

Integration of Environmental Management Accounting in Supporting Green Economy in East Java Province 2023-2025

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ABSTRACT

Objective: This study examines the role of environmental management accounting in supporting green economy implementation in East Java Province during 2023-2025. **Method:** A qualitative descriptive approach based on literature review and secondary data analysis is employed using official statistics from Statistics of East Java Province, publications of the Indonesia Financial Services Authority, and traceable scientific literature. **Results:** The analysis shows that East Java's Gross Regional Domestic Product at current prices increased from IDR 2,953.54 trillion in 2023 to IDR 3,168.29 trillion in 2024 and IDR 3,403.17 trillion in 2025, while annual growth was 4.95%, 4.93%, and 5.33%, respectively. Manufacturing remains the dominant sector in 2025 with a 31.32% contribution. This economic structure strengthens the need for environmental cost measurement and resource-efficiency management. Empirical evidence involving East Java MSMEs indicates that environmental accounting strategy and waste management are associated with sustainability performance, while MFCA supports financial performance. **Novelty:** The study concludes that EMA can connect profitability objectives with green economy goals through environmental cost identification, material and energy flow measurement, green budgeting, green investment appraisal, and environmental performance indicators.

INTRODUCTION

Economic development faces increasingly complex demands, as output growth, investment, and consumption must coexist while managing environmental impacts. The green economy is emerging as a development approach that directs economic activities toward being lower-carbon, resource-efficient, resilient, and inclusive. At the organizational level, this agenda cannot be positioned solely as a social responsibility activity but needs to be integrated into planning, control, performance evaluation, and decision-making mechanisms.

Management accounting plays a crucial role in this integration. Traditional cost information in many organizations tends to lump energy, water, wasted materials, waste management, and environmental compliance costs into overhead accounts. As a result, management can lose visibility into the sources of waste and an inaccurate picture of the economic value of environmental inefficiencies. Environmental Management Accounting (EMA) addresses this problem by combining monetary and physical information so that resource consumption and environmental impacts can be traced to the processes, products, or activities that cause them.

The context of East Java is particularly relevant because the province boasts a large and diverse economic base, including manufacturing, trade, agriculture, transportation,

services, and a network of MSMEs. The Statistics Indonesia (BPS) of East Java Province (2024) noted that East Java's economy in 2023 generated a GRDP of Rp2,953.54 trillion at current prices, growing by 4.95 percent. In 2024, the GRDP increased to Rp3,168.29 trillion, growing by 4.93 percent (BPS of East Java Province, 2025). Furthermore, in 2025, the GRDP reached Rp3,403.17 trillion, growing by 5.33 percent; the manufacturing industry contributed 31.32 percent to East Java's economic structure (BPS of East Java Province, 2026).

These increased economies of scale provide benefits in the form of added value, revenue, and business activity, but also increase the need for materials, energy, water, logistics, and waste management. From a management accounting perspective, the critical issue is not simply whether a company incurs environmental costs, but rather whether the company is able to identify the sources of those costs, determine cost drivers, measure material loss, and use this information to improve processes and investment decisions.

The relevance of EMA to East Java's MSMEs is supported by empirical evidence. Latifah and Soewarno [1], using data from 194 MSMEs in East Java, found that environmental accounting strategy influences sustainability performance, and waste management mediates this relationship. Research by Soewarno, Basoeki, and Tjahjadi [2] on 156 MSME owners or managers in East Java also showed that MFCA partially mediates the relationship between external pressure and financial performance. These findings demonstrate that environmental accounting is not only a reporting instrument but also a cost management and operational efficiency tool.

On the policy side, the development of the Indonesian Taxonomy for Sustainable Finance (TKBI) by the Financial Services Authority (OJK) reinforces the need for more structured sustainability data among companies. TKBI 2024 and TKBI Version 2 in 2025 were developed as a classification of sustainable economic activities that can be used by various user scales, including corporations and MSMEs [3], [4]. Thus, companies' capacity to produce measurable environmental information is increasingly relevant not only for internal control but also for access to financing and communication with stakeholders.

Based on these conditions, this article positions Environmental Management Accounting as an instrument that bridges two often perceived separate interests: profitability and environmental sustainability. The discussion focuses on how green accounting, MFCA, green budgeting, and green investment appraisal can be applied in the context of the East Java economy for the 2023-2025 period.

Theoretical Framework

The integration of environmental management accounting into the green economy framework is grounded in two primary theories:

Legitimacy Theory: Asserts that organizations continuously strive to ensure that they operate within the bounds and norms accepted by external society [5]. In this context, implementing green accounting and EMA serves as a mechanism for companies

to gain social legitimacy by demonstrating a tangible commitment to minimizing environmental degradation.

Resource-Based View (RBV): Proposes that firms achieve a sustainable competitive advantage by effectively managing internal resources that are valuable, rare, inimitable, and non-substitutable [6]. EMA and MFCA function as internal capabilities that optimize raw material and energy efficiency, ultimately reducing operational costs and driving productivity.

Management Accounting and Sustainable Decision Making

Management accounting is an internal information system that provides financial and non-financial information to management for planning, controlling, performance evaluation, pricing, product decisions, investment decisions, and efficiency improvement. In a sustainability-oriented business environment, the objects of management accounting information extend beyond labor and overhead costs to material consumption, energy use, water, defective products, waste, emissions, and environmental prevention and recovery costs.

This expansion is important because environmental impacts inherently have economic consequences. Waste materials have been purchased, processed, transported, and often require disposal costs. Inefficient energy use increases unit costs. Defective products carry costs of raw materials, labor, energy, and machine capacity that do not generate revenue. Therefore, accurate environmental information can improve cost decisions and productivity.

Indonesian literature shows that the relationship between green accounting and company performance is not always consistent. Dianty and Nurrahim [7] found that green accounting significantly impacted financial performance in mining companies, while environmental performance had no partial effect. Tjoa and Widianingsih [8] found that environmental performance had a positive effect on profitability, while green accounting had no effect. These differences in results reinforce the argument that the benefits of environmental accounting depend not solely on recording or disclosure, but also on how information is used to influence management processes and decisions.

Green Economy

A green economy can be understood as a development orientation that integrates economic growth, resource efficiency, environmental risk reduction, and social welfare into a single framework. At the micro level, this concept translates into reduced material and energy use per unit of output, cleaner production, waste control, more environmentally friendly product design, material reuse, and investment in low-emission technologies.

The relationship between the green economy and management accounting lies in the need for measurement. Goals such as energy efficiency or waste reduction will be ineffective if a company lacks baselines, targets, actual costs, physical indicators, and a mechanism for evaluating variances. Therefore, the green economy requires a

management information system capable of converting environmental targets into operational and monetary measures.

Green Accounting

Green accounting is an accounting approach that incorporates environmental dimensions into the identification, measurement, recording, analysis, and reporting processes. From an internal perspective, green accounting helps management identify environmental costs previously hidden within overhead [9]. These costs can include pollution prevention, monitoring, waste treatment, recovery, certification, resource use, and technology investments that reduce environmental impact.

Dewi and Wardani's [10] study of Indonesian manufacturing companies demonstrates the importance of green accounting in discourses on profitability and CSR. Maria and Elisabeth [10] also examine green accounting and environmental performance in relation to profitability and stock prices. While empirical findings vary across studies, this literature indicates that environmental information is increasingly becoming part of the analysis of company performance and value.

Environmental Management Accounting

Environmental Management Accounting is the application of management accounting principles to identify, collect, analyze, and use cost and physical information related to materials, energy, water, waste, and environmental impacts. EMA is not simply an external reporting system. Its primary focus is on improving internal decisions through transparency of resource flows and their associated costs [12].

Conceptually, EMA can be divided into Monetary Environmental Management Accounting (MEMA) and Physical Environmental Management Accounting (PEMA). MEMA records information in monetary units, such as electricity costs, water costs, wasted raw material costs, waste management costs, compliance costs, and savings from recycling. PEMA uses physical units, such as kilograms of raw materials, kWh of electricity, cubic meters of water, kilograms of waste, emission volume, or units of defective products.

The combination of monetary and physical data provides richer information. If electricity costs increase, management not only knows the rupiah increase but can also compare kWh per unit of product. If raw material costs increase, management can identify whether the cause is purchasing prices, changes in production volume, or increased material loss.

Material Flow Cost Accounting

Material Flow Cost Accounting (MFCA) is an EMA technique that tracks the flow and inventory of materials in physical and monetary units. MFCA distinguishes outputs into positive products, namely materials contained in products that have economic value, and negative products or material losses, namely materials that do not become products and ultimately become scrap, residue, emissions, or waste [12].

The strategic value of MFCA lies in uncovering hidden costs. In conventional costing systems, attention is often focused solely on waste disposal costs. MFCA shows

that waste absorbs material purchase costs, energy costs, labor costs, system costs, and management costs. Thus, waste reduction can be treated as a cost reduction program that simultaneously improves environmental performance [13].

Soewarno et al.'s empirical evidence on East Javanese MSMEs supports the benefits of MFCA on financial performance. The study showed that MFCA partially mediated the influence of regulatory and market pressures on financial performance. This indicates that responses to external demands become more valuable when translated into an internal measurement system capable of demonstrating cost and material efficiency [14], [15].

METHODS

This study employed a qualitative descriptive approach based on a literature review and secondary data analysis. This design was chosen because the research objective was to develop a conceptual and policy synthesis regarding the role of management accounting in supporting a green economy in the East Java context, rather than to test causal relationships through a new survey.

The main economic analysis period is 2023-2025. Regional economic data is obtained from the Official Statistics News of the East Java Province Statistics Agency (BPS) released in February of the following year. Therefore, the 2025 annual data uses the BPS publication dated February 5, 2026, because it is the official release containing the full economic realization for 2025. Policy sources use the official OJK publication regarding the 2024 TKBI and the 2025 TKBI Version 2 [3], [4]. Academic literature is selected based on its relevance to environmental accounting, environmental management accounting, MFCA, environmental performance, MSMEs, and company performance, with publications prioritized after 2020.

The analysis was conducted in four stages. First, identifying the development of East Java's GRDP, economic growth, and economic structure. Second, examining the concepts of EMA, green accounting, MFCA, green budgeting, and green investment evaluation. Third, comparing relevant empirical findings, particularly research using East Java's MSMEs as its subject. Fourth, developing an implementation framework that links physical and monetary information to cost decisions, control, investment, and sustainable performance.

A limitation of this approach is that the research results are not intended to represent the level of EMA adoption across all companies in East Java. The conclusions are analytical based on official macro data, policies, and available empirical evidence. Further research could test the proposed framework using surveys, case studies, or direct company data.

RESULTS AND DISCUSSION

Economic Development of East Java 2023-2025

East Java's economic performance from 2023 to 2025 shows sustained expansion. GRDP at current prices increases annually, while economic growth remains at around five percent, rising to 5.33 percent in 2025. This increase reflects the increasing value of production and consumption activities, which must be accompanied by increased efficiency in resource use.

Table 1. Development of GRDP and Economic Growth of East Java 2023-2025.

YEAR	GRDP ADHB	ECONOMIC GROWTH
2023	Rp2,953.54 trillion	4.95%
2024	Rp3,168.29 trillion	4.93%
2025	Rp3,403.17 trillion	5.33%

Source: BPS East Java Province (2024, 2025, 2026), processed by the author.

In 2024, the manufacturing industry contributed 31.29 percent to East Java's economic structure, and its contribution remained dominant at 31.32 percent in 2025 (BPS East Java Province, 2025; 2026). Manufacturing dominance is important from an EMA perspective because this sector has a more complex material flow, involving raw materials, energy, water, finished products, by-products, scrap, failed products, and waste.

Economic growth is not automatically synonymous with a green economy. Growth becomes greener when additional output can be produced with lower material, energy, emissions, and waste intensity. Therefore, macro-scale measures such as GRDP need to be complemented at the company level with efficiency measures, such as kilograms of material per unit of product, kWh per unit, yield percentage, waste ratio, recycling rate, and environmental cost ratio.

For management, this requirement means that an accounting system cannot simply show total production costs. Companies need to understand the proportion of costs caused by material loss, inefficient energy use, defective products, rework, waste management, and environmental compliance costs. This way, company growth can be measured not only by increases in volume and profit, but also by resource productivity.

EMA as a Link between Profitability and Environmental Performance

One of the barriers to implementing a green economy at the corporate level is the perception that environmental activities always represent additional costs. EMA changes this perspective by demonstrating that most environmental impacts stem from process inefficiencies, which also have economic consequences. Waste materials are paid for but do not generate revenue. Wasted energy increases unit costs. Excessive water use increases utility and processing costs.

The logical relationship established by EMA can be summarized as: resource efficiency -> reduction of material loss and energy consumption -> cost reduction -> increased productivity -> improved financial and environmental performance. This relationship does not mean that all environmental investments always produce short-

term profits, but it provides a basis for management to distinguish between mandatory compliance costs, prevention costs, and efficiency investments that have an economic return.

Latifah and Soewarno's (2023) findings reinforce this mechanism. Environmental accounting strategies in East Javanese MSMEs influence sustainability performance, while waste management acts as a mediator. This means that environmental accounting strategies are more effective when translated into operational actions such as waste management. This aligns with the EMA's character as an information system for managerial action, not simply disclosure.

Environmental Costs and Decision Making

Environmental costs need to be separated from overhead so management can identify cost-incurring activities and evaluate the effectiveness of environmental programs. A simple classification can adapt the quality cost approach by distinguishing between prevention costs, detection costs, internal failure costs, and external failure costs.

Table 2. Example of Environmental Cost Classification for Management Accounting.

CATEGORY	EXAMPLE COSTS	MANAGERIAL IMPLICATIONS
PREVENTION COST	Training, clean process design, energy efficient machines	Prevent waste and pollution before it occurs
DETECTION COST	Water monitoring, emissions, environmental audits	Measuring compliance and detecting deviations
INTERNAL FAILURE COST	Scrap, rework, internal waste processing	Demonstrates inefficiencies before the impact of company exit
EXTERNAL FAILURE COST	Recovery, compensation, sanctions, complaint handling	Shows the consequences after the impact occurs
RESOURCE INEFFICIENCY COST	Material loss, excess energy/water	Drive process efficiency and unit cost reduction

Source: Synthesis of Environmental Management Accounting concepts, processed by the author.

One simple indicator is the Environmental Cost Ratio = Environmental Cost / Sales x 100%. This ratio can be compared between periods, but its interpretation requires caution. An increase in the ratio in a given year may indicate inefficiency, but it may also occur because the company is making preventative investments or system improvements whose benefits will only be seen in the following period.

Therefore, monetary indicators must be complemented by physical indicators. A decrease in environmental costs resulting from a company reducing monitoring activities, for example, does not necessarily indicate better performance. Conversely, an increase in prevention costs can reduce internal and external failure costs in the future. EMA helps management see this composition more holistically.

MFCA and Hidden Cost Disclosure

MFCA is relevant for the processing industry and production MSMEs in East Java because it places materials as the primary cost object. This system requires organizations to identify material inputs, positive products, and negative products at each quantity center or process stage. The value of lost materials is then assigned proportional costs for material, energy, systems, and waste management.

For example, if an MSME purchases 1,000 kilograms of raw materials but only 850 kilograms are converted into finished products, then 150 kilograms represents material loss. In conventional accounting, the focus might only be on the cost of discarding those 150 kilograms. In MFCA, the loss value also includes the cost of the materials, the energy required to process them, labor, machine usage, and handling costs. This information allows for more rational prioritization of process improvements.

Soewarno et al. (2023) showed that MFCA in East Javanese MSMEs plays a role in the relationship between regulatory and market pressures and financial performance. This finding is important for the green economy because it demonstrates that sustainability pressures from the government or consumers do not necessarily result in compliance burdens. When translated into material flow measurements, these pressures can drive efficiency, which has financial benefits.

Green Budgeting as a Control Mechanism

Green budgeting is the integration of environmental targets into operational and capital budgets. In this system, environmental targets are not external to the management control system but are instead assigned indicators, baselines, targets, responsible parties, and variance evaluations. For example, the production department might be assigned targets to reduce kWh per unit, reduce material loss, increase recycling rates, or reduce water consumption.

The primary benefit of green budgeting is accountability. Targets simply stated as environmental commitments are difficult to evaluate. When targets are translated into budgets and indicators, management can identify variances, identify causes, and determine corrective actions. Furthermore, environmental targets can be linked to responsibility centers, so the entire sustainability burden isn't placed on a single unit.

Table 3. Examples of Green Budgets and Control Indicators.

INDICATOR	BASELINE	ANNUAL TARGET	ACCOUNTING INFORMATION
ELECTRICITY CONSUMPTION/ UNIT	100%	-10%	kWh and electricity cost per unit

MATERIAL LOSS	100%	-8%	kg of material loss and rupiah value
WATER CONSUMPTION/ UNIT	100%	-5%	m3 and water cost per unit
RECYCLING RATE	30%	50%	kg of recycled material and recovery value
DEFECTIVE PRODUCT	100%	-15%	defective units, rework costs, lost materials

Source : Processed Data

Green Investment Evaluation

Environmentally friendly investments can include solar panels, energy-efficient machinery, water reuse systems, wastewater treatment technologies, higher-yielding machinery, or recycling equipment. Management accounting plays a role in converting environmental benefits into cash flow, which can be analyzed through Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period, and Return on Investment.

In investment evaluations, avoided costs are often overlooked benefits. Machine replacement not only saves electricity but can also reduce scrap, downtime, maintenance costs, waste management costs, and the risk of non-compliance. Therefore, green investment analyses should include all credibly identifiable incremental cash flows.

A simple indicator that can be used as a complement is Green ROI = Net Economic Benefit from Green Investment / Green Investment x 100%. Net economic benefits can include savings in energy, materials, and water, reduced disposal costs, revenue from material recovery, and additional margins from products with green attributes. Green ROI is not a substitute for NPV, but it can aid managerial communication regarding the relationship between environmental investments and economic benefits.

Integration with Sustainable Finance

The Financial Services Authority (OJK) published the Taxonomy for Sustainable Finance in Indonesia on February 20, 2024, and updated it through the TKBI Version 2 in February 2025. The TKBI is a classification of economic activities that supports Indonesia's sustainable development goals and is designed to be used by various user scales, including corporations and MSMEs (OJK, 2024; 2025).

These developments have consequences for a company's internal information system. Classifying sustainable activities and performance disclosure requirements will be easier to meet if the company already has data on energy, materials, water, waste, emissions, and environmental investments. EMA can serve as an internal data source that strengthens consistency between operational decisions, sustainability reporting, and financing requirements.

For MSMEs, these benefits have the potential to grow as financial institutions increasingly use sustainability indicators in their financing product assessments. MSMEs

that can demonstrate resource efficiency and simple environmental cost reporting have a better information base to demonstrate that their improvement activities are not just claims but are supported by operational data.

EMA Implementation Model in East Java MSMEs

Implementing EMA in MSMEs doesn't have to start with complex software. A phased implementation model is more realistic due to limitations in human resources, time, and record-keeping systems. The following stages can serve as a starting point:

Stage 1 - Identify resource flows: List primary raw materials, auxiliary materials, electricity, fuel, water, finished products, failed products, scrap, and waste.

Stage 2 - Physical measurements: Record kilograms of material, kWh of electricity, m³ of water, liters of fuel, units of failed products, and volume of waste.

Stage 3 - Cost monetization: Link physical data with purchase prices, electricity/water rates, labor costs, machine costs, transportation costs, and processing costs.

Stage 4 - Indicator analysis: Calculate yield, waste ratio, energy cost intensity, material loss cost, and environmental cost ratio.

Stage 5 - Decisions and follow-up: Determine process improvements, material changes, supplier selection, preventive maintenance, recycling, or machine investment.

Stage 6 - Periodic evaluation: Compare actual indicators with the baseline and green budget targets every month or quarter.

Recommended Performance Indicators

For EMA to function as a management control system, companies need to use indicators that can be compared across periods. Indicators should be simple, consistent, and relevant to core processes. The following table provides examples of adaptable indicators.

Table 4. EMA Indicators for Companies and MSMEs.

INDICATOR	FORMULA/MEASUREMENT	OBJECTIVE
MATERIAL EFFICIENCY	Material in product / total material input	Measuring material conversion efficiency
WASTE RATIO	Waste / total material input	Measuring the proportion of material lost
ENERGY INTENSITY	kWh / product unit	Measuring energy efficiency
WATER INTENSITY	m ³ / product unit	Measuring water efficiency
ENVIRONMENTAL COST RATIO	Environmental cost / sales	Measuring environmental cost intensity
MATERIAL LOSS COST	The value of material + energy + system in negative product	Assessing the hidden costs of waste

Source: Synthesis of EMA and MFCA, processed by the author.

Integration Framework of Management Accounting and Green Economy

Based on the data and literature analyzed, the conceptual relationship can be formulated as follows:

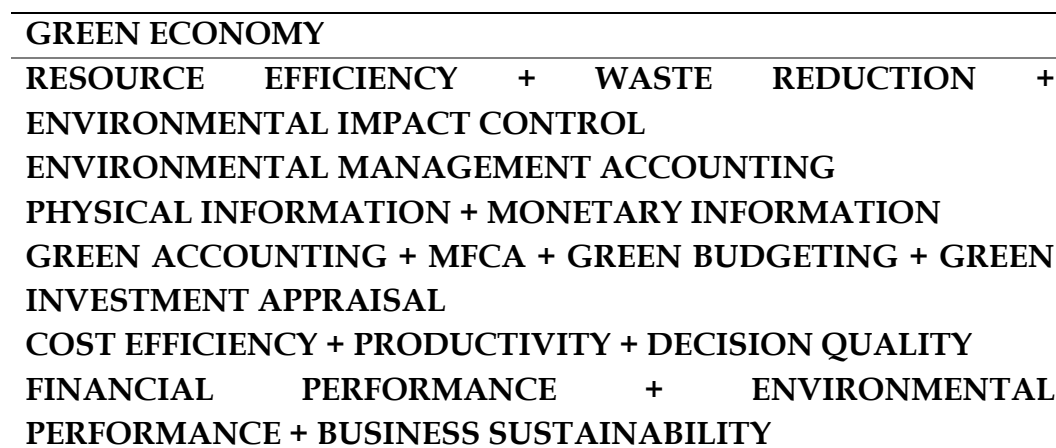


Figure 1. Conceptual framework for the integration of management accounting and the green economy. Source: processed by the author.

The framework demonstrates how the green economy is translated into operational targets through EMA. Physical information provides a tangible measure of resource use, while monetary information demonstrates the consequences of costs and benefits. Green accounting, MFCA, green budgeting, and green investment evaluation then serve as analytical tools to transform this data into managerial decisions.

Within this framework, financial performance and environmental performance are not treated as mutually exclusive objectives. Resource efficiency can improve both when reducing environmental impact stems from reducing waste. However, trade-offs may still occur in compliance investments or technologies with long payback periods. The role of management accounting is to make these trade-offs transparent and measurable so that decisions are not based solely on perceptions.

Implications for East Java

1. Regional governments can incorporate environmental cost literacy and MFCA into MSME mentoring programs, especially in the food and beverage, agricultural processing, textile, craft, and other production activities that have real material losses.
2. Manufacturing companies can expand cost accounting by separating material loss and waste management costs from overhead so that management obtains more accurate information for continuous improvement.
3. Universities in East Java can act as implementation partners by developing simple EMA templates, assisting with material flow measurements, and developing cost dashboards and environmental indicators.
4. Financial institutions can utilize documented efficiency and sustainability information as supporting data in developing sustainable financing, in line with the direction of TKBL.

5. Business associations can promote sectoral benchmarks, for example kWh per unit, waste ratio, or material yield, so that MSMEs have a reference for assessing whether their processes are relatively efficient.

CONCLUSION

Fundamental Finding: The 2023-2025 period shows that East Java's economy continues to grow, with GRDP at current prices increasing from IDR 2,953.54 trillion in 2023 to IDR 3,168.29 trillion in 2024 and IDR 3,403.17 trillion in 2025. Economic growth is 4.95 percent, 4.93 percent, and 5.33 percent, respectively. The economic structure that remains dominated by the processing industry reinforces the urgency of material and energy efficiency as part of the green economy transformation. Environmental Management Accounting (EMA) can serve as an information infrastructure that connects economic and environmental goals. EMA integrates monetary and physical information so that the costs of materials, energy, water, defective products, waste, and environmental investments can be analyzed based on processes and cost drivers. Green accounting helps identify environmental costs, while MFCA uncovers the hidden costs of material loss. Green budgeting places environmental targets within control mechanisms, and green investment appraisal allows environmental investments to be valued based on their incremental cash flow and economic benefits. **Implication:** Thus, management accounting has the potential to transform the green economy agenda into a measurable efficiency program, rather than simply an administrative obligation. Collaboration between local governments, universities, business associations, the financial sector, and businesses is necessary to transform sustainability information into concrete operational decisions. **Limitation:** The analysis is limited by differences in environmental accounting competency, record-keeping practices, resource-data availability, and the integration of financial and environmental indicators among businesses in East Java, particularly MSMEs. **Future Research:** Broader implementation in East Java requires improved environmental accounting competency, simplified record-keeping templates for MSMEs, digitization of resource data, development of sectoral benchmarks, and integration of financial and environmental indicators.

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