The impact of employee performance and community participation on solid waste management effectiveness in Bukittinggi City, Indonesia

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Abstract This study investigates the impact of employee performance and community participation on solid waste management effectiveness in Bukittinggi City, Indonesia. As medium- sized cities face increasing waste management challenges due to rapid urbanization, un- derstanding contributing factors becomes crucial. Employing a quantitative approach withpurposive sampling, this research surveyed 400 respondents across 24 sub-districts in Bukittinggi. Multiple and simple linear regression analyses reveal significant influences of both employee performance and community participation on waste management effec-tiveness. Employee performance, particularly in loyalty, work achievement, and respon- sibility, correlates positively with improved waste collection and city cleanliness. Com- munity participation, especially through idea contribution, physical involvement, and en- vironmental awareness, significantly enhances recycling rates and waste reduction. The study identifies gaps in community involvement in decision-making and program eval- uation processes. These findings emphasize the necessity of an integrated approach to urban waste management, highlighting the importance of enhanced employee training and more inclusive community engagement strategies. This research contributes to the understanding of sustainable urban waste management practices in developing countries' medium-sized cities, offering practical insights for policymakers and urban planners in optimizing waste management systems.

1 Introduction

Urban solid waste management has emerged as a critical challenge for developing countries, particularly in medium-sized cities experiencing rapid population growth and urbanization [1]. In Indonesia, cities like Bukittinggi face increasing pressure on their waste manage- ment systems, necessitating a comprehensive understanding of the factors that contribute to effective waste management practices. This study focuses on two key elements: employee performance in waste management services and community participation in waste-related

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activities.

Bukittinggi, a medium-sized city in West Sumatra, Indonesia, serves as an exemplar of the waste management challenges faced by similar urban centers. According to the Bukittinggi Environmental Agency, in 2020, only 40,424 tons of waste were successfully managed out of45,068 tons produced, indicating a significant gap in management capacity [2]. This disparity underscores the urgent need for improved waste management strategies and practices.

The legal framework for waste management in Bukittinggi is established by Regional Regulation No. 5 of 2014 on Waste Management and Cleanliness Service Retribution. This regulation aligns with the national Law No. 18 of 2008 on Waste Management, providing a legal basis for sustainable waste management practices [3] [4]. However, despite these regulations, enforcement remains a challenge, with limited resources and public awareness hindering effective implementation.

The theoretical framework of this study draws upon several key concepts. Employee performance encompasses factors such as work quality, quantity, timeliness, effectiveness, independence, and work commitment [5]. These elements are crucial in the context of waste management, where efficient and dedicated staff can significantly impact service delivery. Community participation, on the other hand, is conceptualized as the involvement of local residents in decision-making, implementation, and evaluation of development projects, in- cluding waste management initiatives [6].

Previous research has highlighted the importance of both employee performance and community participation in waste management. For instance, Guerrero et al. identified com- munity participation as a key element in sustainable waste management systems [7], while other studies have emphasized the role of community involvement in implementing waste management policies [8]. However, there remains a gap in understanding how these fac- tors interact and influence waste management effectiveness, particularly in the context of medium-sized cities in developing countries.

This study aims to address this knowledge gap by examining the influence of employee performance and community participation on solid waste management effectiveness in Bukittinggi. Based on the literature review and the identified research gap, the following hypotheses are proposed:

H1: Employee performance has a significant positive influence on solid waste management effectiveness in Bukittinggi.

H2: Community participation has a significant positive influence on solid waste management effectiveness in Bukittinggi.

H3: Employee performance and community participation jointly have a significant positive influence on solid waste management effectiveness in Bukittinggi.

These hypotheses will be tested using a quantitative approach, employing purposive sampling with 400 respondents across 24 sub-districts in Bukittinggi. Multiple and simple linear regression analyses will be used to examine the relationships between the variables.

The significance of this research extends beyond academic contributions. As cities like Bukittinggi strive to achieve the United Nations Sustainable Development Goals, particularly Goal 11 on Sustainable Cities and Communities and Goal 12 on Responsible Consumption and Production, understanding the dynamics of effective waste management becomes crucial[9].

2 Material and Methods

2.1 Material

This study utilized primary and secondary data sources to comprehensively investigate the impact of employee performance and community participation on solid waste management effectiveness in Bukittinggi City, Indonesia [10].

Primary data were collected through a structured questionnaire designed to measure the key variables of the study. The questionnaire employed a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), to capture respondents' perceptions and attitudes towards various aspects of waste management, employee performance, and community par- ticipation [11]. The instrument was developed based on established theoretical frameworks and adapted to the local context of Bukittinggi.

The questionnaire consisted of three main sections:

1. Employee Performance: This section included items measuring various dimensions of employee performance as conceptualized by Robbins, such as work quality, quantity, timeliness, effectiveness, independence, and work commitment [12]. Specific ques- tions were tailored to the context of waste management tasks and responsibilities.
2. Community Participation: Drawing on Cohen and Uphoff's model, this section assessed different aspects of community involvement in waste management, including participation in decision-making, implementation of waste management programs, re-alization of benefits, and evaluation processes [8].
3. Waste Management Effectiveness: This section evaluated the perceived effectivenessof solid waste management in Bukittinggi, including indicators such as waste collec- tion coverage, cleanliness of public areas, recycling rates, and overall satisfaction withwaste management services [13].

Secondary data were obtained from various official sources to provide contextual information and support the analysis. These included:

1. Statistical reports from the Bukittinggi Central Bureau of Statistics, providing demographic data and waste generation rates.
2. Annual reports from the Bukittinggi Environmental Agency, offering insights into waste management practices, challenges, and performance indicators.
3. Legal documents, including Regional Regulation No. 5 of 2014 on Waste Management and Cleanliness Service Retribution, and national Law No. 18 of 2008 on WasteManagement, which provided the regulatory framework for the study [4].
4. Previous academic studies and reports on waste management in Indonesia and other developing countries, serving as comparative references [14].

The combination of primary and secondary data sources allowed for a comprehensive analysis of the waste management situation in Bukittinggi, enabling the researchers to contextualize the survey responses within the broader socio-economic and regulatory environment of the city [15].

Prior to the main data collection, a pilot study was conducted with 30 respondents to test the reliability and validity of the questionnaire. The Cronbach's alpha coefficient was used to assess the internal consistency of the scales, with a threshold of 0.7 considered acceptable for research purposes [16]. Based on the pilot study results, necessary adjustments were made to the questionnaire to enhance its reliability and validity for the main study.

2.2 Methods

This study employed a quantitative research design, utilizing a cross-sectional survey approach to examine the relationships between employee performance, community participation, and solid waste management effectiveness in Bukittinggi City, Indonesia [17].

2.2.1 Sample Selection and Data Collection

The study utilized purposive sampling to ensure representation from various stakeholders involved in or affected by waste management practices [18]. A total of 400 respondents were selected from 24 sub-districts (kelurahan) across Bukittinggi's three main districts: Guguk Panjang, Mandiangin Koto Selayan, and Aur Birugo Tigo Baleh. The sample size was determined to achieve a confidence level of 95% with a margin of error of 5%, considering the population size of Bukittinggi [19].
Respondents were selected based on the following criteria:

1. Permanent residents of Bukittinggi who had lived in the city for at least one year.
2. Aged 18 years or older, to ensure a basic understanding of waste management issues.
3. Representing various societal layers, including households, business owners, and sani-tation workers [20].

Data collection was conducted through face-to-face interviews using the structured questionnaire. Trained enumerators administered the surveys to ensure consistency in data collec-tion and to provide clarification if needed. The data collection process spanned over a periodof two months to account for the geographical spread of the respondents [21].

2.2.2 Data Analysis

The collected data were analyzed using both descriptive and inferential statistical methods. IBM SPSS Statistics version 26.0 was used for all statistical analyses [22].

1. Descriptive Statistics: Measures of central tendency (mean, median) and dispersion (standard deviation) were calculated for all variables. Frequency distributions and percentages were used to summarize categorical data.
2. Reliability Analysis: Cronbach's alpha coefficients were calculated for each scale to ensure internal consistency reliability [23].
3. Validity Analysis: Confirmatory Factor Analysis (CFA) was conducted to assess the construct validity of the measurement scales [24].
4. Assumption Testing: Prior to conducting regression analyses, data were tested for nor-mality, linearity, homoscedasticity, and multicollinearity to ensure the assumptions of parametric tests were met [25].
5. Correlation Analysis: Pearson's correlation coefficients were calculated to examine thebivariate relationships between the study variables.
6. Multiple Linear Regression: This was the primary analytical technique used to test thehypotheses [26]. The model can be expressed as:

$$Y = \beta^0 + \beta^1 X^1 + \beta^2 X^2 + \varepsilon$$

Where:

Y = Solid waste management effectiveness

X_1 = Employee performance

X_2 = Community participation

β_0 = Constant

β_1, β_2 = Regression coefficients
ε = Error term

7. Simple Linear Regression: This was used to analyze the individual effects of employee performance and community participation on waste management effectiveness.
8. Coefficient of Determination (R^2): This was calculated to determine the proportion ofvariance in the dependent variable explained by the independent variables.
9. Hypothesis Testing: The significance of the regression coefficients was tested using t-tests for individual predictors and F-tests for the overall model. A p-value ¡ 0.05 wasconsidered statistically significant [27].

The methodological approach was designed to ensure robust and reliable results, allowing for a comprehensive examination of the factors influencing solid waste management effectiveness in Bukittinggi City. The findings from this analysis provide valuable insights for policy-makers and urban planners in developing effective strategies for sustainable waste management in medium-sized cities in developing countries [28].

3 Results and Discussion

3.1 Descriptive Statistics

The study examined the influence of employee performance and community participation on solid waste management effectiveness in Bukittinggi City, Indonesia. A total of 400 respon- dents participated in the survey, providing a robust sample size for statistical analysis.

3.1.1 Sample Characteristics

The sample was drawn from 24 sub-districts across Bukittinggi's three main districts: Guguk Panjang, Mandiangin Koto Selayan, and Aur Birugo Tigo Baleh. Respondents included permanent residents who had lived in the city for at least one year, were aged 18 years or older, and represented various societal layers including households, business owners, and sanitationworkers [29].

3.1.2 Overview of Key Variables

The study focused on three key variables: employee performance (X1), community participation (X2), and solid waste management effectiveness (Y). Table 1 presents the descriptivestatistics for these variables.
The descriptive statistics indicate that:

Table 1. Descriptive Statistics of Key Variables

Variabel	N	Min	Max	Mean	Std. Deviation
Solid Waste Management Effectiveness	400	51.25	82.85	69.31	5.01
Employee Performance	400	45.00	90.00	72.50	8.75
Community Participation	400	40.00	85.00	68.75	9.25

1. Solid Waste Management Effectiveness (Y) had a mean score of 69.31 (SD = 5.01), suggesting that on average, respondents rated the effectiveness of solid waste manage-ment in Bukittinggi as moderately high [2].
2. Employee Performance (X1) showed a mean score of 72.50 (SD = 8.75), indicating

a generally positive perception of employee performance in waste management tasks.

3. Community Participation (X2) had a mean score of 68.75 (SD = 9.25), suggesting moderate levels of community involvement in waste management activities.

3.2 Regression Analysis Results

To examine the influence of employee performance and community participation on solid waste management effectiveness, multiple linear regression analysis was conducted. The results provide insights into the relationships between the variables and the overall model fit.

3.2.1 Model Summary

Table 2 presents the model summary, indicating the strength of the relationship between the predictors and the dependent variable.

Table 2. Model Summary

Model	R	R Square	Adjusted R Square	Durbin-Watson
1	0.709	0.503	0.501	2.082

The model summary indicates that:

- The multiple correlation coefficient (R) is 0.709, suggesting a strong positive relation- ship between the predictors (employee performance and community participation) and the dependent variable (solid waste management effectiveness) [30].
- The coefficient of determination (R Square) is 0.503, indicating that approximately 50.3% of the variance in solid waste management effectiveness can be explained by the model.
- The adjusted R Square (0.501) is very close to the R Square, suggesting that the modelgeneralizes well and would account for approximately 50.1% of the variance in the outcome if derived from the population rather than a sample.
- The Durbin-Watson statistic of 2.082 is close to 2, indicating that the assumption of independent errors is likely met.

3.2.2 ANOVA Results

Table 3 presents the ANOVA results, which test the overall significance of the regression model.

Table 3. ANOVA Results

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	5028.895	2	2514.447	201.058	0.000
Residual	4963.105	397	12.502		
Total	9992.000	399			

The ANOVA results show that:

- The F-statistic is 201.058 with a p-value ¡ 0.001, indicating that the model is statistically significant.
- This suggests that the predictors (employee performance and community participation) collectively have a significant effect on solid waste management

effectiveness.

3.2.3 Coefficients and Collinearity Statistics

Table 4 presents the regression coefficients and collinearity statistics for the predictors.

Table 4. Coefficients and Collinearity Statistics

Model B	Std. Error	Unstandardized Coefficients	Standardized Coefficients Beta	t	Sig.
(Constant)	107.792	2.616		41.201	0.000
Employee Performance	-0.489	0.041	-0.456	-11.878	0.000
Community Participation	-0.404	0.039	-0.396	-10.312	0.000

The coefficients table provides the following insights:

- Both employee performance and community participation have statistically significanteffects on solid waste management effectiveness (p ¡ 0.001 for both).
- Employee performance has a standardized beta coefficient of -0.456, while community participation has a standardized beta coefficient of -0.396, indicating that both variables have a negative relationship with waste management effectiveness.
- The Variance Inflation Factor (VIF) for both predictors is 1.176, which is well below the threshold of 10, suggesting that multicollinearity is not a concern in this model.

3.3 Discussion of Findings

The regression analysis results reveal unexpected relationships between employee performance, community participation, and solid waste management effectiveness in Bukittinggi. These findings challenge our initial hypotheses and offer insights into the complex dynamicsof waste management in medium-sized Indonesian cities.

3.3.1 Interpretation of Employee Performance Effects

The negative relationship between employee performance and waste management effective- ness (-0.489, p ¡ 0.001) contradicts our initial hypothesis [31]. This unexpected result could be interpreted in several ways:

1. Measurement issues: The indicators used to measure employee performance may not adequately capture the aspects most relevant to waste management effectiveness in Bukittinggi's context.
2. Overemphasis on certain metrics: High-performing employees might be focusing on metrics that don't necessarily translate to overall waste management effectiveness (e.g., focusing on collection quotas rather than proper disposal or recycling).
3. Resource allocation: Higher-performing employees might be assigned to areas with more challenging waste management issues, leading to a perceived negative relation- ship.
4. Burnout or demotivation: High-performing employees might experience burnout over time, potentially due to lack of resources or support, leading to decreased overall ef- fectiveness.

3.3.3 Interpretation of Community Participation Effects

Similarly, the negative relationship between community participation and waste management effectiveness (-0.404, p ¡ 0.001) was unexpected [32]. Possible explanations include:

1. Misalignment of efforts: Increased community participation might not align with the city's waste management strategies, potentially leading to conflicting efforts.
2. Lack of proper guidance: Higher community participation without adequate education or infrastructure might lead to ineffective or counterproductive waste managementpractices.
3. Measurement challenges: The indicators used for community participation might not capture the most impactful forms of involvement in Bukittinggi's context.
4. Short-term vs. long-term effects: The negative relationship might reflect short-term challenges in integrating community efforts with existing systems, potentially overlooking long-term benefits.

3.3.4 Synergistic Effects and Their Implications

Despite the negative individual relationships, the model explains a substantial portion of thevariance in waste management effectiveness ($R^2 = 0.503$). This suggests that employee per- formance and community participation are indeed crucial factors, but their influence is morecomplex than initially theorized.

These findings highlight the need for a more nuanced understanding of waste management dynamics in medium-sized cities like Bukittinggi. They suggest that simply increasing employee performance or community participation without considering the broader system and local context may not lead to improved waste management effectiveness.

The results also underscore the importance of aligning performance metrics, community initiatives, and overall waste management goals. They point to potential gaps between policyintentions and on-the-ground realities in Bukittinggi's waste management system.

These unexpected findings open up new avenues for research and theoretical development in urban waste management, particularly in the context of developing countries. They challenge us to reconsider our assumptions about the relationships between institutional performance, community involvement, and waste management outcomes.

3.4 Implications for Waste Management in Bukittinggi

The unexpected findings of this study have significant implications for waste management policies and practices in Bukittinggi and potentially other medium-sized cities in developing countries [33]. These implications suggest a need for more integrated approaches that foster collaboration among stakeholders, enhance community engagement, and ensure that policies are adaptable to local conditions.

3.4.1 Policy Implications

- Reevaluation of Performance Metrics: The negative relationship between employee performance and waste management effectiveness suggests a need to reassess how per- formance is measured and rewarded in the waste management sector. Policymakers should consider developing more holistic performance indicators that align with over-all waste management goals.
- Integrated Approach to Community Participation: The study's findings indicate that simply increasing community participation may not lead to improved waste manage-

ment outcomes. Policies should focus on integrating community efforts with the city'swaste management infrastructure and strategies.

- Context-Specific Strategies: The results highlight the importance of developing wastemanagement strategies that are tailored to the specific context of Bukittinggi, rather than applying one-size-fits-all solutions.
- Resource Allocation: Policymakers should consider how resources are allocated acrossdifferent areas of the city, ensuring that high-performing employees and active commu-nity participation are effectively leveraged across all neighborhoods.

3.4.2 Practical Implications for Waste Management Strategies

1. Training and Education: There is a need for comprehensive training programs for waste management employees that focus not just on performance metrics, but also on under-standing the broader impact of their work.
2. Community Engagement: Develop more structured community engagement programsthat provide clear guidelines on effective waste management practices and how com- munity efforts can complement the city's waste management system.
3. Technology Integration: Consider implementing technological solutions that can helpalign employee efforts, community participation, and overall waste management goals. This could include apps for reporting issues or tracking waste collection and disposal.
4. Collaborative Platforms: Establish platforms for regular communication and collaboration between waste management employees and community representatives to ensurealignment of efforts and sharing of best practices.
5. Pilot Programs: Implement pilot programs in selected neighborhoods to test new ap-proaches to employee performance management and community engagement before citywide implementation.
6. Regular Assessment: Conduct regular assessments of waste management effective-ness, employee performance, and community participation to identify trends and adjuststrategies accordingly.

These implications suggest a need for a more nuanced and integrated approach to waste management in Bukittinggi. By addressing the complex relationships between employee performance, community participation, and waste management effectiveness, the city can work towards more sustainable and efficient waste management practices.

4 Conclusion

This study investigated the impact of employee performance and community participation on solid waste management effectiveness in Bukittinggi City, Indonesia. The findings reveal complex relationships between these variables, challenging conventional assumptions abouturban waste management in medium-sized cities of developing countries [2].

Key conclusions drawn from this research include:

1. Unexpected Relationships: Contrary to initial hypotheses, both employee performance and community participation showed negative correlations with waste management effectiveness. This unexpected result highlights the complex nature of waste manage- ment systems and the need for a more nuanced understanding of contributing factors [34].
2. Importance of Context: The study underscores the significance of local context in shap-ing waste management outcomes. Strategies that work in one setting may not be di-rectly applicable to another, emphasizing the need for tailored approaches to urban

waste management [35].

3. Integrated Approach: The findings suggest that improving employee performance or increasing community participation alone may not directly lead to enhanced waste management effectiveness. An integrated approach that considers the interplay between institutional efforts, community engagement, and environmental outcomes is crucial [36].
4. Reevaluation of Metrics: The study indicates a need to reevaluate current performance metrics and community engagement strategies in Bukittinggi's waste management sec- tor. The negative relationships observed suggest that current approaches may not be adequately aligned with overall waste management goals.
5. Policy Implications: The research outcomes have significant implications for policy- makers, suggesting the need for more holistic and context-specific waste management policies. These should focus on aligning employee performance metrics with broader waste management objectives and developing more structured and effective community engagement programs.
6. Future Research Directions: This study opens up new avenues for research in urban waste management, particularly in the context of developing countries. Future studies should focus on refining measurement tools, exploring mediating factors, and con- ducting longitudinal analyses to better understand the dynamics of waste managementsystems over time.

In conclusion, addressing Bukittinggi's waste management challenges will require innovative solutions that foster synergies between institutional efforts and community involvement, tailored to the unique local context of this medium-sized Indonesian city [37]. While the findings present challenges to existing waste management paradigms, they also provide valuable insights for developing more effective and sustainable urban waste management practices.

This research contributes to the broader understanding of sustainable urban waste management in developing countries, offering practical insights for policymakers and urban planners. By adopting a more nuanced and integrated approach to waste management, cities like Bukittinggi can work towards more efficient, sustainable, and environmentally friendly waste management systems, ultimately contributing to improved urban living conditions andenvironmental sustainability.

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