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Implementation of Circular Economy in Regional Public Service Agencies in Waste Management as a Waste Reduction Strategy in Indonesia

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ABSTRACT

This study explores the implementation of the circular economy in waste management at UPTD Pelayanan Persampahan Kota Cimahi, which operates as a Regional Public Service Agency (BLUD) and functions as a quasi-public entity. As a BLUD, UPTD has the flexibility to manage waste processes independently and efficiently, converting waste into Refuse Derived Fuel (RDF), which is then sold to PT Indocement as an alternative fuel in cement production. The research uses a qualitative case study approach, gathering data through in-depth interviews, observations, and documentation to examine the systematic stages of waste processing. Waste collected from various sources, such as offices, hospitals, markets, and residential areas, is processed into RDF. This circular economy cycle enables the cement produced with RDF to be reused by the community, including the original waste-generating consumers. Findings reveal that this model not only reduces environmental impact by diverting waste from landfills but also generates economic value, highlighting the potential for sustainable partnerships between public waste management and private industry. The study suggests that optimizing BLUD's quasi-public entity status and applying a circular economy model could enhance the effectiveness of responsible, sustainable waste management practices.

Keywords: BLUD; Circular Economy; Quasi-Public Entity; Refuse-Derived Fuel; Sustainability; Waste Management

INTRODUCTION

Waste management in Indonesia is a critical issue requiring special attention from the government. The continuous increase in waste generation, driven by population growth and economic activities, has become a significant challenge in achieving a clean and healthy environment. The responsibility for waste reduction lies with the government, which is expected to provide sustainable solutions for waste management.

To significantly reduce waste volume, the concept of a circular economy emerges as a relevant and effective approach. This concept promotes waste management by transforming waste into something useful or of market value, thereby reducing dependence on new resources. In a circular economy, waste is not merely considered as material to be disposed of but as a potential resource that can be processed into new products, such as compost, Refuse-Derived Fuel (RDF), or other recycled products. Thus, waste management becomes part of a broader and more sustainable economic cycle.

However, one of the main challenges in waste management is funding. Waste processing activities, especially on a large and sustainable scale, require substantial financial resources. The government often faces budgetary constraints, which limit its capacity to manage waste effectively. The required funding includes infrastructure, technology, and skilled human resources for waste processing activities.

To address funding challenges without excessively burdening the government budget, a suitable institutional framework for waste management is the Regional Technical Implementation Unit (UPTD) with the status of a Regional Public Service Agency (Badan Layanan Umum Daerah, BLUD). As a quasi-public entity, BLUD offers financial flexibility, allowing revenues generated from waste processing activities to be reinvested to improve services. The BLUD status enables UPTD to achieve greater financial independence and fosters the implementation of circular economy practices in waste management across Indonesia.

LITERATURE REVIEW

The circular economy concept, first introduced by Walter Stahel (1982) and further expanded by Pearce and Turner (1990), emphasizes the reduction, recycling, and reuse of resources to create a sustainable product lifecycle. For governments, this concept offers an efficient approach to managing waste and natural resources.

On the other hand, the quasi-public entity theory by Osborne and Gaebler (1992) encourages the public sector to adopt managerial flexibility, enabling public organizations to operate as semi-autonomous entities to enhance efficiency and responsiveness. This concept aligns with the New Public Management (NPM) approach, which advocates for transparency and accountability in public services.

In Indonesia, the quasi-public concept is implemented through BLUD under Government Regulation No. 23 of 2005 on the Financial Management of Public Service Agencies, later updated by Government Regulation No. 74 of 2012, and further detailed in Ministry of Home Affairs Regulation No. 61 of 2007 and No. 79 of 2018. These regulations enable BLUDs to adopt managerial flexibility and integrate circular economy principles into their operations.

The interconnection between the circular economy concept, quasi-public entities, and BLUD regulations in Indonesia lies in their shared goal of creating more efficient and

sustainable public services. The circular economy framework provides a foundation for optimizing resource utilization and minimizing the environmental impact of waste. Meanwhile, the quasi-public concept and its implementation in BLUDs offer the necessary flexibility to effectively apply circular economy principles within the public sector.

RESEARCH METHOD

This study employs a qualitative approach using a case study method to analyze the implementation of the circular economy in waste management by BLUD, focusing on the Waste Management Service Unit (UPTD Pelayanan Persampahan) in Cimahi City. The case study was chosen to gain an in-depth understanding of circular economy-based waste management practices.

Data were collected through in-depth interviews with waste management authorities, direct observations of operational activities, and documentation of reports and policies obtained from local government sources.

Data analysis was conducted using a thematic approach to identify key themes, such as the effectiveness of waste management and the challenges in applying circular economy principles in the UPTD. Data triangulation was employed to ensure the validity of findings by cross-verifying results from interviews, observations, and documentation. This study also adhered to ethical standards, including maintaining respondent confidentiality and obtaining participant consent.

RESULTS

The Waste Management Service Unit of Cimahi City manages an average of 100 tons of waste per day, which is transported to the Integrated Waste Processing Facility (Tempat Pengolahan Sampah Terpadu, TPST). This waste originates from various sources, such as offices, hospitals, markets, sports facilities, and residential areas. Each source generates different types of waste, ranging from organic waste like food scraps to inorganic waste such as plastics, paper, metals, and glass. Table 1 details the sources and types of waste generated.

Table 1. Sources and Types of Waste

Sources	Types of Waste
Offices	Paper, cardboard, plastic, used printer cartridges, food waste
Hospitals	Paper, used cotton, syringe wrappers, used syringes, medicine bottles, broken glass, medical waste
Markets	Organic waste, plastic, paper, cardboard, packaging wood, rubber
Restaurants	Food waste, wrapping paper, plastic wrappers
Sports Facilities	Paper, plastic, food waste, grass clippings
Open Fields	Twigs, dry leaves, grass clippings
Roads and Parking Lots	Paper, plastic, dry leaves
Residential Areas	Food waste, paper, cardboard, plastic, metal, fabric, leaves, twigs
Building Construction	Broken bricks, concrete fragments, roof tiles, wood, paper, plastic

Waste from each category is systematically processed upon arrival at the Integrated Waste Processing Facility (TPST). The waste undergoes several stages of treatment

aimed at converting a significant portion of high-calorific-value materials into Refuse-Derived Fuel (RDF). This processing involves a combination of mechanical equipment and modern technology to separate organic and inorganic materials, compact high-value materials, and prepare the final RDF product. The stages of the waste processing to RDF conversion are summarized in Figure 1.

Figure 1. Waste Processing Process into RDF

Waste received at the Integrated Waste Processing Facility (TPST) begins its journey with an initial reception and weighing process to determine the total weight of the waste to be treated. The waste is then directed to a conveyor belt for preliminary mechanical sorting. At this stage, the waste is separated into two main categories using a *gibrig* machine: organic materials such as food scraps, leaves, and twigs, and inorganic materials such as plastic, paper, metal, and glass.

Separated organic waste is typically processed further for various purposes, such as composting or maggot cultivation. Meanwhile, inorganic materials with high calorific value, such as plastic and paper, are directed to the drying stage to reduce moisture content. This drying process prepares the inorganic materials for easier processing in subsequent stages.

Dried inorganic materials are then shredded into small, uniform pieces using a shredding machine to ensure they meet the size specifications for Refuse-Derived Fuel (RDF). The shredded waste is subsequently compacted using a pressing machine, forming RDF bales ready for distribution. As a final step, the produced RDF is re-weighed to verify its quantity and quality before being delivered to PT Indocement, the designated offtaker, for use as an alternative fuel.

The process of converting waste into RDF requires significant investment in infrastructure and equipment to support daily operations. The initial capital expenditure (capex) for constructing the facility and procuring processing equipment totaled approximately IDR 15 billion. The infrastructure includes a specially designed waste processing facility, a conveyor system for initial sorting, a *gibrig* machine for separating organic and inorganic waste, drying machines to reduce the moisture content of inorganic waste, and shredders and pressing equipment for producing RDF according to industry standards.

In addition to the initial investment, managing this facility requires daily operational expenditure (OPEX). These expenses cover costs for labor, electricity consumption, fuel (diesel) for machinery, and equipment maintenance. A detailed breakdown of operational costs is provided in Table 2.

Table 2. Operational Expenditure

Cost Type	Unit (ton)	Price (Rp)	Total Cost (Rp)
Human Resources, Electricity, Fuel	100	120.000	12.000.000
Equipment Maintenance	100	20.000	2.000.000
Total OPEX per day			14.000.000
Total OPEX per Year			168.000.000

Out of the 100 tons of waste processed daily, approximately 60% or 60 tons are successfully converted into Refuse-Derived Fuel (RDF). The produced RDF possesses a calorific value suitable for use as an alternative fuel in the cement industry. The RDF is re-weighed to ensure accuracy before being delivered to PT Indocement, where it is utilized as a substitute fuel to reduce dependence on fossil fuels.

DISCUSSION

The waste management approach at The Waste Management Service Unit of Cimahi City reflects a paradigm shift from the traditional linear economy model of *take-make-waste* to a circular economy model. In a linear economy, waste is generated after the consumption cycle and typically ends up in landfills without efforts to recover its value. This approach not only wastes resources but also places immense pressure on the environment (MacArthur Foundation, 2013). To address these challenges, The Waste Management Service Unit of Cimahi City has adopted circular economy principles by processing solid waste into Refuse-Derived Fuel (RDF), an economically valuable product used as a substitute fuel alongside coal in cement production (Korhonen et al., 2018).

The circular economy model implemented by The Waste Management Service Unit of Cimahi City begins with the collection of waste from various sources, such as households, markets, and public facilities. This waste is then systematically processed through several stages, including sorting, drying, shredding, and pressing, to produce RDF. The RDF generated has a high calorific value, making it suitable as a substitute fuel in the cement industry. This circular economy practice not only reduces waste destined for landfills but also adds economic value to materials previously deemed useless. According to Nasoha et al. (2023), circular economy principles allow waste streams to be transformed into high-value products, creating economic opportunities while reducing environmental burdens. Furthermore, Silva et al. (2019) emphasize that circular economy practices enhance the value chain by integrating waste as a new resource, ultimately driving innovation and generating additional revenue streams.

The transition from a linear to a circular economy also yields significant environmental benefits. By utilizing waste as a raw material for RDF, The Waste Management Service Unit of Cimahi City reduces the cement industry's dependence on coal while lowering carbon emissions from combustion processes. A study by Islami (2022) demonstrates that the use of RDF as a substitute fuel not only helps reduce carbon emissions but also improves energy efficiency in cement production. Additionally, diverting waste from landfills contributes to a reduction in methane emissions, which are often produced from the decomposition of organic waste in landfills.

Figure 2. Circular Economy in Waste Processing into RDF

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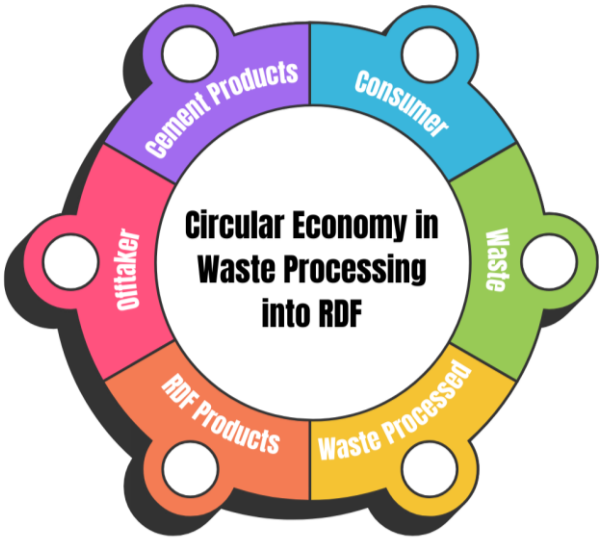

The transformation of waste into Refuse-Derived Fuel (RDF) at the Waste Management Service Unit of Cimahi City establishes a circular economy cycle that begins with consumers and ends with the production of a final product. Consumers, including households, markets, public facilities, and various other sectors, serve as the primary generators of diverse waste types. This waste is collected through a scheduled transportation system that integrates the waste flow into the Integrated Waste Processing Facility (TPST). This initial step marks the beginning of the circular cycle, where materials considered waste are directed toward value recovery processes (Korhonen et al., 2018).

Upon arrival at the TPST, the waste undergoes a series of processing stages aimed at preparing the material for conversion into RDF. These stages include waste sorting to separate organic and inorganic materials, drying to reduce the moisture content of high-calorific-value materials, shredding to achieve the required RDF specifications, and compacting to create efficiently transportable forms. The resulting RDF is an economically valuable product that can be utilized as a substitute fuel in the cement industry alongside coal. According to Shehata et al. (2022), RDF not only reduces dependence on fossil fuels but also provides a practical solution for managing solid waste by leveraging its calorific potential for industrial applications.

In the cement industry, such as at PT Indocement, RDF is utilized to meet energy needs while producing cement as the final product of this cycle. This cement is then redistributed back to society and other sectors, including the very consumers who originally generated the waste. In this circular economy cycle, waste is no longer seen as the end of the material lifecycle but rather as part of a regenerative process connecting consumer and production sectors (Islami, 2022).

This model not only decreases reliance on fossil fuels but also fosters integration between waste management and industrial needs. By utilizing RDF as a substitute material, The Waste Management Service Unit of Cimahi City reduces the burden on landfills while creating collaborative opportunities that support economic and environmental sustainability. A study by Pires and Martinho (2019) highlights that the integration of public and private sectors in a circular economy cycle like this generates dual benefits for both society and industry. Within this context, the circular cycle implemented by The Waste Management Service Unit of Cimahi City serves as a practical and sustainable example of how circular economy principles can be applied.

As a government-affiliated entity, The Waste Management Service Unit of Cimahi City bears the responsibility of ensuring that waste management costs do not overly burden the Regional Budget (APBD). Therefore, the selling price of RDF must at least cover operational costs without aiming for profit. This management approach aligns with the concept of a quasi-public entity, where financial management flexibility allows UPTD to operate more independently. In this regard, the adoption of the Regional Public Service Agency Financial Management Pattern (PPK BLUD) is an ideal solution. BLUDs are designed to provide financial flexibility to government service units, enabling them to establish strategic partnerships with the private sector and set appropriate service tariffs (Malihah & Magfiroh, 2024).

BLUD, as defined by Ministry of Home Affairs Regulation No. 61 of 2007, later amended by Regulation No. 79 of 2018, is a part of the local government granted financial flexibility to operate similarly to a business entity while maintaining public service principles. The BLUD status enables UPTDs to set service fees that reflect operational costs and directly engage in transactions with third parties, such as PT Indocement, the RDF off-taker. In this context, BLUDs do not aim to generate profits but ensure the efficient and sustainable delivery of public services without burdening the Regional Budget (*APBD*). This aligns with the findings of Islami (2022), who highlighted the crucial role of quasi-public entities in integrating public service principles with operational efficiency.

Waste management at the regional level cannot entirely adopt a business-oriented approach, as its primary focus remains on public service. However, traditional UPTDs face limitations, particularly in financial flexibility and the ability to establish strategic partnerships. Therefore, the BLUD mechanism serves as an ideal bridge between operational efficiency and public service delivery. Pires and Martinho (2019) emphasize that quasi-public models, such as BLUDs, offer local governments opportunities to manage resources more efficiently, particularly in waste management scenarios where economic value potential exists.

BLUDs provide UPTDs with the flexibility to collaborate with third parties, including private companies, non-governmental organizations, and local communities, to support operational sustainability and enhance the quality of public services. In RDF production, such collaborations are essential, especially in ensuring the absorption of RDF products by the cement industry, such as PT Indocement. Without BLUD status, traditional UPTDs would face challenges in managing such transactions due to the financial management constraints under the local government budget system (Karimah et al., 2023).

The process of collaboration under the BLUD framework begins with the preparation of legal and administrative documents in accordance with Ministry of Home Affairs Regulation No. 79 of 2018. As a quasi-public entity, BLUDs have the authority to draft and sign partnership agreements focused on improving the efficiency of public services. In the context of RDF management, a collaboration between Cimahi's BLUD UPTD and PT Indocement could include agreements on RDF delivery volumes, agreed-upon selling prices, and logistics mechanisms for transporting RDF from the TPST to the industrial site. Pires and Martinho (2019) highlight that such partnerships strengthen public-private sector integration, creating synergistic economic and environmental benefits.

One of the key advantages of BLUDs in fostering partnerships is their financial management flexibility. As a BLUD, the UPTD can set business service fees, such as RDF pricing, based on operational costs without undergoing complex bureaucratic procedures. Additionally, BLUDs can directly negotiate and make payments to third parties without adhering to the lengthy government procurement process. Islami (2022)

found that this flexibility enables quasi-public entities to adapt more quickly to market demands while maintaining accountability in financial management.

By adopting the Regional Public Service Agency Financial Management Pattern, the Waste Management Service Unit of Cimahi City not only ensures the sustainability of public services but also expands opportunities for partnerships that support circular economy principles. With BLUD status, the UPTD serves as a bridge between local governments and the private sector in creating more inclusive and sustainable waste management solutions.

These partnerships also open avenues for accessing new technologies and innovations in waste management. Korhonen et al. (2018) emphasize that cross-sector collaboration is a key element in the successful implementation of a circular economy. By implementing BLUD financial management, the The Waste Management Service Unit of Cimahi City ensures the operational sustainability of waste management while promoting circular economy principles.

CONCLUSION

The application of circular economy principles at the Waste Management Service Unit of Cimahi City through the processing of waste into Refuse-Derived Fuel (RDF) demonstrates a transformational approach to waste management. The shift from the linear *take-make-waste* economy to a circular economy model enables the regeneration of value from waste materials, reduces dependence on fossil fuels, and mitigates environmental impacts. The integration of systematic waste processing stages, supported by modern technology, allows the UPTD to produce RDF as a substitute fuel for the cement industry, generating both economic and environmental benefits.

The financial aspect of RDF production underscores the importance of aligning operational costs with revenue to ensure sustainability. By producing 60 tons of RDF daily from 100 tons of waste, the UPTD can cover its operational costs through the sale of RDF at a minimum price of IDR 233,333 per ton. This pricing model ensures that RDF production does not burden the Regional Budget (*APBD*), in line with public service principles. However, the flexibility required to manage finances and establish partnerships with third parties can only be achieved through the implementation of the PPK BLUD.

The BLUD status enables the UPTD to function as a quasi-public entity, bridging public service principles with efficient financial management. BLUD provides the autonomy needed for the UPTD to engage in strategic collaborations, such as the partnership with PT Indocement for RDF utilization. This model not only supports the operational sustainability of waste management but also positions the UPTD as a pioneer in implementing circular economy practices in the waste management sector. The success of this initiative serves as a replicable model for other regions aiming to adopt sustainable waste management systems.

LIMITATION

This study has several limitations that need to be acknowledged. First, the research focuses solely on the Waste Management Service Unit of Cimahi City, which may limit the generalizability of the findings to other regions with different waste management systems or socio-economic conditions. Variations in infrastructure, local government support, and community participation levels could influence the success of implementing a circular economy model elsewhere. Additionally, the financial analysis in this study is based on estimated operational costs and potential revenue from RDF sales, which may

be affected by external factors such as fluctuations in energy costs and the quality of waste inputs. Despite these limitations, this study is expected to serve as a foundation for further research and the adaptation of circular economy models in waste management, tailored to the specific local conditions of other regions.

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DECLARATION OF CONFLICTING INTERESTS

The authors declare no potential conflict of interest regarding the research, authorship, and publication of this article. The findings and conclusions presented are solely based on data collected and analyzed during the study, without any influence from the organizations involved in the collaboration.

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