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Enhancing Hazardous Waste Management Through the "SIPENGOLAH LIMBAH B3" Innovation:

Implementation Analysis and Impact

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ABSTRACT

Effective management of hazardous and toxic waste (B3) is crucial for environmental sustainability and public health protection. This study examines the implementation of the "SIPENGOLAH LIMBAH B3" innovation by the Environmental and Forestry Service of South Sulawesi Province, Indonesia. Utilizing George C. Edwards III's policy implementation model and Everett M. Rogers' Diffusion of Innovations theory as analytical frameworks, the research evaluates how this technological innovation has enhanced waste management practices, improved service efficiency, increased transparency, and contributed to environmental sustainability. Data were collected through interviews with key stakeholders involved in the program's implementation, including departmental heads and staff members. The findings indicate that the program successfully reduced waste processing times from up to 72 hours to approximately 18 minutes, digitized administrative processes, and minimized errors in waste recording.

KEYWORDS

Innovation Policy, Public Service Delivery, Hazardous Waste Management

INTRODUCTION

Effective management of hazardous and toxic waste (B3) in Indonesia is crucial for environmental protection and public health (Budiman et al., 2023; Lina, 2021). Indonesian legislation and policy innovations aim to improve waste management governance and services, emphasizing transparency and accountability (Saragi, 2024). Inadequate handling of hazardous waste poses significant health and environmental risks (Budiman et al., 2023; Iswanto et al., 2016). These policies demonstrate a commitment to sustainable development and highlight the need for comprehensive waste management strategies engaging all stakeholders (Lina, 2021; Iswanto et al., 2016; Adi et al., 2023).

The SIPENGOLAH LIMBAH B3 program, developed by the UPT PLB3 subdivision of South Sulawesi Provincial Environmental and Forestry Department, represents a significant advancement in toxic waste management. This initiative replaces traditional practices with an integrated, web-based system designed to enhance transparency, efficiency, and accountability in waste handling. By

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digitizing processes, the program reduces reliance on manual systems, leading to increased operational speed and accuracy (Sumiyati et al., 2022; Abubakar et al., 2022). This aligns with a broader trend of incorporating smart technologies into waste management systems, optimizing waste collection and processing while promoting sustainability (Cahyati, 2023; Raju et al., 2024). Furthermore, it support circular economy principles and contribute to achieving Sustainable Development Goals (SDGs) by addressing the challenges posed by hazardous waste (Kedar & Persov, 2024; Wikurendra et al., 2023).

The program is anchored by two digital platforms: SI MOI (incinerator operational monitoring information system) and SI BOI (online work information system at incinerators). These platforms have revolutionized waste management by enabling real-time monitoring and streamlined coordination among stakeholders, including producers, transporters, and regulators. This has significantly improved operational efficiency, reducing processing times from an average of 72 hours to just 18 minutes (Hossain et al., 2024). Moreover, these technologies enhance transparency in resource allocation and waste management, minimizing corruption risks and fostering public trust in government services (Bułkowska et al., 2023; Salleh et al., 2024). By leveraging IoT and AI technologies, the platforms optimize collection schedules and further enhance operational efficiency (Hossain et al., 2024; Ghahramani et al., 2022; Haque et al., 2020). These innovations not only streamline waste disposal but also contribute to a cleaner, more sustainable environment (Cheema et al., 2022; Salleh et al., 2024).

Despite the program's success, challenges remain, particularly regarding sustainability and scalability. Effective implementation is often hindered by communication barriers, resource limitations, and bureaucratic obstacles (Badu-Yeboah et al., 2018; Godfrey et al., 2013). These studies highlight the critical importance of stakeholder engagement and streamlined bureaucratic processes for successful policy implementation. This aligns with George C. Edwards III's implementation model, which emphasizes communication, resource availability, stakeholder disposition, and efficient bureaucratic structures (Edwards III, 1980; Godfrey et al., 2013; Rodić & Wilson, 2017). Addressing these factors is crucial for enhancing practices and outcomes, enabling more effective waste management across different regions.

Edwards' top-down approach emphasizes the critical role of effective communication among stakeholders, adequate resources, individual disposition, and efficient bureaucratic structures for successful policy implementation. In this program, effective communication between government employees, waste producers, and transporters has been instrumental in ensuring smooth operations and regulatory compliance (Oktoyani et al., 2023). Adequate resources, including funding and technical support, are essential for successful implementation, as evidenced by studies highlighting the significance of resource allocation in waste management initiatives (Hardiyanto et al., 2022; Hasibuan, 2023). Furthermore, the willingness of individuals to embrace innovation and new technologies has been crucial for the program's success, underscoring the importance of individual disposition in effective policy execution (Permana & Hardiana, 2024; Uyun et al., 2022).

This study applies Everett M. Rogers' diffusion of innovations theory, which identifies five key characteristics influencing innovation adoption: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 1983). This framework helps evaluate the effectiveness of the program. The program demonstrates a clear relative advantage through reduced processing times and improved transparency. Its compatibility with existing waste management policies and practices has facilitated its adoption, while the user-friendly nature of its digital tools minimizes complexity (Oliveira & Santos, 2019). The program's successful pilot implementation in South Sulawesi demonstrates its trialability, and the observable benefits, such as increased efficiency and reduced corruption, have promoted its continued use and adaptation.

The program aligns closely with SDG number 12, specifically indicator 12.4.2, which emphasizes responsible consumption and production through the environmentally sound management of hazardous waste. This program significantly advances sustainable waste management practices, contributing to environmental protection and public health in developing countries (Jena et al., 2023; Karthikeyan et al., 2018). By ensuring the responsible handling of hazardous waste, the program addresses

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