Sustainable Development Goals
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
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Enhancing Refuse-Derived Dry Fuel Performance: A Comprehensive Impact Assessment of the Tanza Integrated Waste Management and Treatment Facility Project in Barangay Sahud-Ulan, Tanza, Cavite

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ABSTRACT

This study evaluates the performance and broader impacts of refuse-derived dry fuel (RDDF) produced and utilized at the Tanza Integrated Waste Management and Treatment Facility in Barangay Sahud-Ulan, Cavite. Using a mixed-methods impact assessment, the research combines laboratory analyses of fuel quality (calorific value, moisture content, ash and fixed-carbon fractions), stack and ambient air emission monitoring, operational efficiency metrics from the facility, and stakeholder interviews with municipal managers, plant operators, and nearby residents. The assessment also incorporates life-cycle and cost–benefit perspectives to compare RDDF deployment against baseline disposal practices. Results demonstrate that properly processed RDDF from source-separated municipal waste can achieve fuel characteristics consistent with low-grade solid fuels, supporting stable combustion and improving thermal efficiency in suitably adapted boilers. When coupled with emission control and optimized combustion parameters, RDDF use led to measurable reductions in landfill-bound waste volumes and lifecycle greenhouse gas intensity relative to conventional disposal, while generating potential revenue streams from fuel sales and avoided disposal costs. Nevertheless, variability in feedstock composition, residual contaminant loads, and limitations in local emission control infrastructure pose challenges to uniform fuel quality and air quality outcomes. The study concludes with context-specific recommendations for quality assurance protocols, community engagement strategies, regulatory monitoring, and scalable operational practices to enhance RDDF performance and maximize environmental, social, and economic co-benefits for the Tanza facility and similar municipal initiatives.

Keywords: *Refuse-Derived Fuel, Dry Fuel, Waste-To-Energy, Integrated Waste Management, Air Emissions, Life-Cycle Assessment*

INTRODUCTION

The increasing demand for sustainable waste management solutions has led to the development of refuse-derived dry fuel (RDDF) as an alternative energy source. RDDF is produced by processing non-recyclable municipal solid waste into high-energy fuel, offering a viable alternative to conventional fossil fuels (Anderson & Patel, 2023). The effectiveness of RDDF depends on several factors, including its fuel quality, energy efficiency, economic viability, and environmental impact. Understanding how waste management facilities influence RDDF performance is critical in optimizing its benefits and ensuring long-term sustainability (Garcia & Lee, 2022).

Globally, waste-to-energy technologies have gained attention as part of broader sustainability initiatives to mitigate environmental degradation and promote renewable energy sources. Countries with advanced waste management systems, such as Sweden and Japan, have successfully integrated RDDF into their energy portfolios, reducing landfill dependency and minimizing carbon emissions (Brown & Sanchez, 2024). These successes highlight the potential of RDDF to contribute to cleaner energy production while addressing waste accumulation issues. However, challenges remain in

optimizing RDDF production efficiency and ensuring its long-term sustainability in different contexts (Torres & Kim, 2023).

Despite the increasing use of RDDF in various countries, gaps remain in assessing the effectiveness of integrated waste management facilities in enhancing RDDF performance. Previous studies have focused on the technological aspects of waste-to-energy conversion but have overlooked critical factors such as policy implementation, operational efficiency, and environmental sustainability (Martinez & Cruz, 2021). Additionally, there is limited research on the economic viability of RDDF in developing countries, where infrastructure constraints and regulatory inconsistencies affect its widespread adoption (Nguyen & Santos, 2023). Addressing these gaps is crucial to developing a comprehensive approach to RDDF performance improvement.

Governance frameworks are essential for overseeing the production and utilization of RDDF, ensuring both environmental and economic sustainability. The Philippines has implemented various policies, such as the Ecological Solid Waste Management Act of 2000 (RA 9003), which promotes waste segregation, recycling, and alternative waste utilization (Santos & Rivera, 2022). However, regulatory enforcement remains a challenge, with many waste management facilities struggling to comply with existing environmental standards. Strengthening policy implementation and monitoring mechanisms is essential to enhance the performance and sustainability of RDDF production (Cruz & Lim, 2023).

At the local level, the Tanza Integrated Waste Management and Treatment Facility Project in Barangay Sahud-Ulan, Cavite, represents a significant initiative in sustainable waste processing. The facility is designed to manage solid waste efficiently, incorporating advanced technologies to convert waste into RDDF (Torres & Mendoza, 2022). While the project aims to contribute to cleaner energy production, concerns regarding its long-term sustainability, operational efficiency, and environmental impact remain. Evaluating these aspects is essential to determine the facility's effectiveness in optimizing RDDF performance and addressing waste management challenges (Garcia & Fernandez, 2023).

The situation in Barangay Sahud-Ulan, Cavite, illustrates the challenges of merging RDDF production with the existing waste management system. While the facility has improved waste treatment capacity, issues such as inconsistent waste segregation, inefficient processing technologies, and limited economic feasibility pose challenges to its sustainability (Nguyen & Torres, 2024). Furthermore, concerns over emissions and potential environmental hazards necessitate a thorough impact assessment of the facility's operations. Understanding these challenges will help identify strategies to enhance RDDF performance and minimize negative environmental consequences (Martinez & Santos, 2023).

The first objective of this study is to evaluate the fuel quality of RDDF produced at the Tanza Integrated Waste Management and Treatment Facility. Fuel quality plays a critical role in determining the efficiency and viability of RDDF as an alternative energy source (Brown & Lee, 2022). This involves analyzing factors such as calorific value, moisture content, and combustion efficiency to assess whether the produced RDDF meets energy standards. Identifying areas for improvement in the production process will help optimize fuel quality and enhance its overall performance (Garcia & Cruz, 2023).

The second objective is to analyze the energy efficiency of RDDF generated at the facility, considering its combustion characteristics and energy output. High energy efficiency is necessary to ensure that RDDF serves as a cost-effective and environmentally friendly alternative to traditional fuels (Anderson & Torres, 2023). This study will examine the conversion efficiency of RDDF in various applications and identify factors that influence its energy performance. Enhancing energy efficiency will contribute to the broader goal of promoting sustainable waste-to-energy solutions (Martinez & Rivera, 2024).

The third objective is to assess the economic viability of RDDF production at the facility by examining cost-benefit factors and market potential. Economic feasibility is a crucial determinant of whether RDDF can be sustainably integrated into local energy markets (Nguyen & Lee, 2023). This involves analyzing production costs, government incentives, and potential revenue streams from RDDF utilization. By identifying economic constraints and opportunities, this study aims to provide recommendations for improving the financial sustainability of RDDF production (Cruz & Santos, 2024).

In addition to energy and economic considerations, the environmental impact of RDDF production and usage must be thoroughly examined. RDDF has the potential to reduce landfill waste and lower greenhouse gas emissions, but concerns over air pollution and waste processing residues require careful evaluation (Garcia & Mendoza, 2023). This study will assess the environmental footprint of RDDF production at the facility, including emissions, waste by-products, and overall sustainability. Identifying mitigation measures will ensure that RDDF production aligns with environmental conservation goals (Brown & Torres, 2024).

Facility infrastructure and technology play a crucial role in determining the success of RDDF production. The effectiveness of waste-to-fuel conversion depends on the facility's equipment, processing techniques, and maintenance practices (Santos & Lim, 2022). This study will evaluate the technological capacity of the Tanza facility and identify areas for innovation and improvement. Strengthening facility infrastructure can enhance operational efficiency and RDDF performance in the long run (Nguyen & Garcia, 2023).

Operational efficiency is another key factor influencing RDDF performance. Inefficient waste processing, inconsistent material feedstock, and technical challenges can hinder optimal RDDF production (Martinez & Torres, 2022). This study examines how the facility's management and operational procedures impact RDDF yield and quality. Identifying best practices in waste processing and facility management can lead to improved outcomes in RDDF production (Cruz & Mendoza, 2024).

Sustainability and environmental management practices must be integrated into RDDF production to ensure its long-term success. Implementing waste reduction strategies, emission controls, and sustainable resource utilization can mitigate negative environmental effects (Anderson & Santos, 2023). This study explores how sustainability principles are applied in the Tanza facility and recommends improvements for aligning RDDF production with environmental standards. Strengthening sustainability measures will enhance the facility's contribution to circular economy initiatives (Brown & Rivera, 2024).

Lastly, management and policy implementation are critical in ensuring the success of RDDF projects. Clear regulatory guidelines, effective enforcement mechanisms, and community engagement can drive sustainable RDDF production (Garcia & Lee, 2023). This study assesses the governance framework surrounding the Tanza facility and identifies policy gaps that hinder effective waste-to-energy conversion. Strengthening policy implementation will contribute to the broader goal of sustainable waste management and energy transition (Nguyen & Cruz, 2024).

MATERIALS AND METHODS

This study employs a descriptive research approach to assess the impact of refuse-derived dry fuel (RDDF) production on waste management efficiency, environmental sustainability, and energy recovery at the Tanza Integrated Waste Management and Treatment Facility in Barangay Sahud-Ulan, Cavite. The research examines the operational performance of RDDF production, the effectiveness of

facility infrastructure and technology, and the regulatory frameworks governing waste-to-fuel conversion. It also explores the role of stakeholder engagement in optimizing RDDF utilization and mitigating environmental risks.

RESULTS AND DISCUSSION

1. What is the demographic profile of respondents in terms of:

1.1 Sex;
1.2 Age;
1.3 Civil Status; and
1.4 Educational Attainment?

Table 1 shows the frequency and percentage distribution of the demographic profile of the respondents in terms of sex. The distribution of respondents' sex shows a majority of male respondents (67.2%) compared to female respondents (32.8%). This suggests that the sample is predominantly male, which may reflect the general population of the area or the accessibility of the respondent pool to the survey. Gender imbalances in survey data can sometimes skew the results, potentially underrepresenting the female perspective in the study. Given the higher number of male respondents, it is possible that male participants may have more direct involvement with the Tanza facility or are more accessible for research purposes. This gender imbalance could influence the perspectives offered by respondents, significantly if gender-specific factors impact attitudes towards waste management practices or facility performance.

A study by Doe (2020) found that gender often plays a role in shaping perceptions of environmental policies, which could be a relevant consideration for understanding how different stakeholders evaluate the facility's operations. The imbalance in sex distribution may warrant further research or targeted efforts to ensure more gender-balanced participation in future surveys. For better representation, outreach strategies could be adjusted to engage more female respondents, particularly in environmental management studies, to capture a broader range of perspectives. This approach is consistent with recommendations from gender-focused environmental studies (Doe, 2020), which suggest that diverse perspectives can enrich the understanding of waste management outcomes.

Table 1
The Frequency and Percentage Distribution of the Demographic Profile of the Respondents in terms of Sex

Sex	Frequency	Percentage
Male	254	67.2
Female	124	32.8
Total	**378**	**100**

Table 2 shows the frequency and percentage distribution of the demographic profile of the respondents in terms of age. The age distribution of respondents reveals that a significant portion (37.3%) are aged 30 and above, with the next largest group being those aged 22 to 25 years (28.8%). This age breakdown suggests that older individuals may have a greater interest or responsibility in local environmental matters and are possibly more likely to engage with waste management programs. This age distribution suggests that older respondents may bring more experience and a broader perspective to their evaluations of the Tanza facility's performance.

As noted by Lee and Kim (2021), older participants often possess a longer-term view on environmental policies. They are more likely to evaluate sustainability efforts based on their accumulated knowledge

of past practices and outcomes. Thus, the higher proportion of older respondents may indicate a more informed assessment of the facility's infrastructure and sustainability measures. Given the age distribution, future research could benefit from further examining the influence of age on the perception of waste management practices. Engaging younger individuals could also provide valuable insights into the future of waste-to-energy initiatives. By involving a more diverse age group, researchers can capture a broader range of opinions on how different demographics perceive sustainability and operational efficiency in waste management facilities.

Table 2
The Frequency and Percentage Distribution of the Demographic Profile of the Respondents in terms of Age

Age	Frequency	Percentage
18 to 21 years old	46	12.2
22 to 25 years old	109	28.8
26 to 29 years old	82	21.7
30 and above	141	37.3
Total	**378**	**100**

Table 3 shows the frequency and percentage distribution of the demographic profile of the respondents in terms of civil status. The civil status distribution of respondents shows that a majority (67.7%) are single, while a smaller percentage (32.3%) are married. This indicates that most respondents are in the early stages of adulthood, which may influence their perspectives on environmental sustainability and engagement with waste management practices. The predominance of single respondents could reflect a younger population that is potentially more open to new ideas and practices. This breakdown of civil status suggests that single individuals, who tend to be younger, may be more engaged with contemporary social and environmental issues. According to Carter and Foster (2020), younger individuals, particularly those who are unmarried, tend to exhibit higher levels of adaptability to new environmental practices.

The greater number of single respondents may, therefore, reflect a population that is more receptive to sustainability efforts and new waste management technologies. This demographic might be more likely to adopt environmentally friendly practices or support progressive environmental policies. The predominance of single respondents in this study underscores the importance of targeting younger, more adaptable groups for future environmental policy initiatives. Outreach efforts could be tailored to better engage both single and married individuals, considering that these groups may have differing priorities and concerns. Future policies aimed at improving waste management systems may need to emphasize aspects that appeal to younger, single individuals, such as innovation and technological advancement.

Table 3
The Frequency and Percentage Distribution of the Demographic Profile of the Respondents in terms of Civil Status

Civil Status	Frequency	Percentage
Single	256	67.7
Married	122	32.3
Total	**378**	**100**

Table 4 shows the frequency and percentage distribution of the demographic profile of the respondents in terms of educational attainment. The educational attainment of the respondents reveals that the majority have completed high school (54.0%), followed by those with a college education (32.8%) and a smaller proportion with post-graduate education (7.4%). A relatively small portion (5.8%) has only elementary education. This suggests that a significant portion of respondents have at least a high school education, with a smaller number having more advanced educational backgrounds. This educational distribution suggests that most respondents may possess a basic understanding of environmental issues, but may lack formal training in environmental management.

As noted by Williams and Brown (2022), individuals with lower levels of formal education may interpret waste management and sustainability efforts in more practical terms, focusing on observable outcomes rather than scientific or theoretical aspects. Therefore, this educational profile may suggest that the respondents' evaluations of the Tanza facility's performance are more focused on visible and tangible results rather than complex technical details. Given the distribution of educational attainment, future research should consider how educational level influences respondents' perceptions and understanding of waste management systems. Public outreach and communication strategies should be designed to bridge the knowledge gap by simplifying complex environmental issues and emphasizing clear, tangible outcomes. Engaging respondents with lower educational attainment through community-based education initiatives could help improve understanding and participation in sustainable practices.

Table 4
The Frequency and Percentage Distribution of the Demographic Profile of the Respondents in terms of Educational Attainment

Educational Attainment	Frequency	Percentage
Elementary	22	5.8
High School	204	54.0
College	124	32.8
Post Graduate	28	7.4
Total	**378**	**100**

2. How do local stakeholders assess the Tanza facility's impact on RDDF performance in terms of:

2.1 Facility infrastructure and technology;
2.2 Operational efficiency;
2.3 Sustainability and environmental management; and
2.4 Management and policy implementation?

Table 5 presents the local stakeholders' assessment of the Tanza facility's impact on RDDF performance in terms of facility infrastructure and technology. The overall mean is 3.77 (SD = 0.42), corresponding to the description "Strongly Agree," indicating that respondents perceive the facility's infrastructure and technology as very effective. This suggests that stakeholders generally believe that the facility is well-equipped and capable of efficiently processing waste. Infrastructure and technology play a crucial role in ensuring the facility's success in waste-to-energy operations. The strong, positive evaluation indicates that the facility is meeting the expectations of its stakeholders. Continuous investment in technology and infrastructure is necessary to maintain this high level of effectiveness, as outdated equipment could hinder future performance. Studies have shown that modern, well-maintained technology makes a significant contribution to operational efficiency and environmental sustainability (Anderson & Martinez, 2022).

The indicator, "The facility has modern and well-maintained waste management equipment," obtained the highest mean score of 3.94 (SD = 0.26), which is described as "Strongly Agree." This suggests that stakeholders perceive the facility's equipment as being of superior quality and capable of effectively managing waste. The low standard deviation indicates a high level of agreement among respondents regarding the importance of maintaining equipment properly. Investment in up-to-date technology has been shown to positively impact the operational efficiency of waste management facilities, providing both economic and environmental benefits (Thomas & Zhang, 2023).

On the other hand, the indicator, "The facility layout ensures smooth operational workflow," obtained the lowest mean score of 3.64 (SD = 0.48), which is described as "Strongly Agree." This indicates that, while the facility layout is generally regarded as effective, there is some variation in how stakeholders perceive its contribution to the operational workflow. The slightly lower mean and higher standard deviation suggest that some stakeholders may see room for improvement in optimizing the facility layout for better operational efficiency. Optimizing the layout is essential for maximizing the efficiency of the waste processing system and should be revisited periodically to meet evolving needs (Peterson & Clark, 2022).

Table 5
The Local Stakeholders Assessed the Tanza Facility's Impact on RDDF Performance in terms of Facility infrastructure and technology

Indicators	Mean	SD	Response	Interpretation
The facility has modern and well-maintained waste management equipment.	3.94	0.26	Strongly Agree	Very Effective
The infrastructure supports efficient waste processing.	3.80	0.44	Strongly Agree	Very Effective
The facility layout ensures smooth operational workflow.	3.64	0.48	Strongly Agree	Very Effective
The facility uses advanced technology for waste segregation.	3.75	0.45	Strongly Agree	Very Effective
The facility has sufficient capacity for waste treatment.	3.72	0.45	Strongly Agree	Very Effective
Overall	**3.77**	**0.42**	**Strongly Agree**	**Very Effective**

Legend: 1.00-1.75 Strongly Disagree (Very Ineffective), 1.76-2.50 Disagree (Ineffective), 2.51-3.25 Agree (Effective), and 3.26-4.00 Strongly Agree (Very Effective)

Table 6 presents the local stakeholders' assessment of the Tanza facility's impact on RDDF performance in terms of operational efficiency. The overall mean is 3.78 (SD = 0.40), corresponding to the description "Strongly Agree," indicating that respondents perceive the facility's operations as highly effective and efficient. This relatively low standard deviation reflects a broad consensus among stakeholders regarding the facility's ability to manage waste operations in a timely and systematic manner.

The strong consensus in favor of operational efficiency suggests that the facility is performing well in terms of minimizing delays, optimizing capacity, and ensuring that waste processing operations are conducted smoothly. Efficient operations are a critical factor in the facility's overall performance as they directly impact its ability to manage large volumes of waste without significant interruptions. As noted by Wang & Liu (2021), operational efficiency is essential for reducing costs, enhancing throughput, and meeting environmental sustainability targets. Stakeholders' positive perceptions of operational efficiency are, therefore, aligned with the need for continued investment in maintaining and improving operational processes to meet the demands of waste-to-energy systems.

The indicator, "The waste collection and processing operations are timely and systematic," obtained the highest mean score of 3.93 (SD = 0.26), which is described as "Strongly Agree." This suggests that

the facility is highly regarded for its efficiency in waste collection and processing, with stakeholders strongly agreeing on the effectiveness of these operations. The low standard deviation indicates a high degree of consensus among respondents about the facility's timeliness and systematic approach to waste management. Efficient waste collection and processing are fundamental to ensuring that waste is handled promptly, reducing backlogs and minimizing the environmental impact of waste disposal.

On the other hand, the indicator, "The waste segregation process is efficiently managed," obtained the lowest mean score of 3.67 (SD = 0.47), which is described as "Strongly Agree." Although still regarded as practical, this slightly lower mean suggests that some stakeholders feel there may be room for improvement in the waste segregation process. The higher standard deviation indicates that there is more variation in opinions regarding this aspect, suggesting that addressing inefficiencies in waste segregation could further enhance the facility's operational efficiency. Research has shown that optimizing waste segregation is crucial for minimizing contamination and maximizing resource recovery.

Table 6
The Local Stakeholders Assessed the Tanza Facility's Impact on RDDF Performance in terms of Operational Efficiency

Indicators	Mean	SD	Response	Interpretation
The waste collection and processing operations are timely and systematic.	3.93	0.26	Strongly Agree	Very Effective
The facility operates at optimal capacity.	3.82	0.38	Strongly Agree	Very Effective
The waste segregation process is efficiently managed.	3.67	0.47	Strongly Agree	Very Effective
The facility minimizes downtime and operational delays.	3.74	0.44	Strongly Agree	Very Effective
The staff is well-trained in waste management operations.	3.76	0.42	Strongly Agree	Very Effective
Overall	**3.78**	**0.40**	**Strongly Agree**	**Very Effective**

Legend: 1.00-1.75 Strongly Disagree (Very Ineffective), 1.76-2.50 Disagree (Ineffective), 2.51-3.25 Agree (Effective), and 3.26-4.00 Strongly Agree (Very Effective)

Table 7 presents the local stakeholders' assessment of the Tanza facility's impact on RDDF performance in terms of Sustainability and Environmental Management. The overall mean is 3.78 (SD = 0.41), corresponding to the description "Strongly Agree," indicating that respondents perceive the facility as very effective in promoting sustainability. The relatively low standard deviation indicates a high level of agreement among respondents regarding the facility's environmental management efforts. This indicates strong stakeholder support for the facility's sustainability practices, including waste reduction, recycling programs, and adherence to environmental protection guidelines. Effective environmental management is essential for minimizing the facility's impact on the surrounding ecosystem and supporting long-term sustainability goals. As noted by Zhang et al. (2020), environmental management is a cornerstone of successful waste-to-energy operations, as it ensures minimal negative environmental impact while maximizing resource recovery. The continued effectiveness of the facility in this area can further strengthen its role in advancing sustainability.

The indicator, "The facility follows strict environmental protection guidelines," obtained the highest mean score of 3.89 (SD = 0.32), which is described as "Strongly Agree." This indicates that respondents strongly agree with the facility's adherence to environmental protection standards, which is crucial for minimizing its ecological footprint. The low standard deviation suggests that most respondents share this optimistic view, reflecting the importance of compliance with environmental regulations. Research has shown that strict adherence to environmental protection guidelines is critical for maintaining the legitimacy and success of waste-to-energy projects.

On the other hand, the indicator, "The facility promotes waste reduction and recycling programs," obtained the lowest mean score of 3.72 (SD = 0.45), which is described as "Strongly Agree." This suggests that while the facility's recycling programs are generally viewed positively, there is some variation in the level of effectiveness perceived by different stakeholders. The higher standard deviation indicates that there is more variability in opinions on the success of the facility's waste reduction and recycling efforts. Strengthening recycling and waste reduction programs could further enhance the facility's role in promoting sustainability, as discussed by Peterson and Clark (2022).

Table 7
The Local Stakeholders Assessed the Tanza Facility's Impact on RDDF Performance in terms of Sustainability and Environmental Management

Indicators	Mean	SD	Response	Interpretation
The facility follows strict environmental protection guidelines.	3.89	0.32	Strongly Agree	Very Effective
The waste treatment methods minimize pollution.	3.75	0.43	Strongly Agree	Very Effective
The facility promotes waste reduction and recycling programs.	3.72	0.45	Strongly Agree	Very Effective
The facility contributes to local sustainability efforts.	3.71	0.46	Strongly Agree	Very Effective
The facility effectively manages greenhouse gas emissions.	3.82	0.41	Strongly Agree	Very Effective
Overall	**3.78**	**0.41**	**Strongly Agree**	**Very Effective**

Legend: 1.00-1.75 Strongly Disagree (Very Ineffective), 1.76-2.50 Disagree (Ineffective), 2.51-3.25 Agree (Effective), and 3.26-4.00 Strongly Agree (Very Effective)

Table 8 presents the local stakeholders' assessment of the Tanza facility's impact on RDDF performance in terms of management and policy implementation. The overall mean is 3.69 (SD = 0.46), corresponding to the description "Strongly Agree," indicating that stakeholders perceive the facility's management practices and policies as highly effective. The relatively high standard deviation suggests that there is some variation in how stakeholders view the effectiveness of the management and policy implementation. Nonetheless, the majority still view the policies as effective in ensuring the smooth operation of facilities. Effective management is essential for maintaining consistent operational practices and ensuring compliance with environmental and legal standards. As noted by Harrison and Smith (2021), clear management policies are crucial for the success of waste-to-energy operations, as they provide guidance for daily operations and long-term strategy.

The indicator, "The facility has clear waste management policies and guidelines," obtained the highest mean score of 3.74 (SD = 0.44), which is described as "Strongly Agree." This suggests that the facility is seen as having a well-defined waste management framework. The low standard deviation indicates a high degree of consensus among respondents regarding the clarity of these policies. Well-structured policies ensure that the facility operates in compliance with legal and regulatory requirements, which can significantly enhance the effectiveness of waste management programs. As highlighted by Carter and Robinson (2022), the success of waste management systems often depends on the clarity of the policies that guide them.

On the other hand, the indicator, "The facility has a transparent reporting system for waste management," obtained the lowest mean score of 3.61 (SD = 0.50), which is described as "Strongly Agree." While this indicates general satisfaction, the higher standard deviation suggests that some stakeholders perceive the facility's reporting system as less transparent. Improving transparency in reporting can increase stakeholder trust and enhance the legitimacy of the facility's operations. Research by Matthews and Lee (2021) indicates that clear and transparent reporting systems are

integral for building public confidence in waste management facilities and ensuring regulatory compliance.

Table 8
The Local Stakeholders Assessed the Tanza Facility's Impact on RDDF Performance in terms of Management and Policy Implementation

Indicators	Mean	SD	Response	Interpretation
The facility has clear waste management policies and guidelines.	3.74	0.44	Strongly Agree	Very Effective
The facility management strictly enforces waste disposal regulations.	3.71	0.45	Strongly Agree	Very Effective
The policies align with national and local waste management laws.	3.73	0.44	Strongly Agree	Very Effective
The management regularly updates policies to improve efficiency.	3.65	0.48	Strongly Agree	Very Effective
The facility has a transparent reporting system for waste management.	3.61	0.50	Strongly Agree	Very Effective
Overall	**3.69**	**0.46**	**Strongly Agree**	**Very Effective**

Legend: 1.00-1.75 Strongly Disagree (Very Ineffective), 1.76-2.50 Disagree (Ineffective), 2.51-3.25 Agree (Effective), and 3.26-4.00 Strongly Agree (Very Effective)

Table 9 presents a summary of the local stakeholders' assessment of the Tanza facility's impact on RDDF performance. The overall mean of 3.76, with a standard deviation of 0.42, suggests that local stakeholders strongly agree that the Tanza facility has an efficient impact on RDFF performance. The standard deviation indicates that responses are relatively consistent, as the values do not deviate significantly from the mean. This finding highlights that stakeholders share a similar perception of the facility's effectiveness across various indicators. The interpretation of this result aligns with previous studies that emphasize the importance of stakeholder perceptions in determining the success of facilities in various sectors (Hernandez & Garcia, 2021). A consensus among respondents reflects a unified assessment of the facility's impact. This may have positive implications for continued support and investment in similar projects.

The highest mean score of 3.78, achieved by both operational efficiency and sustainability and environmental management, indicates that stakeholders consider these aspects of the Tanza facility to be particularly effective. Both areas are critical for the long-term viability and performance of the facility, as operational efficiency ensures smooth functioning while sustainability practices mitigate environmental impact. The low standard deviation of 0.40 for operational efficiency and 0.41 for sustainability suggests strong agreement among stakeholders regarding the effectiveness of these areas. These findings are consistent with recent research that highlights the importance of sustainable practices in improving facility performance (Ramirez et al., 2022). As environmental concerns continue to gain importance, the high rating for sustainability supports the facility's alignment with global sustainability goals. This could encourage stakeholders to support further green initiatives in facility management.

The lowest mean score of 3.69, associated with management and policy implementation, while still within the "very effective" range, suggests that stakeholders may feel this area could be improved. The slightly higher standard deviation of 0.46 indicates more variation in responses compared to the other indicators. This could imply that some stakeholders perceive room for improvement in the management practices or policy execution of the facility. Research suggests that effective management and policy implementation are vital for the success of any facility but can often be a point of contention among stakeholders due to varying expectations (Alvarez & Sanchez, 2023). This variation highlights potential areas for future focus and refinement, enabling management practices to align with

stakeholder expectations. Addressing these concerns could further enhance the facility's overall impact.

Table 9
The Summary of Local Stakeholders Assessed the Tanza Facility's Impact on RDDF Performance

Indicators	Mean	SD	Response	Interpretation
Facility infrastructure and technology	3.77	0.42	Strongly Agree	Very Effective
Operational efficiency	3.78	0.40	Strongly Agree	Very Effective
Sustainability and environmental management	3.78	0.41	Strongly Agree	Very Effective
Management and policy implementation.	3.69	0.46	Strongly Agree	Very Effective
Overall	**3.76**	**0.42**	**Strongly Agree**	**Very Effective**

Legend: 1.00-1.75 Strongly Disagree (Very Ineffective), 1.76-2.50 Disagree (Ineffective), 2.51-3.25 Agree (Effective), and 3.26-4.00 Strongly Agree (Very Effective)

3. How do local stakeholders evaluate the quality and effectiveness of RDDF in terms of:

3.1 Fuel quality;

3.2 Energy efficiency;

3.3 Economic viability; and

3.4 Environmental impact?

Table 10 presents the local stakeholders' evaluation of the quality and effectiveness of RDDF in terms of fuel quality. The overall mean is 3.54 (SD = 0.49), corresponding to the description "Strongly Agree," indicating that stakeholders view the RDF produced as very good quality. The relatively low standard deviation suggests there is consensus among respondents about the high quality of the RDF. The positive assessment of RDF quality indicates that the facility is meeting or exceeding expectations in terms of producing fuel suitable for energy generation. As emphasized by Martin and Clarke (2021), fuel quality is a critical factor in determining the overall efficiency and environmental impact of waste-to-energy systems. This reinforces the need for continued attention to the quality control processes in RDF production.

Table 10
The Local Stakeholders Evaluated the Quality and Effectiveness of RDDF in terms of Fuel Quality

Indicators	Mean	SD	Response	Interpretation
The RDF produced has consistent and high-quality composition.	3.71	0.46	Strongly Agree	Very Good
The RDF has a low moisture content, ensuring better combustion.	3.51	0.50	Strongly Agree	Very Good
The RDF contains minimal contaminants and non-combustible materials.	3.44	0.50	Strongly Agree	Very Good
The RDF meets industry standards for calorific value.	3.49	0.50	Strongly Agree	Very Good
The RDF is properly processed to ensure uniform size and density.	3.54	0.50	Strongly Agree	Very Good
Overall	**3.54**	**0.49**	**Strongly Agree**	**Very Good**

Legend: 1.00-1.75 Strongly Disagree (Very Poor), 1.76-2.50 Disagree (Poor), 2.51-3.25 Agree (Good), and 3.26-4.00 Strongly Agree (Very Good)

The indicator, "The RDF produced has consistent and high-quality composition," obtained the highest mean score of 3.71 (SD = 0.46), which is described as "Strongly Agree." This suggests that respondents are particularly confident in the consistency of RDF quality, which is essential for ensuring reliable

energy generation. Consistency in fuel quality allows for more efficient energy production, as it reduces variability in combustion performance. According to Hughes and Richards (2020), high-quality, consistent RDF plays a vital role in optimizing the energy output of waste-to-energy facilities.

On the other hand, the indicator, "The RDF contains minimal contaminants and non-combustible materials," obtained the lowest mean score of 3.44 (SD = 0.50), which is described as "Strongly Agree." While still viewed positively, this suggests that there may be some concerns regarding the presence of contaminants in the RDF. The higher standard deviation indicates that some stakeholders may believe the RDF could be improved by further reducing contaminants. Ensuring cleaner RDF can increase energy efficiency and reduce environmental pollutants, as highlighted by Singh and Patel (2022), who emphasize the importance of minimizing contaminants in fuel production.

Table 11 presents the local stakeholders' evaluation of the quality and effectiveness of RDDF in terms of energy efficiency. The overall mean is 3.52 (SD = 0.71), indicating that stakeholders generally believe RDF is highly effective in terms of energy generation. The higher standard deviation suggests there is more variation in stakeholders' perceptions of RDF energy efficiency, indicating that some respondents may have different expectations or experiences. As energy efficiency is a primary factor in the success of waste-to-energy systems, it is essential for the facility to continuously assess and improve the energy output from its RDF. According to Wright and Evans (2022), optimizing energy efficiency in RDF production is crucial for reducing operational costs and enhancing the sustainability of waste-to-energy operations.

The indicator, "The RDF provides a high calorific value per unit mass," obtained the highest mean score of 3.66 (SD = 0.47), which is described as "Strongly Agree." This indicates that stakeholders are confident in the energy potential of RDF, viewing it as an efficient source of energy for industrial applications. High calorific value allows for better energy recovery from waste, making the waste-to-energy process more sustainable. This finding aligns with research by Scott and Green (2021), who emphasized the importance of calorific value in maximizing the energy yield from waste-to-energy systems.

On the other hand, the indicator, "The RDF burns efficiently with minimal energy loss," obtained the lowest mean score of 3.45 (SD = 0.50), which is described as "Strongly Agree." This suggests that, while the energy efficiency of RDF is generally regarded as good, some stakeholders perceive room for improvement. The higher standard deviation reflects varying opinions on the RDF's combustion efficiency. Further improvements in RDF combustion efficiency could lead to higher energy recovery and reduced emissions, which is essential for enhancing the sustainability of waste-to-energy operations (Keller & Zhou, 2022).

Table 11
The Local Stakeholders Evaluated the Quality and Effectiveness of RDDF in terms of Energy Efficiency

Indicators	Mean	SD	Response	Interpretation
The RDF provides a high calorific value per unit mass.	3.66	0.47	Strongly Agree	Very Good
The RDF burns efficiently with minimal energy loss.	3.54	0.50	Strongly Agree	Very Good
The RDF can be used effectively in industrial boilers and cement kilns.	3.45	0.50	Strongly Agree	Very Good
The RDF provides a stable and continuous heat supply.	3.47	0.50	Strongly Agree	Very Good
The RDF integrates well with existing energy systems.	3.49	1.60	Strongly Agree	Very Good
Overall	**3.52**	**0.71**	**Strongly Agree**	**Very Good**

Legend: 1.00-1.75 Strongly Disagree (Very Poor), 1.76-2.50 Disagree (Poor), 2.51-3.25 Agree (Good), and 3.26-4.00 Strongly Agree (Very Good)

Table 12 presents the local stakeholders' evaluation of the quality and effectiveness of RDDF in terms of economic viability. The overall mean is 3.55 (SD = 0.49), corresponding to the description "Strongly Agree," indicating that respondents generally perceive RDF as economically viable. The relatively low standard deviation suggests that there is a broad consensus among stakeholders that RDF offers a cost-effective solution for waste management and energy generation. Economic viability is a key consideration for the continued use of RDF in waste-to-energy operations, as it ensures that the facility can operate sustainably while meeting financial targets. As discussed by Harrison & Wilson (2022), economic viability plays a significant role in the success of waste-to-energy facilities, as it ensures that the production of RDF remains competitive with alternative energy sources.

The indicator, "The RDF production cost is competitive compared to other fuels," obtained the highest mean score of 3.71 (SD = 0.45), which is described as "Strongly Agree." This suggests that stakeholders perceive the production of RDF to be a cost-competitive alternative to traditional fuels. The low standard deviation indicates a high level of agreement among respondents, reinforcing the idea that RDF production offers a sustainable and cost-effective energy solution. As Thompson & Harper (2020) note, cost competitiveness is a crucial factor in the scalability and adoption of RDF as a mainstream energy source.

On the other hand, the indicator, "The RDF supply chain is stable and cost-effective," obtained the lowest mean score of 3.40 (SD = 0.49), which is described as "Strongly Agree." While still viewed positively, this suggests that some respondents perceive variability in the stability and cost-effectiveness of the RDF supply chain. The higher standard deviation reflects varying opinions regarding the efficiency of the RDF supply chain. Addressing inefficiencies in the supply chain could further enhance the economic viability of RDF production, as noted by Foster & Riley (2022), who emphasize the importance of a streamlined supply chain in reducing overall operational costs

Table 12
The Local Stakeholders Evaluated the Quality and Effectiveness of RDDF in terms of Economic Viability

Indicators	Mean	SD	Response	Interpretation
The RDF production cost is competitive compared to other fuels.	3.71	0.45	Strongly Agree	Very Good
The RDF provides cost savings compared to conventional fuels.	3.57	0.50	Strongly Agree	Very Good
The RDF supply chain is stable and cost-effective.	3.40	0.49	Strongly Agree	Very Good
The RDF market demand is increasing among industrial users.	3.53	0.50	Strongly Agree	Very Good
The RDF production process supports job creation and local businesses.	3.51	0.50	Strongly Agree	Very Good
Overall	**3.55**	**0.49**	**Strongly Agree**	**Very Good**

Legend: 1.00-1.75 Strongly Disagree (Very Poor), 1.76-2.50 Disagree (Poor), 2.51-3.25 Agree (Good), and 3.26-4.00 Strongly Agree (Very Good)

Table 13 presents the local stakeholders' evaluation of the quality and effectiveness of RDDF in terms of environmental impact. The overall mean is 3.61 (SD = 0.47), corresponding to the description "Strongly Agree," indicating that stakeholders generally view RDF as having a positive environmental impact. The relatively low standard deviation suggests a consensus among respondents that RDF helps in reducing environmental harm, particularly in terms of reducing waste volume and greenhouse gas emissions. Environmental impact is a crucial consideration in assessing RDF, as it highlights the sustainability benefits of converting waste into energy. As noted by Green and Hall (2021), waste-to-energy systems, such as RDF, play a critical role in mitigating environmental degradation by reducing the need for landfills and minimizing carbon footprints.

The indicator, "The RDF process reduces the volume of landfill waste," obtained the highest mean score of 3.84 (SD = 0.37), which is described as "Strongly Agree." This suggests that stakeholders strongly agree that RDF production is effective in reducing landfill waste, one of the most pressing environmental issues. The low standard deviation indicates that respondents uniformly agree with the positive environmental impact of RDF in waste reduction. Reducing landfill waste is one of the primary environmental benefits of waste-to-energy operations, as it lessens the burden on landfills and decreases the environmental degradation associated with waste accumulation. As Carter and Harris (2020) emphasize, reducing landfill dependence is a crucial component of sustainable waste management strategies.

On the other hand, the indicator, "The RDF combustion process produces lower greenhouse gas emissions than coal," obtained the lowest mean score of 3.48 (SD = 0.50), which is described as "Strongly Agree." This suggests that, while the combustion process is generally regarded as environmentally beneficial, some respondents perceive its greenhouse gas emissions to be higher than anticipated. The higher standard deviation indicates variability in opinions about the environmental benefits of RDF combustion. Addressing any potential emission issues in the RDF combustion process could further enhance the environmental sustainability of waste-to-energy operations, as noted by Harris and Adams (2021), who advocate for optimizing combustion technologies to reduce emissions further.

Table 13
The Local Stakeholders Evaluated the Quality and Effectiveness of RDDF in terms of Environmental Impact

Indicators	Mean	SD	Response	Interpretation
The RDF process reduces the volume of landfill waste.	3.84	0.37	Strongly Agree	Very Good
The RDF combustion process produces lower greenhouse gas emissions than coal.	3.70	0.46	Strongly Agree	Very Good
The RDF is sourced from sustainable and non-hazardous waste materials.	3.53	0.50	Strongly Agree	Very Good
The RDF helps in reducing overall pollution levels.	3.48	0.50	Strongly Agree	Very Good
The RDF minimizes the need for raw material extraction.	3.52	0.50	Strongly Agree	Very Good
Overall	**3.61**	**0.47**	**Strongly Agree**	**Very Good**

Legend: 1.00-1.75 Strongly Disagree (Very Poor), 1.76-2.50 Disagree (Poor), 2.51-3.25 Agree (Good), and 3.26-4.00 Strongly Agree (Very Good)

Table 14 presents the summary of local stakeholders who evaluated the quality and effectiveness of RDDF. The overall mean score of 3.56, with a standard deviation of 0.54, reflects that local stakeholders strongly agree on the very good quality and effectiveness of the RDDF. The relatively low standard deviation suggests that there is a consensus among respondents regarding the positive assessment of the RDDF's performance across the various indicators. This consistent perception emphasizes the facility's alignment with stakeholder expectations and its perceived effectiveness. Recent studies indicate that when stakeholders provide similar evaluations, it reflects an accurate reflection of organizational performance, which can reinforce support for continued development (Johnson & Lee, 2021). The "very good" interpretation of the overall score indicates that the facility is meeting its goals and gaining trust. This could translate into future investments and commitment from stakeholders.

The highest mean of 3.61, recorded for environmental impact, indicates that stakeholders believe the facility is exceptionally effective in minimizing its environmental footprint. The standard deviation of 0.47, which is slightly lower than the overall score, shows that responses are relatively consistent in recognizing the facility's environmental contributions. This finding aligns with the growing

importance of environmental sustainability in facility management, with stakeholders increasingly prioritizing eco-friendly practices (Garcia et al., 2022). The facility's focus on sustainability is likely to attract further support and recognition from local communities and environmental advocacy groups. This may encourage similar facilities to adopt green practices and could influence policy decisions regarding environmental standards. This rating suggests a strong positive impact on the community's environmental well-being.

The lowest mean score of 3.52 for energy efficiency, although still categorized as "very good," shows it is the least highly rated among the indicators. The standard deviation of 0.71 is the highest among the indicators, indicating more variation in responses. This variability may suggest that while stakeholders generally agree on the facility's energy efficiency, some may perceive opportunities for improvement in this area. Research highlights that energy efficiency remains a common challenge for facilities aiming to optimize performance while reducing operational costs (Perez et al., 2023). Addressing this variability could provide a foundation for enhancing energy management strategies, which can contribute to both cost savings and improved environmental outcomes. This provides an area for improvement that could enhance the facility's performance in the future.

Table 14
The Summary of Local Stakeholders Evaluated the Quality and Effectiveness of RDDF

Indicators	Mean	SD	Response	Interpretation
Fuel Quality	3.54	0.49	Strongly Agree	Very Good
Energy Efficiency	3.52	0.71	Strongly Agree	Very Good
Economic Viability	3.55	0.49	Strongly Agree	Very Good
Environmental Impact	3.61	0.47	Strongly Agree	Very Good
Overall	**3.56**	**0.54**	**Strongly Agree**	**Very Good**

Legend: 1.00-1.75 Strongly Disagree (Very Poor), 1.76-2.50 Disagree (Poor), 2.51-3.25 Agree (Good), and 3.26-4.00 Strongly Agree (Very Good)

4. Is there a significant difference in how respondents evaluate RDDF performance when grouped according to their demographic profile?

Table 15 depicts the test of significant difference in how respondents evaluated RDDF performance when grouped according to their demographic profile. The data show a significant difference in the evaluations between male and female respondents, with male respondents reporting higher mean scores (3.82) compared to female respondents (3.52). This suggests that male respondents generally perceive the RDDF performance more favorably than female respondents. The statistical analysis confirms that this difference is statistically significant, which may indicate differing perspectives or experiences among male and female stakeholders regarding the facility's operations.

Table 15
Test of Significant Difference in how Respondents Evaluated RDDF Performance when Grouped According to their Demographic Profile

Demographic Profile	Evaluated RDDF Performance					
	Category	**Mean**	**f-value**	**t-value**	**Remarks**	**Decision on Ho**
Sex	Male	3.82	6.412	0.000	Significant	Rejected
	Female	3.52				

Significant if p-value <0.05
Legend: Ho is rejected if Significant
Ho is failed to reject if Not Significant

Gender differences in environmental attitudes have been widely discussed, and this finding suggests that male respondents may have a greater direct involvement with or higher trust in waste-to-energy systems. Understanding these differences is crucial for designing targeted engagement strategies and ensuring that both genders are effectively involved in decision-making processes. Previous research has highlighted the importance of considering gender in environmental policy and management to better address the needs of all community members (Peterson & Martin, 2020). Tailoring communication to address these gender-based differences could further improve public acceptance and participation in RDDF initiatives.

Table 16 depicts the test of significant difference in how respondents evaluated RDDF performance when grouped according to their demographic profile. The data indicate that there are no significant differences in the evaluation of RDDF performance across different age groups, with the mean scores ranging from 3.77 to 3.83. This suggests that age does not have a strong influence on how stakeholders perceive the performance of the RDDF facility. The lack of significant differences may imply that respondents across various age groups generally share similar opinions about the facility's effectiveness. Given that the age groups range from 18 to 21 years old to those 30 years and above, it seems that all age demographics view the RDDF performance positively. This could be due to the increasing awareness of environmental issues and waste management among all age groups in modern societies. As noted by Lee and Kim (2021), collective environmental awareness across generations often leads to similar evaluations of sustainability efforts. The findings suggest that outreach efforts may not need to be tailored based on age, as there seems to be a consensus about the facility's performance.

Table 16
Test of Significant Difference in how Respondents Evaluated RDDF Performance when Grouped According to their Demographic Profile

Demographic Profile	Evaluated RDDF Performance					
	Category	**Mean**	**f-value**	**p-value**	**Remarks**	**Decision on Ho**
Age	18 to 21	3.83	0.378	0.769	Not Significant	Failed to Reject
	22 to 25	3.80				
	26 to 29	3.77				
	30 and above	3.82				

Significant if p-value <0.05
Legend: Ho is rejected if Significant
Ho is failed to reject if Not Significant

Table 17 depicts the test of significant difference in how respondents evaluated RDDF performance when grouped according to their demographic profile. The data shows a significant difference between single and married respondents, with singles rating RDDF performance higher (mean = 3.82) than married respondents (mean = 3.52). This suggests that marital status may influence how respondents perceive the effectiveness of the RDDF facility, with singles generally expressing more favorable opinions. The statistical analysis confirms that the difference in evaluations is significant, highlighting the potential influence of personal circumstances on environmental perceptions. This difference could be due to varying lifestyle factors between single and married respondents, such as their level of involvement in local environmental practices or their exposure to waste management initiatives. As highlighted by Thompson and Nguyen (2022), unmarried individuals tend to show more significant support for sustainability practices, which may explain the more positive evaluation of RDDF performance. Understanding the role of marital status in environmental perceptions could help design more targeted outreach and communication strategies.

Table 17
Test of Significant Difference in how Respondents Evaluated RDDF Performance when Grouped According to their Demographic Profile

Demographic Profile	Evaluated RDDF Performance					
	Category	**Mean**	**f-value**	**t-value**	**Remarks**	**Decision on Ho**
Civil Status	Single	3.82	6.313	0.000	Significant	Rejected
	Married	3.52				

Significant if p-value <0.05
Legend: Ho is rejected if Significant
Ho is failed to reject if Not Significant

Table 18 depicts the test of significant difference in how respondents evaluated RDDF performance when grouped according to their demographic profile. The data reveals no significant differences in evaluations across different educational groups, including those with elementary, high school, college, and post-graduate education. The mean scores across these groups range from 3.75 to 3.91, indicating that educational level does not significantly impact how respondents evaluate the RDDF's performance. This lack of significant difference may reflect the increasing level of environmental awareness across all educational levels, with individuals from diverse educational backgrounds holding similar views on waste-to-energy systems. As noted by Carter and Harris (2021), environmental awareness is often shaped more by exposure and experience rather than formal education alone. This suggests that outreach efforts targeting RDDF performance should focus on accessibility and information dissemination rather than targeting specific educational groups.

Table 18
Test of Significant Difference in how Respondents Evaluated RDDF Performance when Grouped According to their Demographic Profile

Demographic Profile	Evaluated RDDF Performance					
	Category	**Mean**	**f-value**	**t-value**	**Remarks**	**Decision on Ho**
Educational Attainment	Elementary	3.91	1.546	0.202	Not Significant	Failed to Reject
	High School	3.77				
	College	3.85				
	Post Graduate	3.75				

Significant if p-value <0.05
Legend: Ho is rejected if Significant
Ho is failed to reject if Not Significant

5. Is there a significant relationship between the Tanza facility's operational factors and RDDF performance?

Table 19 depicts the test of significant relationship between the Tanza facility's operational factors and RDDF performance. The data show a significant negative relationship between operational efficiency and energy efficiency ($r = -0.147$, $p = 0.004$), suggesting that higher operational efficiency may be associated with a decrease in energy recovery efficiency. This is an interesting finding because while operational efficiency is crucial for ensuring the smooth processing of waste and reducing operational delays, it might unintentionally affect the energy output if too much focus is placed on streamlining processes at the expense of energy recovery mechanisms. A reduction in energy recovery could lead to lower energy production from RDF, ultimately decreasing the facility's sustainability. The result highlights the importance of striking a balance between operational improvements and energy efficiency to achieve optimal performance. As discussed by Wright and Thompson (2022), increasing

operational efficiency should not come at the expense of energy recovery, which is crucial to the success of waste-to-energy systems.

Moreover, no significant relationships were found between other operational factors, such as facility infrastructure, sustainability, and management policies, and RDDF performance. This suggests that these factors might not have as direct an impact on performance as operational efficiency does. The lack of significant relationships may indicate that these elements, while still important, are less impactful in influencing RDDF outcomes compared to operational efficiency. It is essential for the facility to continually refine and integrate the various operational factors, ensuring they work in harmony to support RDDF performance. As noted by Green and Baker (2021), the holistic integration of operational factors is crucial for maintaining a balanced approach that optimizes the overall efficiency and environmental impact of waste-to-energy systems.

Table 19
Test of Significant Relationship between the Tanza Facility's Operational Factors and RDDF Performance

Operational Factors	RDDF Performance											
	Fuel Quality			**Energy Efficiency**			**Economic Viability**			**Environmental Impact**		
	R	**p-value**	**Ho**	**R**	**p-value**	**Ho**	**R**	**p-value**	**Ho**	**R**	**p-value**	**Ho**
Facility Infrastructure and Technology	.069	.180	NS	-.061	.235	NS	-.037	.475	NS	-.007	.897	NS
Operational Efficiency	-.062	.226	NS	-.147**	.004	S	-.096	.062	NS	.029	.568	NS
Sustainability and Environmental Management	.036	.488	NS	-.054	.293	NS	-.062	.228	NS	-.010	.849	NS
Management and Policy Implementation	.024	.637	NS	-.007	.895	NS	.016	.750	NS	.134**	.009	S

Significant if p-value <0.05
Legend: Ho is rejected if Significant
Ho is failed to reject if Not Significant

6. Does the Tanza Integrated Waste Management and Treatment Facility significantly affect RDDF performance?

Table 20 depicts the test of significant effect of the Tanza integrated waste management and treatment facility to RDDF performance. The results show that the facility's operational factors, particularly sustainability and environmental management, have a significant adverse effect on RDDF performance. This suggests that specific operational strategies, such as sustainability and environmental management practices, might not be fully aligned with or supportive of optimizing RDF production and energy recovery. The findings suggest that while sustainability and environmental management are crucial goals, their current implementation may hinder the facility's ability to optimize RDDF performance. The misalignment could be due to a variety of factors, such as insufficient integration between sustainability efforts and RDF production systems, leading to inefficiencies in the overall waste-to-energy process. As highlighted by Martin and Davis (2021), achieving a balance between operational practices and environmental goals is crucial for ensuring that waste-to-energy systems operate optimally while minimizing their environmental impact.

Furthermore, the negative effect observed in the operational factors suggests that revisiting the facility's operational model may be necessary. Ensuring that sustainability efforts align with the

technical and operational goals of RDF production and energy generation is essential for enhancing overall RDDF performance. This may involve adjusting sustainability strategies, enhancing energy recovery systems, and refining operational procedures to ensure that both environmental objectives and energy efficiency are achieved. As emphasized by Foster and Zhang (2020), aligning sustainability with operational practices can lead to more effective waste management systems that not only reduce environmental impact but also enhance operational outcomes. Revising the facility's operational framework could help strike the right balance, leading to improved performance in both environmental management and RDF production.

Table 20
Test of Significant Affect of the Tanza Integrated Waste Management and Treatment Facility to RDDF Performance

Model		Unstan. Coefficients		Stan. Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.718	.431		13.254	.000
	Facility Infrastructure and Technology	-.124	.086	-.077	-1.437	.152
	Operational Efficiency	-.168	.079	-.112	-2.135	.033
	Sustainability and Environmental Management	-.146	.071	-.110	-2.058	.040
	Management and Policy Implementation	-.076	.059	-.067	-1.279	.202

Note: Adjusted r2=.056 ANOVA for Regression F= 5.549, p=.000

7. Based on the findings, what policies and strategies can be recommended to improve RDDF production, enhance fuel quality, and promote sustainability in waste-to-energy conversion?

Based on the findings, the following policies and strategies are recommended to improve RDDF production, enhance fuel quality, and promote sustainability in waste-to-energy conversion:

Enhancing Operational Efficiency. The study reveals that while operational efficiency is generally viewed positively, it may have a negative impact on energy efficiency. To address this, a policy should be implemented that ensures operational improvements do not compromise energy recovery systems. This includes streamlining waste processing while integrating energy recovery mechanisms, ensuring that both operational efficiency and energy production are optimized. A focus on improving energy efficiency through better waste segregation and reduction of contaminants can enhance the calorific value of RDF, which in turn boosts energy recovery.

Continuous Investment in Technology and Infrastructure. The stakeholders' positive evaluations of the facility's infrastructure and technology highlight the importance of modern, well-maintained equipment in RDDF production. A policy focused on regular upgrading and maintenance of waste management equipment is crucial. This will ensure that the facility remains capable of meeting future waste volumes and technological advancements, thereby maintaining an efficient and sustainable process. Additionally, investing in new technologies for waste sorting and energy recovery could further improve RDF quality.

Strengthening Waste Segregation and Recycling Programs. Although the facility’s recycling and waste reduction programs are viewed positively, there is room for improvement. A strategy to improve the effectiveness of waste segregation at the facility can significantly reduce contaminants in the RDF, enhancing fuel quality. Policies should focus on training staff, adopting best practices for segregation, and investing in advanced sorting technologies to minimize contamination and improve RDF consistency.

Balancing Sustainability with Operational Goals. The negative relationship between sustainability and environmental management and RDDF performance suggests that sustainability practices need to be more closely aligned with RDF production and energy generation goals. A strategy could be developed that integrates sustainability efforts with RDF production systems, ensuring that both environmental management goals and energy efficiency are pursued together. For example, revising environmental management strategies to prioritize energy recovery and waste-to-energy systems can lead to improved performance outcomes without compromising sustainability.

Improving Policy Transparency and Communication. The facility's policies are generally well-regarded; however, transparency in reporting could be enhanced. A policy should be implemented to enhance the transparency of waste management reports, especially regarding environmental impact and operational efficiency. Regular public reporting and clear communication of the facility's environmental benefits will build trust among stakeholders and improve community engagement. This can also involve educating the public on the environmental and economic benefits of RDF production.

Developing Community-Based Education Programs. Given the relatively low levels of educational attainment among respondents, policies could focus on developing community-based education programs that enhance public understanding of waste-to-energy processes and sustainability. These initiatives should aim to simplify complex technical issues and emphasize clear, tangible environmental and economic outcomes of RDF production.

By implementing these strategies, the Tanza facility can enhance its operational efficiency, improve the quality of RDF produced, and promote sustainability in waste-to-energy conversion, ultimately contributing to a more environmentally responsible and economically viable waste management system

CONCLUSION

The findings of this study highlight the importance of integrated approaches to waste management and RDF production. While the Tanza facility has made significant progress in meeting operational and environmental goals, there are still areas that require further attention, such as optimizing waste segregation, improving RDF quality, and aligning sustainability practices with operational efficiency. The study also revealed that demographic factors, particularly sex and marital status, influence how stakeholders evaluate RDDF performance, underscoring the importance of considering these variables when developing engagement strategies. Moreover, the significant relationship between operational efficiency and energy recovery efficiency emphasizes the importance of balancing both aspects for optimal RDF production.

Moving forward, the Tanza facility must prioritize enhancing its operational and environmental practices to maximize RDF production while minimizing any adverse environmental impacts. The integration of sustainability and operational goals will be key to improving the facility's overall performance and ensuring its long-term success. By addressing the areas identified in the findings, such as refining waste segregation practices, improving transparency, and aligning operational models with energy recovery goals, the Tanza facility can better contribute to environmental sustainability and enhance the quality of the RDF produced.

Recommendations

Based on the summary and conclusion of the study, here are the recommendations:

1. **For Local Government Units (LGUs) and Policymakers**. LGUs and policymakers should prioritize the development of regulatory frameworks that encourage continued investment in waste-to-energy technologies and promote regular evaluations of facility performance. Strengthening

policies that address the reduction of contaminants in RDF and enhancing waste segregation practices at the community level will also be crucial for improving the quality of RDF.

2. **For Waste Management Companies and Business Stakeholders**. Waste management companies and business stakeholders should collaborate with the facility to invest in advanced waste sorting technologies and optimize the RDF production process. They should also focus on improving the stability and cost-effectiveness of the RDF supply chain to ensure long-term economic viability.
3. **For Environmental Advocacy Groups and Local Communities**. Environmental advocacy groups and local communities should collaborate to raise awareness about the environmental benefits of RDF production and waste-to-energy systems. They should also support initiatives that promote waste reduction and recycling at the local level, ensuring that community involvement aligns with broader sustainability goals.
4. **For Researchers and Academicians**. Researchers and academicians should conduct further studies on the relationship between operational efficiency and energy recovery in waste-to-energy systems. Additionally, investigating the impact of demographic factors on environmental attitudes could help tailor more effective outreach and education programs for various community groups.
5. **For Energy and Environmental Conservation Practitioners**. Energy and environmental conservation practitioners should focus on optimizing energy recovery processes in RDF production. This can be achieved through the use of advanced combustion technologies that enhance efficiency and minimize greenhouse gas emissions, ensuring that RDF production remains both economically viable and environmentally sustainable.

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