

## ENVIRONMENTAL COST MANAGEMENT AND CLIMATE CHANGE INVESTMENT FOR SUSTAINABLE PRODUCTION, SOCIAL RESILIENCE, AND COMMUNITY WELL-BEING

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### ARTICLE HISTORY

Received : 21-07-2026

Revised : 23-08-2026

Accepted : 18-09-2026

### KEYWORDS

*Climate Change Investment, Community Well-Being, Environmental Cost Management, Social Resilience, Sustainable Production*

### ABSTRACT

Environmental cost management and climate change investment are increasingly important for strengthening sustainable production, organizational resilience, and community well-being amid environmental and disaster-related risks. This study aims to examine how environmental cost management and climate change investment support sustainable production, social resilience, and community well-being at PT XYZ Regional Office of East Java. A qualitative case study approach was employed involving six purposively selected informants from warehouse operations, production, and finance functions. Data were collected through semi-structured in-depth interviews and analysis of internal company documents covering the 2020–2025 period and analyzed thematically through coding, triangulation, document analysis, and iterative interpretation. The findings indicate that environmental cost management encompasses prevention, detection, internal failure, and external failure costs, with greater emphasis on preventive and detection activities to minimize product deterioration and production disruptions. Climate change investment, particularly earthquake-resistant warehouse infrastructure and environmental control systems, supports production continuity, protects rice stocks, and reduces vulnerability to environmental and disaster-related risks. The findings also suggest that resilient infrastructure contributes to worker safety, food-supply continuity, organizational preparedness, and social resilience. However, environmental cost recording remains only partially integrated into formal accounting systems. The study implies that integrating environmental cost management with climate change investment can strengthen sustainable production, risk reduction, and food-security continuity.

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### INTRODUCTION

Environmental degradation caused by anthropogenic activities has become increasingly systemic, involving land-use change, resource overexploitation, inefficient production, and losses throughout food supply chains. These conditions generate interconnected ecological, economic, and social consequences, including production losses, environmental costs,

social vulnerability, and declining community well-being. Within food systems, environmental pressures originate not only from production and land-use conversion but also from storage, processing, and distribution activities. In Indonesia, environmental degradation and disaster risks can further disrupt agricultural productivity and food distribution, making food loss and waste (FLW) reduction an important environmental, economic, and social intervention (Tchintcharauli-Harrison et al., 2022).

Climate change intensifies these vulnerabilities by altering environmental conditions that affect production and postharvest activities. Elevated temperature and humidity accelerate biological deterioration, particularly in rice, with storage conditions above 25°C and 65% relative humidity increasing the risk of fungal contamination and quality degradation (Knight et al., 2022; Poetelea et al., 2025). Climate-related disruptions are particularly concerning in developing countries with limited adaptive infrastructure because product deterioration generates additional costs through replacement, reprocessing, transportation, and disposal. Therefore, climate-resilient production and storage investment should be considered not merely as infrastructure expenditure but as a mechanism for reducing environmental costs, maintaining food availability, and strengthening community resilience. In addition to climate-related risks, tropical regions such as Indonesia are also vulnerable to geological hazards, including earthquakes, which can further threaten storage infrastructure, disrupt operational continuity, and increase the risk of food-stock losses.

From a management perspective, sustainable production requires environmental risks and their associated costs to be incorporated into organizational decision-making. Climate-related shocks, including droughts, pest outbreaks, and extreme weather events, can compromise storage stability and food availability, while investments incorporating environmental performance indicators can reduce FLW and improve economic resilience (Rahman Ramadhan et al., 2023). Environmental cost management provides a framework for identifying costs associated with emissions, waste, resource inefficiency, product deterioration, and climate-related disruptions. Through green accounting, these environmental externalities can be incorporated into strategic resource allocation, with empirical evidence showing that environmental cost disclosure can improve environmental and financial performance while strengthening organizational accountability (Alani & Omotayo, 2023; Saleh et al., 2023).

Climate change investment complements environmental cost management by translating environmental risk information into preventive and adaptive actions. Investments in resilient infrastructure, environmental monitoring, adaptive storage technologies, and efficient logistics can reduce stock damage, operational downtime, quality deterioration, and distribution disruption. These benefits extend beyond organizational performance because maintaining essential food supplies can reduce community exposure to food insecurity and economic instability. In this context, PT XYZ Regional Office of East Java has a strategic role in maintaining national rice reserves through procurement, storage, and distribution. Previous studies have emphasized climate-smart postharvest practices (Natalie et al., 2024), environmental influences on storage quality (Zhang, 2024), structural resilience (Technology & Agency, 2021), and modern storage technologies for reducing FLW (Nath et al., 2024).

Despite growing evidence on climate-smart postharvest practices, storage quality, resilient infrastructure, and FLW reduction, existing studies tend to examine these dimensions independently. Research has not sufficiently explained how environmental cost management can be integrated with climate-resilient investment to identify, evaluate, and reduce the environmental and operational costs associated with infrastructure failure, particularly in rice storage. Furthermore, the broader implications of such integration for sustainable production, food-supply continuity, and social resilience remain underexplored. This creates an important research gap because preventive investment may generate benefits that extend beyond direct financial returns, including avoided stock losses, reduced operational disruption, improved worker safety, and continued access to essential food supplies. Therefore, an integrated assessment is needed to demonstrate how environmental cost information can support climate-related investment decisions while simultaneously addressing organizational resilience and community well-being.

To address this gap, this study develops a scenario-based assessment linking environmental cost management with climate-resilient investment. The analysis estimates potential losses from storage infrastructure failure under seismic-event scenarios using secondary data, institutional reports, and analytical assumptions. The benefit–cost framework considers stock value loss, infrastructure damage, logistics disruption, operational downtime, and quality degradation. The scenario estimates indicate potential losses of approximately IDR 1.5 trillion without resilient infrastructure compared with approximately IDR 200 billion following the implementation of earthquake-resistant warehouses and integrated environmental control systems.

These figures are scenario-based projections rather than historical longitudinal measurements and are therefore intended to illustrate the potential economic feasibility of preventive environmental investment.

The study contributes an integrated framework connecting environmental cost management and climate change investment with sustainable production, social resilience, and community well-being. The framework combines environmental cost identification, benefit–cost evaluation of resilient infrastructure, and assessment of adaptive production and storage technologies. By integrating environmental, economic, and social dimensions, the study positions climate investment as a strategic mechanism for reducing production losses, maintaining food availability, strengthening operational resilience, and protecting community welfare.

## METHOD

This study employed a qualitative approach with a case study design to examine the implementation of environmental cost management and climate change investment in supporting sustainable production, social resilience, and community well-being at PT XYZ Regional Office of East Java. The research focused on warehouse, production, and finance activities that are directly related to environmental cost management, climate-related investment, production continuity, and operational resilience. The study covered organizational practices and internal data from 2020–2025.

Informants were selected using purposive sampling based on their knowledge and direct involvement in the research subject. Six informants participated, comprising three primary informants (Head of Warehouse/Operations, Production Manager, and Finance Manager) and three supporting informants from warehouse, production, and finance staff. Data were collected through direct observation, semi-structured in-depth interviews, and documentation. The interview instrument consisted of open-ended questions addressing environmental cost identification and recording, climate change investment, production and storage risks, investment decision-making, and implications for social resilience and community well-being. Documentary data included financial and environmental cost records, investment and maintenance documents, stock loss records, quality inspection reports, and relevant standard operating procedures (SOPs) for the 2020–2025 period.

Data were analyzed using thematic analysis through coding, categorization, and identification of relationships among environmental costs, climate change investment, sustainable production, environmental risks, and social resilience. Data validity was strengthened through source and method triangulation by comparing interview findings with observations and relevant company documents. The analysis was conducted iteratively to identify consistent patterns and develop conclusions regarding the role of environmental cost management and climate change investment in strengthening production continuity, organizational resilience, and community well-being.

## RESULT AND DISCUSSION

### Results

This study examined environmental cost management and climate change investment in supporting sustainable production, social resilience, and community well-being at PT XYZ Regional Office of East Java. The findings were obtained from semi-structured interviews with six informants, direct observations, and internal company documents covering 2020–2025. The results are presented in two main dimensions: (1) environmental cost management and climate change investment and (2) their contributions to sustainable production, economic and social resilience, and community well-being.

### Environmental Cost Management and Climate Change Investment

**Table 1.** Environmental Cost Management and Climate Change Investment Findings

| Indicator        | Findings and Empirical Evidence                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Prevention Costs | Preventive activities included routine maintenance of ventilation systems, roofing, transportation equipment, and warehouse infrastructure. Internal maintenance records for 2021–2024 showed consistent budget allocation for these activities. The Warehouse Manager emphasized that preventive maintenance was economically preferable to responding to damaged stocks, stating, “Routine maintenance is much cheaper than replacing damaged stock after quality deterioration occurs.” |
| Detection Costs  | Quality inspections, moisture testing, and pest monitoring were conducted periodically. Inspection reports from 2022–2024 confirmed regular monitoring. However, the related environmental detection costs were not yet fully separated or integrated into formal accounting records.                                                                                                                                                                                                      |

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Internal Failure Costs       | Internal failure costs included reprocessing damaged rice and managing non-hazardous waste. Production records indicated recurring quality deterioration, although detailed costs were not systematically recorded. A production staff member explained, “We often reprocess rice that does not meet standards, but the cost is not always calculated in detail.” This indicates that some environmental and operational costs remain embedded in routine production activities. |
| External Failure Costs       | No significant community complaints related to waste were identified during the study period. Nevertheless, internal environmental risk assessments indicated potential reputational and social risks if environmental performance deteriorates.                                                                                                                                                                                                                                 |
| Climate Change Investment    | Financial planning documents for 2023–2025 indicated that earthquake-resistant warehouse construction was estimated to require approximately 15–20% higher initial investment than conventional structures. The additional investment was intended to reduce potential damage and support operational continuity.                                                                                                                                                                |
| Climate Adaptation Practices | Warehouse records showed increased aeration and fumigation during periods of elevated temperature and humidity. The Production Manager reported that “When humidity rises, we must increase fumigation frequency to maintain quality.” This practice reflects operational adaptation to environmental conditions affecting rice quality.                                                                                                                                         |
| Resilient Infrastructure     | Observations and safety documentation indicated improved structural stability and reduced vulnerability to seismic hazards following the implementation of earthquake-resistant infrastructure. Informants also associated resilient infrastructure with improved worker safety and better protection of stored rice stocks.                                                                                                                                                     |

Source: Processed Qualitative Data from Interviews, Observations, and Internal Company Documents, 2026

The findings in Table 1 show that environmental cost management was primarily implemented through preventive maintenance, environmental monitoring, quality inspection, and responses to product deterioration. Interview evidence indicates that prevention was perceived as more beneficial than responding to losses after they occurred. At the same time, climate-related investment was reflected in both operational adaptation and resilient warehouse infrastructure. However, some environmental costs, particularly detection and internal failure costs, remained embedded in operational expenditure rather than being separately identified in formal accounting records.

### Contributions to Sustainable Production, Resilience, and Community Well-Being

**Table 2.** Contributions to Sustainable Production, Social Resilience, and Community Well-Being

| Dimension                 | Contribution Based on Empirical Findings                                                                                                                                                                                                                                                                                                                                                                                           |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sustainable Production    | Preventive maintenance, environmental monitoring, adaptive storage practices, and resilient infrastructure supported production continuity, reduced stock deterioration, and improved resource utilization. Interview findings indicated that preventive and early-detection activities were preferred because they enabled the company to address risks before they resulted in greater product losses or operational disruption. |
| Economic Resilience       | Internal planning documents indicated that earthquake-resistant construction required an estimated 15–20% higher initial investment. The previously estimated 7–10-year ROI was based on internal feasibility analysis and avoided-loss scenarios rather than realized historical returns.                                                                                                                                         |
| Social Resilience         | Resilient warehouse infrastructure contributed to worker safety and organizational preparedness for environmental and disaster-related risks. Protecting warehouse facilities and rice stocks also supported the organization's ability to maintain operations during disruptive events.                                                                                                                                           |
| Community Well-Being      | Maintaining rice quality, stock availability, and distribution continuity contributed indirectly to food security and community welfare. Because the study did not employ a separate quantitative community-impact instrument, this contribution is interpreted as an organizational and food-supply function rather than a directly measured community-level outcome.                                                             |
| Environmental Performance | Improved ventilation, environmental monitoring, preventive maintenance, and reduced product deterioration supported environmental management and potentially reduced waste generation. However, the absence of quantitative emissions data prevented direct measurement of emission reductions.                                                                                                                                    |

Source: Processed Qualitative Data from Interviews, Observations, and Internal Company Documents, 2026

### Research Findings

The interview data indicate that environmental cost management at PT XYZ is predominantly preventive rather than reactive. The Warehouse Manager emphasized the economic importance of routine maintenance in avoiding greater losses from stock deterioration. This finding is consistent with warehouse observations showing routine maintenance of ventilation, roofing, transportation equipment, and other infrastructure. The Production Manager further explained that environmental conditions influence operational decisions, particularly through increased fumigation when humidity rises. These statements demonstrate that environmental risk considerations are incorporated into daily warehouse and production activities, even though the associated costs are not always separately recorded.

The findings also show that climate change investment extends beyond responses to temperature and humidity. Earthquake-resistant warehouse infrastructure represents a longer-term preventive investment intended to protect productive assets and maintain operational continuity. Internal planning documents estimated that resilient construction would require approximately 15–20% greater initial investment than conventional construction. However, the estimated 7–10-year return period represents a scenario-based projection derived from avoided losses, maintenance savings, and operational continuity, rather than an observed financial return.

From a sustainability perspective, the combination of preventive environmental cost management and resilient infrastructure supports sustainable production by reducing the likelihood of stock deterioration, operational disruption, and resource losses. The social implications are reflected primarily in improved worker safety, protection of rice reserves, and the continuity of essential food supplies. Nevertheless, community well-being and environmental performance were not directly quantified. The findings therefore indicate a potential social and environmental contribution rather than a statistically measured impact at the community level.

An important finding is that environmental cost management has not yet been fully integrated into the company's formal accounting system. Detection activities and internal failure costs, such as inspection, reprocessing, and product deterioration, may occur as part of routine operations without being explicitly classified as environmental costs. This condition limits the company's ability to determine the full economic value of preventive environmental investment. Integrating environmental cost identification with investment evaluation could therefore provide a more comprehensive basis for assessing the benefits of climate-resilient infrastructure.

### Discussion

#### Environmental Cost Management and Sustainable Production

The findings indicate that environmental cost management at PT XYZ has gradually developed from a predominantly operational practice into a strategic mechanism for supporting sustainable production and reducing climate-related production risks. Based on observations, interviews with six informants, and internal documentation, environmental expenditures were identified through prevention, detection, internal failure, and external failure costs. Preventive expenditures, particularly for warehouse maintenance, environmental monitoring, quality control, and disaster-risk mitigation, were prioritized because reactive responses to stock deterioration and infrastructure damage were perceived to generate greater operational disruption. This finding indicates that environmental cost management can support production continuity by shifting organizational attention from corrective responses toward preventive risk management.

These findings are consistent with the environmental management accounting perspective proposed by (Danial et al., 2025), which emphasizes systematic environmental cost classification as a basis for organizational decision-making and risk control. The PT XYZ case demonstrates that environmental expenditures are increasingly considered in operational planning and infrastructure investment decisions rather than being treated solely as compliance-related expenditures. Nevertheless, environmental cost recording remains partially integrated because several environmental expenditures are still incorporated into general operational expenses rather than being systematically identified through specific accounting codes. This condition limits the organization's ability to accurately evaluate the full economic contribution of environmental management to sustainable production.

The findings further show that prevention and detection activities support sustainable production through quality inspection, pest control, ventilation maintenance, aeration, and environmental monitoring. Such practices are particularly important under changing temperature and humidity conditions, which can increase biological deterioration and postharvest

losses. These findings are consistent with (Danial, 2024), who associate green accounting and environmental cost management with operational efficiency and organizational risk control. Within food supply chains, environmental expenditures can simultaneously function as climate adaptation costs because they protect production quality against climate variability, humidity, pests, and fungi (Huang, 2022; Hultgren, 2025). The gradual development of green accounting at PT XYZ therefore represents an important step toward more transparent environmental cost management and sustainable food production (Connor, 2023).

#### **Environmental Cost Allocation and Organizational Decision-Making**

Environmental costs at PT XYZ are primarily associated with warehouse maintenance, rice quality inspection, pest control, waste management, and activities supporting product quality. This classification is consistent with Mustika et al. (2023), who distinguish environmental costs into prevention, detection, internal failure, and external failure categories. The empirical evidence indicates that prevention costs are perceived as more economical than expenditures resulting from stock damage, declining quality, and distribution disruptions. However, the absence of a dedicated Chart of Accounts (COA) for several environmental expenditures indicates that environmental cost information has not yet been fully institutionalized within formal financial reporting.

The interview findings reinforce this condition. Production personnel described environmental expenditure as supporting quality inspection, pest control, SOP maintenance, and preservation activities, whereas finance personnel explained that environmental costs are still gradually being incorporated into green accounting practices. Costs associated with reducing stock-loss risks and earthquake-resistant warehouse infrastructure may still be recorded together with operational expenditures. This suggests that the organization has developed substantial environmental management practices at the operational level, while accounting formalization remains at an earlier stage. Strengthening this integration would enable management to distinguish preventive environmental investment from routine operational expenditure and evaluate its contribution to production sustainability more accurately.

The four environmental cost categories provide further insight into this process. Prevention costs include ventilation maintenance, roof repairs, equipment servicing, and staff training, while detection costs involve inspection, quality testing, and operational monitoring. Internal failure costs arise from product treatment, waste management, and corrective actions, whereas external failure costs relate to potential environmental and social consequences outside the organization. The findings indicate that prevention and detection are strategically important because they can reduce the likelihood of internal and external failure costs. This pattern supports (Zainab & Burhany, 2020) and (Mustika et al., 2023), particularly regarding the economic value of preventive environmental management.

#### **Climate Change Investment and Sustainable Production**

Climate change investment at PT XYZ extends environmental cost management from accounting recognition to preventive organizational action. The development of earthquake-resistant warehouses, environmental control systems, energy-efficient lighting, and improved storage management demonstrates an investment strategy directed toward maintaining production continuity under environmental and disaster-related uncertainty. These investments are particularly relevant to sustainable production because they seek to reduce stock deterioration, maintain quality, and minimize disruptions in food distribution. The findings are consistent with (Knight et al., 2022), who emphasize the importance of adaptive storage conditions in protecting food quality and reducing climate-related losses.

The scenario-based investment analysis indicates that a 5,000-ton earthquake-resistant warehouse requires an estimated investment of approximately IDR 12 billion, compared with approximately IDR 10 billion for a conventional structure. The additional investment is associated with reinforced construction, maintenance, environmental control, and disaster-risk mitigation. Based on the study's internal assumptions, the investment is projected to generate an ROI within approximately 7–10 years. These values should be interpreted as scenario-based estimates rather than realized financial returns. Similarly, the estimated additional cost of IDR 410/kg and the resulting illustrative selling price of IDR 13,910/kg represent a simulation intended to demonstrate the potential cost implications of resilient infrastructure rather than a definitive market price.

The sensitivity analysis further demonstrates that the economic implications of climate change investment depend on infrastructure costs, production volume, and cost allocation mechanisms. The estimated additional cost ranges from IDR 300/kg under a low-cost scenario to IDR 550/kg under a high-cost scenario, with the base scenario estimated at IDR 410/kg.

Therefore, the economic feasibility of environmental investment should not be assessed solely through initial construction expenditure but also through its potential to reduce losses, stabilize production, and maintain operational continuity over time.

#### **Climate-Resilient Infrastructure and Organizational Resilience**

Earthquake-resistant warehouses constitute a central form of climate and disaster-resilient investment in the PT XYZ case. Designed according to SNI 1726:2019, these facilities combine structural resilience with temperature and humidity control, quality monitoring, and efficient aeration systems. This integrated configuration positions warehouse infrastructure not simply as a physical asset but as an environmental investment capable of supporting sustainable production and reducing vulnerability to environmental disruption. The findings are consistent with (Lumbangaol & Samran, 2024), particularly concerning the importance of resilient storage infrastructure in hazard-prone regions.

The findings also indicate that earthquake-resistant warehouses can contribute to employee safety, stock protection, and organizational confidence in maintaining food reserves. The estimated 15–20% higher construction cost is therefore associated with a broader set of expected benefits, including reduced structural vulnerability, lower potential stock losses, and improved operational continuity. These findings reinforce the Triple Bottom Line perspective, which emphasizes the simultaneous consideration of economic, environmental, and social dimensions in sustainability practices (Kahfi & Syamsuddin, 2025).

#### **Disaster Risk Management and Social Resilience**

The PT XYZ case demonstrates that climate change investment also contributes to social resilience through diversified storage and distribution strategies. East Java's exposure to earthquakes, floods, volcanic activity, and other hazards requires the organization to maintain alternative storage capacity and contingency mechanisms. The distribution of approximately 50% of stock to earthquake-resistant company-owned warehouses and 25% each to partnership and leased warehouses reduces dependence on a single facility. Buffer stock and rapid distribution mechanisms further support continuity of food availability during disruptive events.

This strategy is consistent with (Umar & Wilson, 2023), who emphasize diversified storage and inventory resilience as mechanisms for absorbing supply-chain shocks. The prioritization of resilient facilities also corresponds with supply-chain resilience practices described by (Sahamony et al., 2024), while buffer stocks and rapid distribution support proactive disaster-risk management (Smith, 2024). Collectively, these mechanisms strengthen organizational capacity to maintain essential food supplies during environmental disruptions, reinforcing the role of climate-resilient investment in social resilience (Le, 2025).

#### **Social Resilience and Community Well-Being**

The social implications of environmental cost management and climate change investment extend beyond internal organizational performance. The findings indicate that resilient warehouses, improved storage technologies, and stock-management systems support the continuity of rice supplies for communities in East Java, particularly during crisis conditions. Such continuity can strengthen public trust in PT XYZ and contribute to community resilience by reducing vulnerability to interruptions in essential food availability. These findings are consistent with (Mandhaputri et al., 2023) and (Rany et al., 2020) who emphasize the broader social and economic benefits associated with environmental investment.

The social dimension is also reflected in worker safety, employment opportunities, disaster-relief activities, environmental programs, and the organization's responsibility for safeguarding national food reserves. Therefore, community well-being in this study is understood primarily through food availability, supply continuity, public trust, and reduced exposure to disruption rather than through direct measures of household welfare. This distinction is important because the present study is qualitative and organizationally focused; consequently, the observed social benefits represent empirically supported organizational contributions rather than statistically measured community-level welfare effects.

#### **Integrated Interpretation**

Overall, the findings demonstrate that environmental cost management and climate change investment are mutually reinforcing components of sustainable production and resilience at PT XYZ. Environmental cost management provides information for identifying prevention, detection, and failure-related expenditures, while climate change investment translates environmental risk information into preventive infrastructure and adaptive operational practices. Their integration contributes to production continuity, resource efficiency, stock protection, and disaster preparedness while simultaneously generating social benefits through worker protection, food availability, and community resilience.

The findings extend the Triple Bottom Line perspective by demonstrating that environmental investment can simultaneously address economic efficiency, environmental risk, and social needs (Kahfi & Syamsuddin, 2025). However, the study also identifies an important institutional challenge: environmental costs remain only partially integrated into formal accounting systems. Consequently, future implementation should strengthen environmental cost classification, establish dedicated accounting codes where appropriate, and integrate environmental and social indicators into investment evaluation. Such integration would enable PT XYZ to assess not only the financial feasibility of climate investment but also its contribution to sustainable production, social resilience, and community well-being.

## CONCLUSION

This study finds that the integration of environmental cost management and climate change investment supports sustainable production and resilience at PT XYZ Regional Office of East Java. Preventive environmental cost management and climate-resilient investment contribute to maintaining rice quality, reducing potential operational losses, protecting strategic food reserves, and supporting production continuity. The study also highlights that resilient infrastructure provides broader benefits through improved worker safety and strengthened organizational preparedness for environmental and disaster-related risks, thereby contributing to social resilience and community well-being.

The contribution of this study lies in integrating environmental cost management with climate-resilient investment within the context of rice storage and distribution, extending the assessment beyond operational efficiency to include environmental and social dimensions. However, environmental costs are not yet fully integrated into the formal accounting system, limiting comprehensive evaluation of their economic and sustainability implications. The findings imply that organizations should strengthen environmental cost identification and integrate it with investment evaluation and sustainability indicators. Such integration can support more informed managerial decisions by considering economic efficiency, environmental protection, disaster resilience, and continuity of essential food supplies.

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