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The Application of Green Accounting in Industrial Wastewater Management

Muh Fuad Randy [1*] Fitri Indah Sari M [2] Husain [3] Hasan [4]

[1*, 2,3,4] STIE YPUP Makassar, Makassar, Indonesia.

Email: fuadrandy@stieypup.ac.id, fitriindahsari1990@gmail.com, star.one2789@gmail.com, hasan.jasdik89@gmail.com

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The author(s) declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

ABSTRACT

Purpose: This study aims to examine the application of green accounting in waste management at PT. ABCDE, focusing on five stages of environmental cost allocation: identification, recognition, measurement, presentation, and disclosure.

Research Method: This research used a descriptive qualitative approach. Data were collected through interviews, observation, and documentation at PT. ABCDE is a company that manages liquid waste from production processes. Data were analyzed using the Miles and Huberman model, consisting of data reduction, data presentation, and conclusion drawing.

Results and Discussion: The findings show that PT. ABCDE has applied green accounting in the stages of recognition, measurement, and disclosure. Environmental costs are recognized on an accrual basis, measured using historical cost, and disclosed in the notes to the financial statements. However, the identification and presentation stages are not fully aligned with applicable accounting standards because environmental costs are still combined with general administrative expenses. This indicates that the company's environmental cost reporting requires further improvement.

Implications: The study suggests that PT. ABCDE should separate environmental costs from general expenses and present them more transparently in financial reports.

Originality: This study provides specific insight into the implementation of green accounting based on five environmental cost allocation stages in liquid waste management.

Keywords: green accounting; industrial wastewater management; management accounting.

1. Introduction

Environmental degradation has become a global concern in recent decades because it directly threatens human life. Environmental degradation can be caused by two main factors: natural causes and human activities. However, the impact of human activity tends to be greater than that of natural factors, as it can cause ongoing damage. One of the primary causes of human-induced environmental degradation is industrial activity, which often neglects environmental considerations in its operational processes. According to data from the Environmental Protection Agency (EPA), over 70% of global water and air pollution is caused by poorly managed industrial activities, such as the discharge of liquid waste, emissions of hazardous gases, and soil contamination (EPA, 2022). In Indonesia, similar issues also exist, particularly in the coastal aquaculture industry. The operational activities of companies that generate

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large amounts of waste can adversely affect the environment, especially when such waste is discharged directly into water bodies without adequate treatment. According to a 2023 report from the Ministry of Environment and Forestry (KLHK), approximately 60% of industrial companies in coastal areas have not implemented waste management systems that meet established environmental standards. This phenomenon indicates that many companies continue to operate without considering environmental aspects, thereby causing adverse effects on the surrounding environment. To mitigate these negative impacts, the concept of clean production is used to implement green accounting within a company.

Research on the application of green accounting has attracted significant attention in recent years. Several previous studies have explored various aspects of green accounting implementation for managing the environmental impacts of corporate activities. Khanum (2020) examined the application of green accounting in the manufacturing industry, focusing on how companies can manage waste efficiently through these principles. This study found that effective waste management through a green accounting approach can reduce operational costs and the resulting environmental impacts. Furthermore, Nilasari (2014) examined the application of green accounting in food and beverage companies, with a primary focus on solid waste management. Findings from this study indicate that companies implementing green accounting can manage waste more efficiently and enhance their corporate image in the public eye. On the other hand, Pertiwi (2017) examined the application of green accounting in chemical industry companies, specifically the management of liquid waste generated by production processes. This study demonstrated that green accounting can assist companies in identifying, measuring, and reporting environmental costs resulting from production processes. Although various studies have examined the application of green accounting across various industrial sectors, research specifically examining its application in the aquaculture industry remains very limited.
Section Three

Although various studies have examined the application of green accounting in the manufacturing, food and beverage, and chemical industries, studies on its application in the aquaculture industry remain very limited. Previous research by Khanum (2020), Nilasari (2014), and Pertiwi (2017) indicates that the application of green accounting in managing solid and liquid waste can help companies reduce negative environmental impacts and optimize waste management costs. However, these studies have focused more on land-based industrial sectors and have paid less attention to industries operating in coastal areas or whose waste is directly connected to aquatic environments. This creates a research gap that needs to be addressed, given that the characteristics of waste generated by the aquaculture industry differ significantly from those of other industries. Liquid waste from the aquaculture industry can directly impact marine ecosystems if not properly managed, making the effective implementation of green accounting in this industry critically important. Furthermore, previous research has tended to overlook clean production as part of green accounting implementation in the aquaculture industry.

This study aims to address the previously identified research gap by examining the application of green accounting in the aquaculture industry. This field remains under-researched in the context of environmental accounting implementation. The primary focus of this study is to analyze the application of green accounting at PT. ABCDE, with a particular emphasis on the management of wastewater generated from clean production activities. This study covers the processes of identifying, recognizing, measuring, presenting, and disclosing the environmental costs associated with the company's clean production activities. The novelty of this research lies in the application of green accounting in the aquaculture industry, which is characterized by liquid waste and is often directly connected to the

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marine environment—unlike other industrial sectors that generally focus on solid waste or land-based liquid waste. Through this research, it is hoped that a deeper understanding can be gained of how implementing green accounting practices can assist companies in managing waste effectively and delivering more optimal economic and environmental benefits. Thus, this research aims to contribute to the development of the concept of green accounting in the aquaculture industry, a topic that has not been extensively discussed in previous studies.

The remainder of this paper is organized as follows. Section 2 provides a literature review and hypothesis development. Section 3 presents the research method and design. Section 4 provides a discussion. Section 5 is Concluding Remarks and Recommendations.

2. Literature Review and Hypothesis Development

2.1 Management Accounting

Hansen et al. (2021) state that management accounting encompasses a variety of systematic processes designed to identify, measure, recognize, present, and disclose costs related to a company's operational activities. This approach emphasizes that every cost element arising from operational activities must be processed using appropriate methods to generate relevant and reliable information for decision-making. One of the key concepts developed by Hansen and Mowen is the importance of integrating all costs, including environmental costs, into a structured accounting system. This aims to enhance transparency and accuracy in the preparation of financial reports on environmental impact management. The application of the principles proposed by Hansen and Mowen is believed to assist companies in addressing increasingly complex modern accounting challenges, including the implementation of Green Accounting, which prioritizes a more comprehensive management of environmental costs (Schaltegger et al., 2013).

In implementing Green Accounting, the theory developed by Hansen and Mowen provides a conceptual foundation for a more structured process for managing environmental costs. The application of the accrual basis method recommended by Hansen and Mowen can improve the accuracy of environmental cost recording. The use of the accrual method provides a more comprehensive picture of the various costs associated with waste management activities (Guthrie, 1998). This aligns with the concept proposed by Hansen and Mowen, which emphasizes the importance of using appropriate methods, such as historical cost, for measuring environmental costs (Zhou et al., 2021). This approach also supports the use of measurable and accountable monetary units in accordance with applicable accounting principles (Dierkes & Siepelmeyer, 2025). Thus, the theory proposed by Hansen and Mowen is relevant to Green Accounting, which requires companies to manage environmental costs accurately and transparently.

The theory developed by Hansen and Mowen also emphasizes the importance of presenting and disclosing environmental costs clearly and transparently in financial statements. According to Wang et al. (2016), a well-structured presentation of environmental costs can enhance stakeholders' trust in the company. This is supported by findings from Santana & Lopez-Cabrales (2019), which show that adequate disclosure of environmental costs can positively affect a company's image and add value to the organization. Proper disclosure of environmental costs can provide accurate information regarding a company's efforts to manage its environmental impacts (Kraft et al., 2011). This concept aligns with the theory of Hansen and Mowen, who consider proper presentation and disclosure to be integral parts

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of an effective environmental cost management process (Schaltegger et al., 2013). By applying this theory, companies can more easily integrate various costs associated with environmental management activities into a more accurate and accountable reporting process.

2.2 Green Accounting

Environmental Accounting, or Green Accounting, is an accounting concept that has evolved alongside companies' growing awareness of sustainability and social responsibility issues. This approach aims to integrate environmental aspects into a company's accounting system by identifying, measuring, recognizing, presenting, and disclosing costs associated with environmental management activities. According to Gunarathne & Lee (2015), Environmental Accounting provides a framework that enables companies to evaluate the environmental impact of their operations and present accurate information to stakeholders. Additionally, Latif et al. (2020) suggest that external pressures, including government regulations, industry standards, and social expectations, can drive the adoption of environmental accounting. Thus, the application of Green Accounting is not limited to waste management but also encompasses pollution prevention, environmental rehabilitation, and efficient resource use.

The basic principles of Environmental Accounting include five main elements: identification, recognition, measurement, presentation, and disclosure of environmental costs (Lamberton, 2005). Identification is the initial stage aimed at recognizing all activities that impact the environment and the associated costs. The recognition of environmental costs by companies generally follows the accrual basis, which allows costs to be recorded when a payment obligation is recognized, even if the funds have not yet been disbursed (Soto-Acosta, 2024). In a study by Qian et al. (2011), it was found that applying the accrual method in Environmental Accounting can provide more comprehensive information on a company's expenditures related to environmental activities. The measurement of environmental costs is also a critical consideration. Based on a review conducted by Swalih et al. (2024), the commonly used measurement methods are historical cost and current cost. Although historical cost is considered easier to implement, this approach often overlooks changes in economic value relevant to sustainability. On the other hand, the current cost method is considered more accurate in reflecting actual economic value, although its implementation is more complex and requires greater resources (Freeman III et al., 2014). Thus, selecting the appropriate measurement method is critical to ensuring the accuracy of companies' environmental cost reports.

The recognition and disclosure of environmental costs in financial statements are key elements of Green Accounting. Adequate disclosure can enhance a company's transparency in presenting information related to environmental management activities (Syrotenko et al., 2021). Disclosures in financial statements enable stakeholders to assess the extent to which a company is committed to managing its environmental impacts. Clear presentation of environmental costs can add value to a company by enhancing its reputation and stakeholder trust (Baah et al., 2022). Furthermore, Latan et al. (2018) highlight that disclosing environmental costs can also positively impact a company's long-term financial performance. This is supported by findings from Nässén et al. (2024), which reveal that companies that transparently disclose environmental costs are better equipped to withstand external pressures and improve their public image.

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2.3 Waste management

Waste management is a process that encompasses various activities, ranging from collection and transportation to treatment and safe disposal. This process also involves monitoring and regulating these activities to ensure that the waste generated does not adversely affect the environment or human health. Effective waste management must be based on fundamental principles widely accepted across industries, particularly in liquid waste management (Rajaram et al., 2016). Liquid waste generated from various industrial activities must be properly managed to prevent environmental contamination. In the aquaculture industry, for example, the liquid waste produced has different characteristics compared to that from the manufacturing sector (Mukwarami & van der Poll, 2024). Therefore, companies must identify the types of waste generated to ensure treatment processes are carried out accurately and efficiently. Inadequate waste management can lead to greater environmental harm and damage a company's reputation among stakeholders (Latan et al., 2018).

Furthermore, the key principles of waste management include waste minimization, recycling, and safe waste disposal. A clean production-based approach is becoming increasingly important in modern waste management concepts (Kasemsap, 2017). Applying these principles can help companies reduce negative environmental impacts while improving operational efficiency. This is supported by evidence that applying clean production-based waste management principles can reduce long-term production costs and enhance a company's positive image (Azam & Jamil, 2024). The selected waste treatment methods must be tailored to the characteristics of the generated waste to achieve optimal results (Gisi et al., 2016). For example, in the aquaculture industry, filtration, sedimentation, aeration, and water control are commonly used to manage liquid waste. The use of appropriate methods can yield optimal results and help companies meet established waste management standards (N. Gunarathne & Lee, 2015). Thus, it is important for companies to continually adopt waste management techniques that align with the characteristics of the waste generated and applicable standards.

Effective waste management is not limited to the application of appropriate treatment techniques; it also involves recognizing, measuring, and disclosing the costs associated with these activities. Latan et al. (2018) emphasize that accurate recording and reporting of waste management costs are crucial for providing a clear picture of the costs companies incur in managing environmental impacts. In the context of environmental accounting, waste management costs need to be identified, measured, and reported transparently in the company's financial statements. The approach proposed by Gunarathne et al. (2021) suggests that the measurement methods used must be consistent with the sustainability goals the company aims to achieve. Appropriate cost recognition can provide a more accurate picture of the costs the company incurs in managing its waste. Companies that transparently disclose environmental costs can enhance stakeholder trust in their commitment to managing environmental impacts (Qian et al., 2011). Adequate cost disclosure can also positively impact the company's reputation and support long-term sustainability (Zatini et al., 2025).

3. Research Method

This study employs a qualitative descriptive approach to collect data for description, substantiation, and development, and to uncover deeper knowledge or theories regarding the application of green accounting in wastewater management at PT. ABCDE. A qualitative descriptive research design was chosen because it allows the researcher to systematically describe the facts, properties, and

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characteristics of the research object under study through careful, comprehensive data analysis (Sugiyono, 2013). The subject of this study is PT. ABCDE, located at Jl. Poros Makassar – Parepare KM. 138, Jalange Village, Mallawa Subdistrict, Mallusetasi District, Barru Regency. This study focuses on the application of green accounting by analyzing the aspects of identification, recognition, measurement, presentation, and disclosure of environmental costs implemented by the company. This study was conducted over a period of one month and involved relevant parties within the company. Data collection techniques in this study included interviews, observations, and documentation. Interviews were conducted with the parties involved in implementing green accounting at PT. ABCDE. Observations were conducted by directly observing the company's operational activities related to wastewater management. Documentation was used to collect relevant evidence to support this study. Data analysis was performed using the Miles and Huberman (2014) interactive model, which comprises the stages of data collection, data reduction, data presentation, and conclusion drawing. This technique aims to ensure the data aligns with the applied theory and to produce a systematic overview of the implementation of green accounting at the research site. All data obtained were carefully analyzed to provide accurate and comprehensive conclusions aligned with the research objectives.

4. Results and Discussion

4.1 Analysis Results

Based on the results of a study conducted by the researcher through interviews with two participants who played key roles in this research, it was found that the waste generated during the production process at the company consists of only one type: liquid waste obtained from the breeding ponds used in the production process, whether from shrimp farms or milkfish farms. For industrial aquaculture companies, waste generated must not be discharged directly into the marine environment. Thus, the waste management process at PT. ABCDE consists of four stages: filtration, sedimentation, aeration, and water quality control.

The waste generated by PT. ABCDE is in liquid form. Managing this waste naturally incurs certain costs. To further optimize waste management, PT. ABCDE collaborates with a third party for waste management. This aligns with an interview with Mr. Rahman, Head of the Environmental Division, as follows:

> *"To optimize waste management, the company engages an external party—specifically the Industrial Services Standardization and Policy Agency—to conduct routine testing of wastewater and seawater"* **(Environmental Division Participant)**

To provide a more complete explanation of waste management costs, the company has itemized each expense incurred, particularly for 2022 and 2023, as detailed in **Appendix** Tables A1 and A2.

The Application of Environmental Accounting in Waste Management at PT. ABCDE

- *Identification*
  Interviews with the environmental division found that PT recognizes the environmental costs associated with waste management. ABCDE includes labor costs, seawater testing costs, wastewater testing costs, domestic waste transportation costs, and hazardous waste transportation costs.
- *Confession*

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About recognition, it is known that PT. ABCDE recognizes expenses using the accrual method. These costs are recognized as expenses when incurred for environmental maintenance activities; in other words, the transaction is recognized regardless of whether cash changes hands. PT. ABCDE recognizes expenses on an accrual basis.

- *Measurement*
  It is known that PT. ABCDE has properly implemented the measurement steps in calculating environmental accounting costs related to waste management, using historical cost as the measurement basis and the Indonesian Rupiah as the currency unit, as stated by the finance or accounting staff. PT. Esapulii Prakarsa Utama measures the value and amount of waste management costs incurred in monetary units, specifically, the costs to be paid relative to the realized budget from the previous period.
- *Presentation*
  It is known that the company has implemented measures regarding the presentation of financial statements, whereby the details of costs incurred from waste management at PT Esaputlii Prakarsa Utama are presented as part of the financial statements—specifically, they are included in the company's income statement under "other general administrative expenses" with account number 6916 000. PT Esaputlii Prakara Utama has not yet reported environmental costs separately, as explained by an employee from the accounting department during an interview.

  > *"The company has not yet prepared a separate report or a specific report on environmental costs. Environmental costs incurred by the company—particularly those related to waste management—are included in the income statement under 'other general administrative expenses,' and electricity costs associated with waste management are still combined with the company's total electricity expenses."*
  > **(accounting division participant).**
- *Disclosure*
  In terms of disclosure, PT. ABCDE not only reports and discloses the company's performance but also discloses the environmental costs incurred in the notes to the company's financial statements. PT. ABCDE discloses environmental costs, including a breakdown of the costs and their total amounts, in the Environmental Management Plan.

4.2 Discussion

4.2.1 Identification of Environmental Costs

The environmental costs incurred by PT. ABCDE have been identified in various activities related to the company's environmental management, particularly regarding liquid waste management. Based on the research findings, liquid waste management activities at this company encompass several cost categories, including salaries for environmental managers, wastewater testing, waste transportation, and other environmental management costs. This identification of environmental costs is undertaken to manage and monitor the environmental impacts of the company's production activities, particularly those related to liquid waste from shrimp and milkfish hatchery ponds. This indicates that PT. ABCDE has allocated a certain amount of costs directly related to environmental conservation efforts.

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4.2.2 Discrepancies Between Environmental Cost Identification and the Theory of Hansen and Mowen

The identification of environmental costs conducted by PT. ABCDE does not fully align with the theory proposed by Hansen and Mowen. According to this theory, environmental costs should be identified and presented separately from other general administrative costs to facilitate easier tracking and analysis. However, in practice, PT. ABCDE only recognizes environmental costs as part of other general administrative expenses, as well as electricity and water costs. Consequently, this grouping of costs does not provide clear information to management or external parties regarding the specific amount of costs incurred for environmental management. This indicates that the company's environmental cost identification process still needs improvement to meet applicable standards.

4.2.3 Recognition of Environmental Costs Using the Accrual Basis

The recognition of environmental costs by PT. ABCDE is in accordance with generally accepted accounting principles, specifically using the accrual basis. In practice, costs are recognized based on transaction evidence in the form of Virtual Account Billing provided by the environmental division to the finance division or the accounting department. This cost recognition occurs when the obligation to pay has been established, or in other words, the cost is recognized when the payment obligation has been fulfilled. This aligns with the definition of elements to be recognized under the Framework for the Preparation and Presentation of Financial Statements (KDPPLK) Paragraph 83 of 2015, which states that costs must be recognized when an outflow occurs that reduces future economic benefits. This practice demonstrates that the company has effectively applied the accrual method in recognizing environmental costs.

4.2.4 Measurement of Environmental Costs Based on Historical Cost

Regarding the measurement of environmental costs, PT. ABCDE uses the historical cost method, measured in Indonesian rupiah. This measurement is based on the actual costs the company incurs in the waste management process. This approach aligns with the Framework for the Preparation and Presentation of Financial Statements (KDPPLK) Paragraph 100, which states that cost measurement must be conducted using the historical cost approach—that is, the amount of cash or cash equivalents paid to acquire an asset. Thus, it can be concluded that PT. ABCDE has applied a measurement method consistent with applicable accounting standards in measuring environmental costs. However, the use of this historical cost method still needs to be accompanied by a more in-depth cost-benefit analysis to determine whether it optimally reflects the actual costs incurred.

4.2.5 Inadequate Presentation of Environmental Costs

The presentation of environmental costs by PT. ABCDE still has weaknesses that need to be addressed. Based on interviews with employees in the accounting department, it was found that the company has not presented environmental costs separately from other general administrative expenses. Costs incurred for waste management are still combined in the income statement under the general administrative expenses account with account number 6916 000.

This practice does not comply with Financial Accounting Standards, which recommend that environmental costs be clearly separated from other costs to make the information presented more

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transparent and accountable. Additionally, electricity costs associated with waste management are still combined with the company's total electricity expenses, thereby reducing the accuracy of financial reporting on environmental costs.

4.2.6 Disclosure of Environmental Costs in Compliance with Financial Accounting Standards

Regarding disclosure, PT. ABCDE has provided adequate disclosure regarding the environmental costs incurred. This disclosure is included in the notes to the financial statements and in the Environmental Management Efforts Report (UKL), which details environmental costs and total expenses incurred. This disclosure is considered to be in accordance with Financial Accounting Standards, which require companies to report incurred environmental costs transparently. With clear disclosure, the company can provide a more accurate picture of its environmental management efforts. However, the company's disclosures could be further optimized by presenting environmental costs separately in the primary financial statements, making them easier for stakeholders to analyze.

5. Concluding Remarks and Recommendation

This study aims to examine the application of green accounting in wastewater management at PT. ABCDE, focusing on five main stages: identification, recognition, measurement, presentation, and disclosure. The results of the study indicate that the company has managed its waste by allocating related costs, including labor, seawater testing, wastewater testing, domestic waste transportation, hazardous waste (B3) transportation, and electricity and water costs. The company uses an accrual basis to recognize environmental costs and measures them at historical cost. Environmental cost disclosures have also been included in the notes to the financial statements. However, it was found that the company's identification and presentation of environmental costs do not yet fully comply with applicable accounting standards.

The value of this study lies in its effort to integrate green accounting into the aquaculture industry, which has rarely been the focus of previous research, by analyzing its application at PT. ABCDE, this study makes an original contribution in identifying the waste management stages that have been implemented and those that still need improvement. In practice, the results of this study can serve as a reference for companies seeking to optimize the management of environmental costs further, thereby making them more transparent and measurable. The managerial implication is that companies need to separate environmental costs from administrative and general costs so they are easier to identify and present to financial statement users. Additionally, this study can encourage companies to continue developing the application of green accounting in accordance with applicable accounting standards.

However, this study has several limitations. First, the study was conducted on only one company, PT. ABCDE, so the results may not be generalizable to the aquaculture industry as a whole. Second, this study employed a qualitative descriptive method relying on data collection through interviews, observations, and documentation, which allows for subjectivity in data interpretation. Third, this study is limited to liquid waste management and does not examine other relevant aspects of green accounting implementation. For future research, it is recommended that researchers use more diverse methods, such as quantitative or mixed methods, to obtain more comprehensive results. Additionally, the application of green accounting in the aquaculture industry should be further examined on a larger

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scale, while also considering other aspects such as solid waste management and the measurement of environmental impacts on marine ecosystems.

Statement of Use of Generative AI

During the preparation of this work, the author used ChatGPT to assist in improving clarity and readability of the text. The author reviewed and edited the output and takes full responsibility for the content of the publication.

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Corresponding author
Muh Fuad Randy can be contacted at: fuadrandy@stieypup.ac.id

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Appendix

Table A1. Sample testing costs for 2023

Date	Description	Debit Amount	Credit Score
06-Jan	Cost of wastewater sample testing	370.000,00	
06-Feb		370.000,00	
22-Mar		410.000,00	
13-Apr		370.000,00	
20-Mei		370.000,00	
09-Jun		740.000,00	
16-Jul		370.000,00	
31-Agu		370.000,00	
30-Sept		370.000,00	
13-Okt		370.000,00	
30-Nov		370.000,00	
20-Des		370.000,00	
Total		**4.850.000,00**	

Table A2. Waste management costs for 2023

Date	Description	Debit Amount	Credit Score
10-Jan	Cost of Wastewater Sample Testing at Labkess Makassar	370.000,00	
16-Feb	Shipping Costs for Documents to PT. Mitra Hijau Makassar (MOU on the Transportation of Hazardous Waste)	10.000,00	
20-Feb	Costs for Wastewater Sampling and Testing by the Central Office Team	2.205.000,00	
07-Mar	Costs for Wastewater Sampling and Testing by the Standards Agency	1.333.000,00	
03-Apr	Costs for Wastewater Sampling and Testing by the Standards Agency	1.386.000,00	
06-Apr	Travel Expenses for Wastewater Sampling by the Standardization Agency	750.000	
08-Mei	Costs for Wastewater Sampling and Testing by the Standards Agency	1,386.000,00	
14-Jun	Travel Expenses for Wastewater Sampling by the Standardization Agency	700.000,00	
14-Jun	Costs for Water Sampling and Testing Waste for Environmental Agency Reporting	1,386.000,00	
07-Juli	Travel Expenses for Wastewater Sampling by the Standardization Agency	1,386.000,00	
10-Juli	Travel Expenses for Wastewater Sampling by the Standardization Agency	750.000,00	
07-Agus	Travel Expenses for Wastewater Sampling by the Standards Agency	1,386.000,00	
07-Agus	Costs for the Transportation and Disposal of Hazardous Waste via BRI Bank. PT. Mitra Hijau Asia	18.590.613,00	
07-Sept	Costs for Wastewater Sampling and Testing	1.386.000,00	
23-Okt	Costs for Wastewater Sampling and Testing by the Standards Agency	1.386.000,00	
13-Nov	Costs for Wastewater Sampling and Testing by the Standards Agency.	1.386.000,00	
Total		**35.796.613,00**	

Source: *PT. ABCDE (2023)*