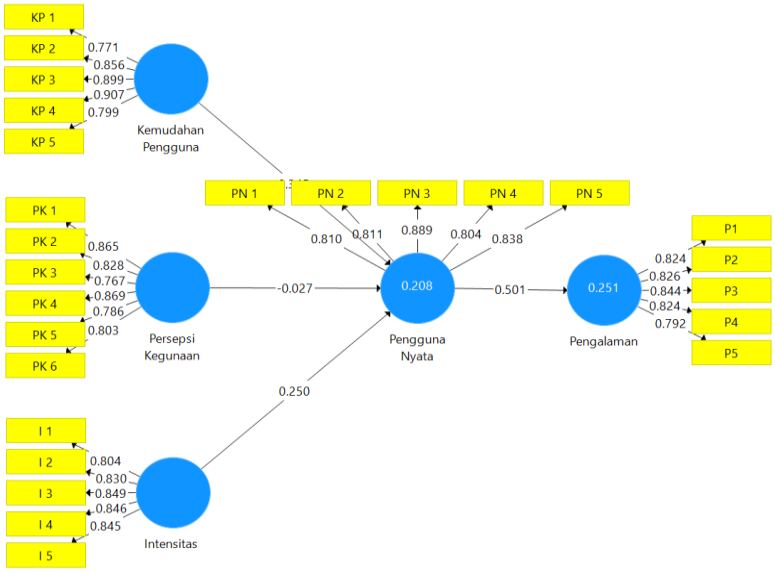


Figure 1. Results of the Outer Model Research Test on SmartPLS 3. (2024)

Convergent Validity Test Results

The value of the additional factor is used to evaluate convergent validity. For this, each indicator must meet the threshold>0.7, and the Average Variation Extracted (AVE) value for each variable must exceed 0.5 (Sholihin & Ratmono, 2020; Lance et al., 2006). The SmartPLS application uses two iteration stages. The formation of the measurement model is the first stage, and then the PLS algorithm is used for calculation. The results of the convergent validity assessment are shown in Table 4.

Table 3. Convergent validity assessment

Variables	Indicator	Loading Factor	Information	Average Variance Extracted (AVE)
Intensity	I 1	0.804	Valid	0.697
Intensity	I 2	0.830	Valid	
Intensity	I 3	0.849	Valid	
Intensity	I 4	0.846	Valid	
Intensity	I 5	0.845	Valid	
Ease of Use	KP 1	0.771	Valid	0.72
Ease of Use	KP 2	0.856	Valid	
Ease of Use	KP 3	0.899	Valid	
Ease of Use	KP 4	0.907	Valid	
Ease of Use	KP 5	0.799	Valid	
Experience	P1	0.824	Valid	0.676
Experience	P2	0.826	Valid	
Experience	P3	0.844	Valid	
Experience	P4	0.824	Valid	
Experience	P5	0.792	Valid	
Real Users	PK 1	0.865	Valid	0.691
Real Users	PK 2	0.828	Valid	
Real Users	PK 3	0.767	Valid	
Real Users	PK 4	0.869	Valid	
Real Users	PK 5	0.786	Valid	
Real Users	PK 6	0.803	Valid	
Perception of Usefulness	PN 1	0.810	Valid	0.673
Perception of Usefulness	PN 2	0.811	Valid	
Perception of Usefulness	PN 3	0.889	Valid	
Perception of Usefulness	PN 4	0.804	Valid	
Perception of Usefulness	PN 5	0.838	Valid	

Source: Data Processing Results, using the SmartPLS.3 application. 2024

All indicators meet the criteria of convergent validity, according to the results of data processing. All variables in this study are considered valid if the value of the external load on each variable is more than 0.7.

Test Results

Hypothesis testing is the final step in analyzing the influence between variables in a structural model; this is done to determine whether the relationship between the variables is significant. The bootstrapping process is used in this test to produce significance values such

as t-statistics, p-values, and relationships between constructs. The level of significance used in this study is 5%. This indicates that the hypothesis will be accepted if the t-statistic is greater than the t-table, which is 1.96. Consequently, the purpose of this examination is to determine whether there is a significant influence between the variables studied.

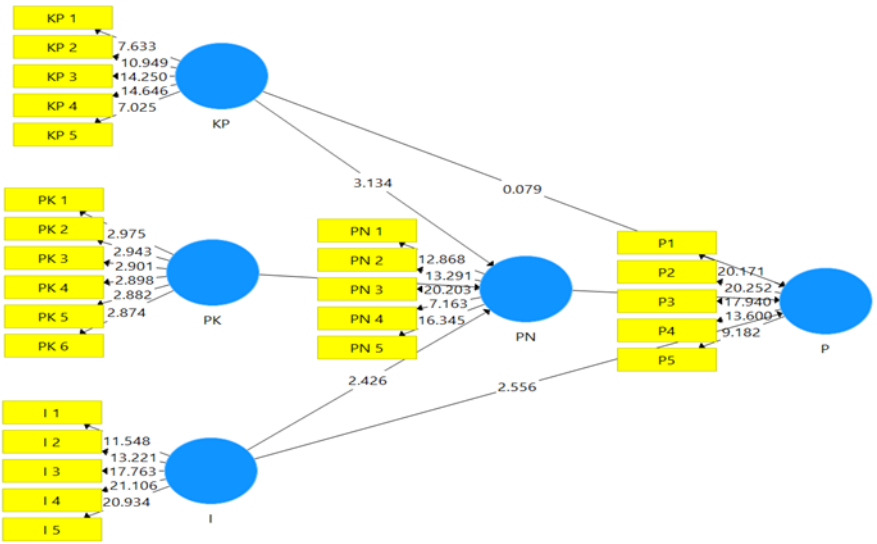


Figure 2. Test Results with bootstrapping using the SmartPLS 3 application

Figure 4 shows the results of bootstrapping output with the SmartPLS 3 application. Based on the results of the bootstrapping test, five hypotheses can be accepted, while one hypothesis is rejected. Table 4 below provides further explanation.

Table 4. Path Coefficient Results

Hypothesis	T-Statistics	P Values	Information
Intensity (BIU) -> Real Users (AU)	2.395	0.017	Accepted
User Ease (PEU) -> Real Users (AU)	3.213	0.001	Accepted
Real Users (AU) -> Experience (PU)	5.691	0.000	Accepted
Perceived Usability (ATU) -> Actual Users (AU)	0.181	0.857	Rejected

Source: SmartPLS 3 data processing (2024)

The results of the bootstrapping test on the relationship between variables show that there are three accepted hypotheses and one rejected hypothesis. First, there is a T statistic value of 2,395 with a P value of 0.017, which is smaller than the significance level of 0.05 in the relationship between User Intensity and Real Users. This shows that the intensity of use significantly affects the level of actual use. As a result, more frequently involved users are more likely to become real users (Anggraeny, 2020).

Second, there is a significant relationship between Ease of Use and Real Users, with a statistical T value of 3.213 and a statistical P value of 0.001. This indicates that the ease of use of an application or system positively impacts user loyalty, with the highest statistical T value of 5.691 and a statistical P value of 0.000, indicating a strong influence of actual users on the experience. This hypothesis is finally rejected. These results indicate that the perceived usefulness of a system or application does not affect the user's decision to use it.

User Intention Perception towards Actual Users.

There is a significant relationship between the intensity of user intention to use (Behavioral Intention to Use/BIU) and the application of palm oil mill waste management technology into organic fertilizer (Actual Use/AU). The statistical analysis results show a p-value of 0.017 and a T statistic of 2.395. The intention to use technology significantly affects adoption in the field, with a p-value below 0.05. This means that the stronger the user's intention to utilize technology, the more likely the technology is to be adopted and applied in everyday practice (Bagheri et al., 2024).

The management of PT Padasa Enam Utama sees the adoption of waste management technology as a strategic opportunity to improve operational efficiency and reduce negative environmental impacts (Ksenofontov et al., 2019). In general, management views waste management technology positively because they believe it can provide sustainable economic benefits (Elizabeth Shirley et al., 2024). The notion that businesses involved in technology adoption will be more successful in their implementation is supported by the significant relationship found between user intentions and technology adoption (Sozoniuk, 2022).

In addition, PT Padasa management emphasized the importance of using sustainable waste management technology (Mashudi et al., 2023). They argue that the high managerial and operational intention to adopt this technology will increase the company's chances of utilizing it. Management also believes that using this technology can reduce dependence on chemical fertilizers. This will ultimately increase production efficiency and reduce fertilizer input costs (Sarsenova & Alpysbaeva, 2020; Mashudi et al., 2023).

Palm oil mill waste management techniques, especially those that produce organic fertilizer, are considered by management as a strategic solution to improve the internal supply chain (Abisha & Vanany, 2022). The company can become more independent by using waste as organic fertilizer to meet its fertilizer needs without relying on external suppliers. This management perception strongly correlates with technology acceptance, improved soil quality, and plantation productivity. This perception greatly helps the sustainability of business operations (Romelah et al., 2017).

PT Padasa's management pays close attention to environmental benefits when using this technology. They believe that as part of the company's social responsibility to preserve the environment, it must manage waste properly. This management perception aligns with statistical results that show a positive correlation between the intention to use technology and its application in the field. By reducing the amount of waste produced and using existing waste to produce organic fertilizers, the company can not only reduce the negative impact on the environment. However, it can meet increasingly stringent environmental regulations (Camilleri, 2020).

Finally, PT Padasa believes that using palm oil mill waste management technology can improve the company in the eyes of consumers and other stakeholders. Environmentally friendly technology can improve the company's image as an environmentally and socially responsible organization. This is very important in an industry increasingly aware of sustainability issues (Khairani, 2024). Therefore, adopting this technology has environmental and operational benefits and is an important part of the company's strategy to thrive in a competitive business world.

Perceived Ease of Use (PEU) to Actual Users (AU)

The statistical analysis results show a significant relationship between palm oil mill waste management technology in organic fertilizer and Perceived Ease of Use (PEU), with a T-statistic value of 3.213 and a p-value of 0.001. Perceived ease of use of technology

significantly influences the adoption and implementation of technology in operational practices, with a p-value far below the threshold of 0.05. This means the possibility of technology being used in palm oil mill waste management is more significant if it is easier for users.

PT Padasa Enam Utama management's perception of how easy it is to use waste management technology in this context is critical to its successful implementation. According to management, Technology designed to be simple and easy for workers to use will accelerate the technology acceptance process (Wijaya et al., 2023). They believe this ease will encourage early adoption and sustain it long-term. Technology that is easy to understand tends to be easier to use, but complex technology hinders training and operations. In addition, PT Padasa management said that the ease of use of technology directly impacts greater operational efficiency (Rahayu et al., 2022). Easy-to-use technology saves time and costs because it does not require intensive training (Chen & Bennett, 2010). This convenience allows employees to concentrate more productively on processing factory waste into organic fertilizer without experiencing complicated technical difficulties. This is in line with management's goal of optimizing the use of plantation human resources.

Management's perception of how easy a technology is to use also influences the sustainability of future technology adoption. Management recognizes that complex and challenging technology adoption will reduce employee interest and hinder widespread adoption. Easy-to-use technology can make waste management in organic fertilizer more sustainable. This allows plantation operations to run more efficiently in the long term without significant technical barriers (A. Abdullah et al., 2015).

From an environmental perspective, PT Padasa management believes that easy-to-use technology will be more effective in supporting the goal of environmentally friendly waste management. This technology allows workers to process waste regularly and accurately so that the amount of waste disposed of can be minimized and environmental benefits can be maximized. As a result, the ease of technology affects the fulfillment of the company's environmental responsibilities and increased efficiency.

Overall, PT Padasa management sees the ease of use of waste management technology as a strategic factor to ensure smooth operations and sustainability of the company. Easy-to-adopt technology can help companies improve in the eyes of consumers and other stakeholders in addition to considering operational and environmental aspects (Stefani & Cilvanus, 2020). Management believes that easy-to-use technology can help the company maintain its position as an innovative and environmentally responsible industry player while competing in the growing palm oil industry.

Actual User Perception (AU) -> User Experience (PU)

The results of the statistical analysis show a very significant relationship between actual users (Actual Use/AU) and user experience (Perceived Usefulness/PU) in the technology of managing palm oil mill waste into organic fertilizer, with a T-statistic of 5.69 and a p-value of 0.000. The benefits perceived by users of the technology significantly affect the level of adoption in actual practice. In other words, the greater the benefits users perceive, the greater their tendency to actively implement the technology in operations (Shrestha & Vassileva, 2019). This is indicated by the p-value, which is far below the threshold of 0.05.

In this case, the management of PT Padasa Enam Utama said that the perception of the benefits or usefulness of technology greatly influences the decision to adopt it (Siu Shing Man, 2022). They believe that waste management technology will be accepted and used more widely if it can provide real benefits, such as increasing the efficiency of organic

fertilizer production and waste management (Amrawaty et al., 2015). Positive experiences with the use of technology are essential to encourage wider adoption in the field.

In addition, the PT Padasa Enam Utama management considered the positive experience resulting from implementing this technology to be very important for their decision to expand its implementation across the Plantation (Bellemare et al., 2022). The clear benefits of the technology, such as reduced costs and increased agricultural yields, encouraged management to have more confidence in it (Lynn et al., 2023). This encouraged the business to invest and integrate waste management technology more deeply into their operations. Waste management technology reduces diseases, including Ganoderma (Utami & Siregar, 2022). By improving soil structure and microbiological balance, organic fertilizer from palm oil mill waste can improve soil health and reduce the risk of Ganoderma infection (Kurniawan et al., 2022; Jannah & Kurniawan, 2017).

In addition, management perception shows how important the role of technology is in the company's strategy to achieve long-term sustainability (Syam, 2024). Waste management technology offers many tangible benefits, such as reducing our dependence on chemical fertilizers and utilizing waste efficiently. This technology also supports the company's commitment to sustainable agricultural practices. Management believes that technology that shows real added value improves operational efficiency and enhances the company's environmental responsibility.

Positive experiences in waste management can also enhance a company's reputation in the market. Companies with proven technologies can strengthen their image as innovative and socially responsible industry players. Favorable user experiences can be a valuable promotional tool to attract customers and stakeholders increasingly concerned about sustainability. Overall, these statistical results indicate that the perceived benefits of waste management technology significantly influence its uptake and utilization. According to the perception of PT Padasa management, implementation, and sustainability are helped by positive experiences with technology. Palm oil companies can improve operational efficiency, support sustainability, and improve their reputation in the industry by providing helpful technology (Anyaoha & Zhang, 2023).

Perceived Usefulness (ATU) -> Actual Use (AU)

The results of the statistical analysis show that, in evaluating the relationship between Perceived Usefulness (Attitude Toward Using/ATU) and Actual Use (AU) of palm oil mill waste management technology, there is a T-statistic value of 0.181 with a p-value of 0.857. The p-value far above the significance limit of 0.05 indicates that no significant relationship exists between the perception of the usefulness of technology and the level of application of the technology in practice.

Statistical results show that while managers may have favorable views about the benefits of waste management technologies, these views do not always correspond to how the technology is used in real life. These results suggest that in addition to perceived usefulness alone, other variables, such as cost, technical support, and operational constraints, may be more influential in determining the level of technology adoption (Tiwari et al., 2020; Qureshi et al., 1992).

Positive attitudes toward technology are important, but PT Padasa Enam Utama management is not always significant in using technology. They recognize that while there is a perception that technology has many benefits, effective adoption in the field does not always match this perception. Therefore, when deciding to adopt technology, they must consider the cost of implementation, technical support, and availability of resources. The

company recognizes that perceptions about the usefulness of a technology can influence attitudes toward it. However, things like technological complexity and economic benefits must also be considered. Even though technology is viewed positively, management may find that practical issues such as cost or technical complexity hinder wider adoption.

In addition, PT Padasa management emphasized the importance of addressing the practical barriers encountered when implementing the technology. To increase technology adoption, adequate training, technical support, and financial incentives must be considered. To generate effective technology adoption in the field, positive perceptions of the usefulness of the technology must be balanced with appropriate support. These statistical results indicate that a more comprehensive understanding of the technology is needed. While perceptions of usefulness are critical, effective technology implementation requires many practical factors and adequate support. PT Padasa Enam Utama must develop strategies to improve perceptions of usefulness, address operational challenges, and provide the necessary assistance to implement waste management technology successfully.

CONCLUSION

Based on the results of data processing and wetting, several conclusions can be made:

1. Palm oil mill waste (PKS) is utilized at PT as an organic fertilizer. Padasa Enam Utama has proven effective in reducing the spread of Ganoderma disease while replacing chemical fertilizers.
2. The policy of implementing factory waste management technology into organic fertilizer at PT. Padasa Enam Utama focuses on making it easier to use and intensive.
3. Processing palm oil mill waste into organic fertilizer depends on cooperation between supportive policies, strong institutional encouragement (especially from management policies), and budget allocation. These three factors are the main drivers of the process's success.

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