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Environmental Accounting for Sustainable Water Management: A Case Study of Artesian Wells

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Abstract

This study aims to implement Environmental Management Accounting (EMA) in community-based clean water management, especially artesian wells in Cempaka Sari, Sekaran, Gunungpati District, Semarang City. The method used is a qualitative case study with data collection through semi-structured interviews and document analysis. The results of the study indicate that EMA has been implemented simply but effectively. EMA is physically implemented through recording water usage with a meter, while EMA is monetarily implemented through recording operational costs and allocation of reserve funds. Despite facing various challenges such as limited human resources and technical limitations, this system shows a high level of transparency, accountability, and community participation. The implementation of EMA provides benefits for efficiency, financial control, and long-term environmental desires.

Keywords

artesian wells, clean water, environmental accounting, water management

INTRODUCTION

As research on environmental accounting in Indonesia increases, the term becomes more widely recognised. Environmental accounting deals with reporting and auditing related to environmental aspects. Its scope includes the process of identifying, monitoring, analysing, reporting, and presenting information on the costs associated with the environmental impacts of an organisation's activities (Aruan, 2021).

Environmental issues are becoming a topic of increasing global concern. The increasing exploitation of natural resources negatively impacts the balance of the ecosystem. One type of natural resource that is vulnerable to crises is water. Therefore, in managing clean water supply, responsibility must be prioritised in strategic planning to pay greater attention to the impact of their operations on the environment. One important approach to supporting this sustainability is Environmental Management Accounting (EMA), which allows companies to identify the costs and environmental impacts of their activities (Gunarathne & Lee, 2021). One form of water management developing in the community is using artesian wells, managed independently by the local community. In the Cempaka Sari area of Sekaran, Gunungpati District, Semarang City, artesian wells meet daily clean water needs. However, the practice of managing these artesian wells still faces environmental challenges and a lack of public awareness of the long-term ecological impacts that can threaten the sustainability of water resources. Therefore, applying EMA to water resource management is crucial.

EMA covers two main aspects: Physical EMA, which records the physical flow of materials and energy, and Monetary EMA, which focuses on recording costs related to environmental impacts (Mukwarami et al., 2023). Implementing EMA can improve operational efficiency and environmental cost transparency, as well as support process innovation within an organisation.

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(Fuzi et al., 2021). In managing artesian wells, EMA helps strengthen social legitimacy and fulfils
community expectations for responsible resource management.

Although EMA has been proven beneficial conceptually, its application in water management within non-governmental organisations has not been extensively researched. There remains doubt whether environmental recording systems are properly integrated into operational management.

Artesian well management is expected to implement EMA principles to ensure efficient and sustainable water resource management, in line with the Sustainable Development Goals (SDGs). However, many still focus on traditional financial reporting, neglecting the systematic recording of environmental costs (Kassim et al., 2024). This gap indicates the need for more in-depth research to understand the actual state of EMA implementation in artesian well management in the Cempaka Sari area, Sekaran, Gunungpati District, Semarang City.

Research on EMA in the public sector, particularly in drinking water companies, is still limited. Several studies, such as those conducted by Gunarathne dan Lee (2021) serta Mukwarami (2023). More focus is on the manufacturing sector, and there is not much discussion about the clean water public service sector. A case study on Gunungpati Community Self-Help Group by Susilowati (2023)shows the potential for EMA adoption in local communities. The context of self-managed artesian well management by the community has not been widely studied. Therefore, this study fills this gap by examining the application of EMA in artesian well management in the Cempaka Sari area, Sekaran, Gunungpati District, Semarang City.

This study aims to analyse the application of Environmental Management Accounting (EMA) in managing artesian well water resources in Cempaka Sari, Sekaran, Gunungpati District, Semarang City. Specifically, this study aims to identify the application of the physical and monetary aspects of EMA and evaluate the challenges and opportunities in improving the sustainability of clean water management in artesian well management in the Cempaka Sari, Sekaran, Gunungpati District, Semarang City.

LITERATURE REVIEW

Environmental Management Accounting

Environmental management accounting theory emphasises the importance of integrating environmental aspects into accounting systems, where measuring and reporting the environmental impacts of business activities is key to better decision-making. Environmental Management Accounting (EMA) is an approach that integrates environmental aspects into management accounting systems to support sustainable decision-making. EMA consists of two main components: Physical EMA, which records the flow of natural resources such as water and energy, and Monetary EMA, which measures the costs associated with environmental impacts (Gunarathne & Lee, 2021). Implementing EMA helps organisations identify efficiency opportunities, reduce waste, and increase transparency of environmental performance (Fuzi et al., 2021).

Other studies have shown that institutional and regulatory pressures, including water utilities, are key drivers of EMA adoption in the public sector. However, challenges such as a lack of management awareness and resources often hinder implementation (Rahmawati et al., 2024) Another study Susilowati et al. (2023) in local communities, it was revealed that a participatory approach can improve the implementation of EMA. However, the context of artesian well management as a self-managed water management initiative by communities remains underexplored. Sustainable water management requires the integration of technical, economic, and environmental aspects. EMA plays a role in ensuring efficient and accountable water resource allocation (Mukwarami et al., 2023).

Water Management

An artesian well, popularly defined, is a well whose water can flow to the surface without the need for pumping. This phenomenon is a natural one caused by specific geological conditions. The geological conditions that favour the existence of an artesian well are the position of the well surface under pressure from a confined aquifer (a layer of rock or sand containing water),

allowing the water in the well to rise to the surface or to an elevation corresponding to the point where hydrostatic equilibrium is achieved (Solikhah & Maulina, 2021).

The use of water from artesian wells, due to their geological characteristics, is considered a potential groundwater source. This is because artesian wells are low in susceptibility to contaminants and relatively easy to access, as they require no pump installation or electrical energy expenditure. Therefore, observation and investigation of the various potentials of artesian wells are necessary to meet the community's increasing water needs.

Groundwater management is the implementation, planning, monitoring, and evaluation of groundwater conservation, groundwater utilisation, and control of groundwater's destructive potential (Susilowti et al., 2023). Groundwater management is regulated by Government Regulation No. 43 of 2008 concerning Groundwater. The provision of clean water is a particular concern, particularly for drinking water. Water management controls and moves water resources to minimise damage to life and property and maximise their efficient and beneficial use. Proper water management in dams and embankments reduces the risk of a flood dam.

METHODS

This research uses a qualitative case study approach, focusing on an artesian well managed by a local community organisation. This approach is suitable for exploring in-depth how Environmental Management Accounting is implemented in clean water management practices by local managers. The data used in this study consisted of primary and secondary data. The Primary data were collected through semi-structured interviews with artesian well managers, particularly those involved in operational activities and environmental accounting. These interviews aimed to obtain information on implementing Physical EMA (recording the physical flow of water, energy, and other materials) and Monetary EMA (environmental costs such as waste management, conservation, and restoration).

Secondary data was obtained through a review of internal company documents such as financial reports, payment recaps, monthly meter readings, customer receipts, and local regulations related to water and environmental management. External documents, such as scientific journals and policy reports, were also reviewed to support the validity of the theory and empirical findings.

Data analysis was conducted using a descriptive qualitative approach using a thematic approach to identify patterns, challenges, and opportunities in the implementation of EMA in artesian well environments. The findings were analyzed to address three leading research focuses: the level of implementation of Physical and Monetary EMA in artesian well management, the obstacles encountered in the EMA implementation process, and the potential benefits of EMA implementation in supporting sustainable clean water management. This research is expected to contribute to the understanding of environmental management accounting practices in the public service sector and serve as a reference for strengthening environmental policies and management in regional companies.

RESULTS AND DISCUSSION

The implementation of EMA in the management of the artesian well in RT 02/RW 02 has been simple yet consistent since its inception in 2015. Although it doesn't use a complex recording system, the management manually records monthly expenses and income. Each customer has their own water meter, and bills are calculated based on water usage at a rate of Rp 2,000 per cubic meter. Billing is done door-to-door with each customer or through transfers to the neighbourhood association's account, with a dual monitoring system (two manager signatures for disbursement of funds).

Transparency and accountability are key values in the implementation of EMA by the management of this artesian well. Customers are informed of the results of their management through regular monthly meetings. The collected funds are used not only for operational costs but also for reserve funds, machine replacements, and social assistance, such as providing basic necessities to customers. This demonstrates that the EMA (Energy-Friendly Water Supply) has been implemented as a tool for transparency, financial control, and social

decision-making.

EMA management is based on Physical EMA, which involves recording water usage using meters at each household. Total water usage is calculated monthly and recorded in Excel. Furthermore, regulations are in place to prevent misuse of water lines, such as prohibiting meter connections or installing machines independently, which could jeopardise water distribution.

Water flow management is also a consideration. When water flow decreases, the solution taken to ensure smooth water management is maintained is to build additional wells. To date, four wells have been constructed to provide soft water distribution and support each other. Each well is supported by an interconnected pipe network to maintain a stable supply. Technical challenges encountered include meter damage, which results in inaccurate water usage data. Therefore, field officers routinely check and replace the wells when necessary. In monetary terms, all costs, such as electricity, staff salaries, and machine maintenance, are recorded separately but compiled into monthly reports. Reserve funds are also allocated for new well construction or other urgent needs. An interest-free loan system is implemented, reflecting the principle of social sustainability in financial management.

Tabel 1.
EMA Physical average monthly water usage

Although there are no written guidelines, management is based on community deliberation. Decisions, especially those related to financing or major expenditures, are discussed collectively. Cooperation and unity are the main foundations of a well-managed policy. Some challenges faced include late client payments and a lack of human resources (HR) for field officers. Social factors and family relationships hinder the implementation of strict sanctions. However, community support and the need for clean water are key factors driving the program's sustainability.

The implementation of EMA has had a positive impact on profitability and management transparency (Signori & Bodino, 2013). Residents can enjoy water services at affordable prices, while well managers can manage water use and distribution operations with sound financial oversight (Batchelor et al., 2016). Other benefits include the availability of emergency funds, social assistance, and the sustainability of collectively managed water resources (Tingey-Holyoak & Pisaniello, 2019).

Water resources are the foundation of national development, aimed at ensuring the well-being and prosperity of the community (Sendawula et al., 2020). Therefore, water resources must be managed harmoniously to ensure their sustainable use (Gibassier, 2018). Sustainable water resource management is a moral commitment for all environmental stakeholders (Mahmud et al., 2022). Resource management is aimed at the benefit of both present and future generations (Escriva-Bou et al., 2020).

Essentially, sustainable development represents a threshold for the rate of natural resource utilisation to empower natural resources to advance public welfare (Elmahdi, 2019). Sustainable water resource management is based on a strategy that seeks to achieve balance and harmony between economic, ecological, and socio-cultural aspects to increase water efficiency, minimise losses, and improve and conserve the environment (Kamienski et al., 2019). The basic policies for implementing sustainable water resource management are: a) development for economic growth; b) waste reduction; c) establishing environmental quality standards; d) natural resource capacity; and e) community participation (Silvana Signori , 2013).

Meanwhile, the principles of water resource management that can be implemented are: a) maintaining the continuity of water catchment functions; b) controlling water resource utilization; c) regulating water source boundary areas; d) forest and land rehabilitation; e) water conservation; f) controlling groundwater use; g) water quality management; h) controlling water pollution; i) utilizing water resources; j) controlling the destructive power of water; k) groundwater resource technology and information systems; and community empowerment (Chartzoulakis & Bertaki, 2015; Qiu et al., 2021).

CONCLUSION

This study found that implementing EMA in managing artesian wells in Cempaka Sari has been simple yet effective. Managers manually record water usage and financial transactions, but have adopted the principles of transparency and accountability through monthly reporting and a dual monitoring system. Physical EMA is reflected in the recording of water volume, while Monetary EMA is reflected in managing operational costs and reserve funds. Challenges include limited human resources and technical constraints, but community support is a key factor in sustainability. This study shows that a community-based EMA approach contributes to sustainable clean water management.

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