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Evaluating Waste Bank Effectiveness in Batam City: Linking Participation Gaps with Strategic Management

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This study aims to evaluate the effectiveness of the Waste Bank as a community-based waste management instrument in Batam Kota District, focusing on the gap between knowledge and participation as well as the formulation of strengthening strategies through SWOT analysis. The study employs a mixed-methods approach with data collection via a questionnaire administered to 100 respondents, in-depth interviews, and field observations. The quantitative component involved a structured questionnaire administered to active Waste Bank customers. The qualitative phase included interviews with Waste Bank managers, representatives of the Batam City Environmental Agency (DLH), and relevant stakeholders involved in Waste Bank management. The results indicate that while the community's level of knowledge is relatively high (68%), actual participation in waste sorting remains low (35%). Operationally, waste management still faces limitations, particularly in the processing of organic waste most of which still ends up at the Final Processing Site (FPS)—as well as the dependence of Unit Waste Banks on the Main Waste Bank for the management of non-organic waste. The SWOT analysis results indicate that Waste Bank management falls into Quadrant I (SO strategy), suggesting development opportunities through institutional strengthening, enhanced processing capacity, and expanded cross-sectoral partnerships. This study confirms that the effectiveness of Waste Banks is determined not only by the level of community participation but also by institutional capacity and adaptive partnership networks in supporting a sustainable waste management system.

Keywords: Waste; Community participation; Management; SWOT Analysis

INTRODUCTION

Batam is one of the regions with the fastest population growth in Indonesia, with a population of 1,256,600 in 2023 (BPS Kota Batam, 2024). This growth is driven by urbanization, labor migration, and Batam's strategic position as an industrial, commercial, and MICE hub. The increase in population and economic activity directly contributes to rising waste generation from residential, commercial, and service sectors. In 2024, Batam City's monthly waste volume averaged over 23 million kilograms, peaking at 25.8 million kilograms. This situation indicates that pressure on the urban waste management system is intensifying and has the potential to cause more complex environmental problems if not balanced by an effective management system (He et al., 2024).

However, waste management in Batam City remains dominated by the conventional "collect-transport-dispose" paradigm, which focuses on end-of-pipe treatment and does not yet emphasize waste reduction at the source. The impact of this approach is an increasing reliance on the Telaga Punggur as Final

Disposal Site (FDS), which is currently reported to be overloaded and no longer capable of optimally implementing a controlled landfill system. This situation not only increases the risk of environmental pollution but also poses potential health hazards to communities living near the FDS. In fact, normatively, national policy through Law No. 18 of 2008 on Waste Management has emphasized the importance of a paradigm shift toward management based on reduce, reuse, and recycle (3R). However, the implementation of this policy at the local level still faces various structural and cultural obstacles (Ulhasanah et al., 2025).

One of the main challenges in 3R-based waste management is the low level of community participation in source-separating waste. Yet, community participation is a key element in the success of a sustainable waste management system. Literature reviews indicate that the effectiveness of community-based waste management programs is significantly influenced by active community engagement, institutional capacity, as well as policy support and multi-stakeholder collaboration

. In other words, the success of waste management is not solely determined by the availability of infrastructure but also by the social and institutional aspects that support changes in community behavior (Fitrianto et al., 2024).

In this context, waste banks have emerged as an innovative approach to community-based waste management. Waste banks not only serve as a means of waste reduction through sorting and collection but also as an economic empowerment tool that provides financial incentives to the community. Through the "saving waste" mechanism, the community is encouraged to shift their perception of waste from something worthless to a resource with economic value. Additionally, waste banks serve as a medium for environmental education, fostering the development of sustainable eco-friendly behaviors (Prabawati et al., 2023).

Nevertheless, various studies indicate that the effectiveness of waste banks remains context-dependent and is not yet uniformly distributed across different regions. Common challenges include fluctuations in community participation rates, limited managerial capacity, weak institutional systems, and dependence on the market prices of recycled materials, which tend to be unstable (P. A. Zahra & Shohibuddin, 2025). In fact, in some cases, community participation in waste banks is merely tokenistic, where the community is involved in the initial stages such as outreach and registration but remains inactive during the program's implementation and evaluation phases (Dhifira, 2025). This situation indicates that the success of waste banks is not solely determined by the existence of the program but also by the quality of participation and governance that support the program's sustainability (Margaretha, 2025).

Many academics have conducted research on the effectiveness of waste bank programs, with varying focuses depending on the location and aspects of the study. Koko and Lee (2024) examined the effectiveness of the Bali Bersih Waste Bank in waste management efforts, emphasizing community participation and operational management of the waste bank. This study showed that program effectiveness is largely determined by social and institutional support in the local community. Meanwhile, Anyanwu et al. (2025) evaluated the effectiveness of the Senyum Mandiri Waste Bank in Bandung City. This study revealed that the effectiveness of waste management through waste banks is determined by the consistency of outreach and the intensity of community involvement in routine activities, but did not address government involvement in depth. A different focus is seen in the study by Valentina et al. (2025) which highlighted factors influencing community participation in waste bank management. They found that the level of community understanding, perceptions of economic benefits, and ease of access to waste bank facilities were the dominant factors that encouraged or hindered community participation.

Research by Thanh et al. (2023) focuses more on the effectiveness of institutions in regional waste management through Waste Management Sites (TPPAS) in the Greater Bandung area. While relevant from an institutional perspective, this study is more macro-level and does not address local community involvement in waste bank units. Zahra and Shohibuddin (2025) compared the effectiveness of waste banks between the cities of Bandung and Yogyakarta. The results showed significant differences in the implementation of waste management strategies, influenced by local policy factors and community support. However, this study did not specifically examine the dynamics of the effectiveness of waste banks under the direct supervision of local governments.

Furthermore, previous research also indicates that analytical approaches in waste bank management remain largely fragmented. Most studies focus solely on either community participation or program effectiveness in isolation, without integrating these into the formulation of comprehensive management strategies. On the other hand, the use of SWOT analysis in waste management research is generally still descriptive and has not been optimally utilized as a basis for formulating implementable and context-specific strategies. This results in recommendations that are often not operational and fail to address real-world challenges on the ground.

Given these conditions, there is a need to develop a more integrative analytical approach by linking the level of community participation with management strategies within a systematic framework. Therefore, this study aims to assess the effectiveness of waste banks through the relationship between community participation and management strategies formulated using SWOT analysis in Batam City. This study is expected to provide a scientific contribution to enriching community-based waste management studies, particularly in integrating social and managerial aspects, as well as generating more contextual and practical strategic recommendations for strengthening a sustainable urban waste management system.

METHODS

Research Design

This study employed a mixed-methods approach using a sequential explanatory design, consisting of two consecutive phases: quantitative and qualitative. The quantitative phase was conducted first to evaluate community participation in household waste management through Waste Bank Units (WBUs) in Batam Kota District. Subsequently, the qualitative phase was carried out to explain and interpret the quantitative findings, particularly the observed gap between community knowledge and actual participation in waste sorting.

The quantitative component involved a structured questionnaire administered to active Waste Bank customers. The results were analysed descriptively to

identify participation patterns and the implementation of household waste management practices. These findings informed the qualitative phase by guiding the selection of key informants and determining the main issues explored during in-depth interviews.

The qualitative phase included interviews with Waste Bank managers, representatives of the Batam City Environmental Agency (DLH), and relevant stakeholders involved in Waste Bank management. Field observations and document reviews were also conducted to obtain contextual information regarding operational practices, institutional capacity, and existing management constraints.

Integration of quantitative and qualitative findings was conducted during the interpretation stage. Quantitative results identified the level of community participation and existing participation gaps, while qualitative findings provided explanations for these patterns and served as the basis for identifying internal and external strategic factors. These factors were subsequently analysed using the SWOT framework to formulate recommendations for strengthening community-based household waste management in Batam Kota District. The sequential explanatory design enabled quantitative findings to be complemented and interpreted through qualitative evidence, thereby providing a more comprehensive understanding of the research problem.

Purposive Sampling

The author employed purposive sampling, involving 100 respondents, on the grounds that this was adequate for community-based social research. However, no statistical justification was provided. The actual active population, the sampling formula, the margin of error and the power were not explained, even though the number of active customers was 362.

The study was conducted in Batam Kota District, Batam City, involving ten Waste Bank Units (WBUs) selected as the research sites. These WBUs were selected because they were actively operating under the coordination of the Central Waste Bank (BSI) and represented different operational characteristics, membership sizes, and management capacities. Collectively, the selected WBUs had approximately 362 active registered customers.

The target population for the quantitative phase consisted of all active customers registered in the selected Waste Bank Units. A non-probability purposive sampling technique was employed because the study required respondents with direct experience in household waste management through Waste Bank activities. Respondents were selected based on the following inclusion criteria: (1) being registered as an active Waste Bank customer, (2) having deposited recyclable waste at least twice during the previous three months, and (3) voluntarily agreeing to participate in the study.

Although the selected Waste Bank Units had approximately 362 active customers, participation in the survey was voluntary. Consequently, only customers who met the inclusion criteria and were willing to complete the questionnaire during the data collection period were included in the study. A total of 100 respondents participated in the quantitative survey. This sampling approach ensured that the collected data reflected the experiences of active Waste Bank participants while maintaining voluntary participation in accordance with research ethics.

For the qualitative phase, purposive sampling was also employed to select information-rich informants who were directly involved in Waste Bank management and policy implementation. A total of 15 key informants participated in the interviews, comprising three representatives from the Batam City Environmental Agency (DLH), two representatives from the Central Waste Bank (BSI), and managers of the ten selected Waste Bank Units. These informants were chosen because of their roles in planning, implementing, and supervising community-based waste management programmes. Their perspectives were used to explain the quantitative findings, identify the factors contributing to the participation gap, and formulate strategic recommendations through the SWOT analysis.

Research Location

The method describes the approach used in the research, including the research design, population and sample, data collection instruments, and analysis techniques. The description should be clear enough so that it can be replicated by other researchers. If using an existing method, provide appropriate references.

The Batam Kota Subdistrict is one of 12 subdistricts in the City of Batam, established pursuant to Local Regulation No. 2 of 2005 on Subdistrict Expansion. This subdistrict consists of six urban villages: Baloi Permai, Taman Baloi, Sungai Panas, Belian, Teluk Tering, and Sukajadi. In 2024, the population of Batam Kota Subdistrict was recorded at 212,048 people (BPS Kota Batam, 2025), with the largest population concentration in Belian Village. High population density, particularly in areas such as Sungai Panas, leads to increased domestic activities and the potential for household waste generation. Data from the Batam City Environmental Agency (Dinas Lingkungan Hidup) shows that the potential daily waste generation in the Batam Kota District's reached 131,699.2 kg per day in 2024 and increased to 134,572.8 kg per day in 2025, necessitating effective and participatory management strategies.

As part of the 3R (*reduce, reuse, recycle*)-based waste management policy, the Batam City Government, through the DLH, is promoting the development of Waste Bank Unit (BSU) as a tool for reducing waste at the source. According to 2024 data from the Batam City Environmental Agency (DLH), there are 31 BSU in Batam Kota District, with 24 BSU managed by the community

out of a total of 163 BSU across the entire city of Batam. These BSU operate under the coordination of the Central Waste Bank (BSI) and are managed by the community, schools, and other institutions.

Table 1.
Waste Banks in the Study Area

Name of Waste Bank Unit	Village	Location	Year Established	Number of Active Customers (approx.)
Frensiana Bersinar	Belian	Frensiana Garden	2023	50
Legend of Bali	Baloi Permai	Legend of Bali	2015 / 2023	>50
Maju Jaya	Belian	Mediterranean Park	2024	25
Eternal Jasmine	Baloi Permai	Legend of Malacca	2021	12
Paper Flowers	Belian	Taman Raya Phase 2	2015 / 2024	30
Mediterranean Series	Belian	Mediterranean Park	2015	25
Carnation	Baloi Permai	Legend of Malacca	2010	10
Perumnas	Sungai Panas	Nusa Jaya Housing Complex	2023	>80
Jelita	Belian	Taman Raya Phase 4	2019	30
Mutiara Decade	Belian	Bukit Raya	2017	50
Total				362

This study employs a mixed-methods approach using a sequential explanatory design, which involves the gradual integration of quantitative and qualitative methods, where quantitative data are analyzed first and then explored in greater depth through qualitative data. This approach was chosen to gain a more comprehensive understanding of the effectiveness of waste bank management, particularly in linking community participation levels to the formulation of management strategies. The use of this design is based on Creswell (2014), who states that mixed methods can provide a more complete understanding compared to the use of a single method.

The study was conducted in Batam Kota Subdistrict, Batam City, focusing on 10 Waste Banks (BSU) selected as the study sites. The population in this study consisted of all active waste bank customers at the study sites. The sampling technique used purposive sampling, with the following respondent criteria: (1) being an active waste bank customer, (2) having deposited waste at least twice in the past three months, and (3) being willing to participate as a research respondent. Based on these criteria, a total of 100 respondents were selected. This number is considered adequate for community-based social research aimed at describing the phenomenon of community participation (Sugiyono, 2019).

Quantitative data were collected via a questionnaire designed based on community participation indicators derived from the concept proposed by Cohen and Uphoff (1980), which encompasses four dimensions:

participation in decision-making, implementation, utilization of outcomes, and evaluation. The research instrument used a Likert scale with a range of 1–5. Validity was tested using Pearson’s Product-Moment correlation, while reliability was assessed using Cronbach’s Alpha, with an alpha value > 0.70 indicating that the instrument is reliable (Ghozali, 2018). Qualitative data were obtained through in-depth interviews, field observations, and document analysis. Informants were selected through purposive sampling, including waste bank managers, representatives from the Environmental Agency (DLH), and relevant partners such as corporate social responsibility (CSR) entities. Qualitative data was used to strengthen, explain, and interpret the quantitative results, particularly in identifying internal and external factors influencing the effectiveness of waste bank management.

To ensure the validity of the data, this study employed triangulation techniques, including both source triangulation and methodological triangulation. Source triangulation was conducted by comparing information from various informants, while methodological triangulation was carried out by comparing the results of questionnaires, interviews, and observations (Sugiyono, 2019). This approach aims to enhance the validity and credibility of the research findings.

Data analysis was conducted in several stages. First, quantitative analysis was used to measure the level of community participation and describe the empirical conditions. Second, qualitative analysis was used to identify strategic factors, which were then classified into

internal factors (strengths and weaknesses) and external factors (opportunities and threats). Next, the IFAS (Internal Factor Analysis Summary) and EFAS (External Factor Analysis Summary) matrices were compiled. The determination of weights in the IFAS and EFAS was based on the relative importance of each factor, with a total weight of 1.00. Meanwhile, ratings are assigned based on actual conditions in the field using a 1–4 scale, where a score of 1 indicates a very weak condition or major threat, and a score of 4 indicates a very strong condition or major opportunity. Scores are obtained by multiplying the weight by the rating. The results of the IFAS and EFAS calculations are then used to determine the organization’s position within the SWOT quadrant diagram, which serves as the foundation for formulating a contextual and practical waste bank management strategy in Batam City.

Instrument Validity and Reliability

The quantitative instrument consisted of 13 questionnaire items grouped into three constructs: household waste sorting (3 items), waste reduction and reuse practices (7 items), and the role of Waste Banks (3 items). Prior to the main analysis, the questionnaire was tested for validity and reliability using responses from the 100 survey participants.

Construct validity was assessed using the Pearson Product-Moment correlation by comparing the calculated item-total correlation coefficient (r-value) with the critical value (r-table = 0.197; α = 0.05; n = 100). Internal consistency was evaluated using Cronbach's Alpha. The validity and reliability tests were calculated using Microsoft Excel based on the Pearson Product-Moment correlation formula and Cronbach's Alpha coefficient.

Table 2.
Validity and Reliability Test Results

Construct	Number of Items	Calculated r-value	Cronbach's Alpha	Interpretation
Household Waste Sorting	3	0.619–0.753	0.473	All items were valid
Waste Reduction and Reuse	7	0.440–0.649	0.487	All items were valid
Role of Waste Banks	3	0.538–0.827	0.332	All items were valid

The validity test indicated that all questionnaire items had calculated correlation coefficients exceeding the critical value ($r = 0.197$), confirming that every item was empirically valid and suitable for measuring the intended variables. The calculated r-values ranged from 0.440 to 0.827, indicating acceptable item discrimination across all constructs.

The Cronbach's Alpha coefficients ranged from 0.332 to 0.487, which are below the conventional threshold commonly recommended for psychometric scale development. However, these values should be interpreted cautiously because each construct consisted of a relatively small number of questionnaire items, particularly the household waste sorting and Waste Bank role constructs, each containing only three items. Previous methodological studies have shown that Cronbach's Alpha is highly sensitive to the number of items within a scale, and instruments with few items frequently produce lower alpha values despite demonstrating acceptable content validity (Taber, 2018).

Furthermore, this study employed a descriptive mixed-methods approach aimed at evaluating community participation rather than developing or validating a latent measurement model. To strengthen the credibility of the

findings, the quantitative results were triangulated with in-depth interviews, field observations, and document analysis. Therefore, the instrument was considered appropriate for describing community participation patterns and supporting the integration of quantitative and qualitative findings.

Instrument Validity, Reliability, and Data Analysis

The quantitative instrument consisted of 13 questionnaire items grouped into three constructs: household waste sorting (3 items), waste reduction and reuse practices (7 items), and the role of Waste Banks (3 items). Prior to the main analysis, the questionnaire was tested for validity and internal consistency using responses from the 100 survey participants. Item validity was assessed using the Pearson Product-Moment correlation by comparing the calculated item-total correlation coefficient with the critical value (r-table = 0.197; α = 0.05; n = 100). Reliability was evaluated using Cronbach's Alpha. All statistical analyses were performed using Microsoft Excel.

Table 3.

Validity and Reliability Test Results

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The validity test demonstrated that all questionnaire items exceeded the critical correlation value ($r = 0.197$), with calculated correlation coefficients ranging from 0.440 to 0.827, indicating that all items were empirically valid for measuring the intended constructs. The Cronbach's Alpha coefficients ranged from 0.332 to 0.487. Although these values are lower than the conventional threshold commonly applied in psychometric scale development, they should be interpreted with caution because each construct contained only three to seven items. Previous methodological studies have shown that Cronbach's Alpha is highly sensitive to the number of items within a scale, and relatively low alpha values are common in instruments with few items (Taber, 2018). Furthermore, this study adopted a descriptive mixed-methods approach in which quantitative findings were triangulated with in-depth interviews, field observations, and document analysis, thereby strengthening the credibility of the research findings.

Following the instrument testing, quantitative data were analysed using descriptive statistics, including frequencies, percentages, and mean scores, to describe respondent characteristics and community participation in

household waste management through Waste Banks. To examine the relationships among the study variables, Spearman's Rank Correlation analysis was performed because the questionnaire data were measured using a five-point Likert scale, producing ordinal data that did not require the assumption of normality. The analysis examined the relationships between household waste sorting, waste reduction and reuse practices, the role of Waste Banks, and community participation.

Qualitative data obtained from interviews, field observations, and document analysis were analysed thematically to identify factors influencing community participation and Waste Bank management. Finally, the quantitative and qualitative findings were integrated through SWOT analysis. Internal and external strategic factors identified from both datasets were compiled into the Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) matrices. Each factor was assigned a weight according to its relative importance and a rating based on field conditions. The weighted scores were then used to determine the strategic position of Waste Bank management and formulate appropriate development strategies.

respondents were within the productive age group (26–35 years), suggesting that participation was largely driven by economically active community members. In terms of educational attainment, most respondents had completed a bachelor's degree, followed by senior high school education and diploma-level education. Regarding occupation, housewives represented the largest respondent group, followed by private-sector employees, entrepreneurs, and government employees. These findings indicate that participation in Waste Bank activities involved individuals from various educational and occupational backgrounds, providing a broad representation of the community participating in household waste management in Batam Kota District.

RESULT AND DISCUSSION

A total of 100 active Waste Bank customers participated in the quantitative survey. Table 1 presents the demographic characteristics of the respondents, including gender, age, educational attainment, and occupation. Reporting these characteristics provides an overview of the respondents' socio-demographic profile and supports the interpretation of community participation in household waste management through Waste Banks.

Overall, the respondents represented diverse demographic backgrounds. Female respondents constituted the majority of the participants, indicating that women played a more dominant role in household waste management and Waste Bank activities. Most

Table 4.

Demographic Characteristics of Respondents (n = 100)

Characteristic	Category	Frequency (n)*	Percentage (%)*
Gender	Male	20	20.0
	Female	80	80.0

Characteristic	Category	Frequency (n)*	Percentage (%)*
Age (years)	18–25	5	5.0
	26–35	54	54.0
	36–45	30	30.0
	>45	11	11.0
Education	Senior High School (SMA/SMK)	29	29.0
	Diploma	15	15.0
	Bachelor's Degree (S1)	54	54.0
	Postgraduate (S2/S3)	2	2.0
Occupation	Housewife	38	38.0
	Private Employee	23	23.0
	Entrepreneur	22	22.0
	Government Employee	15	15.0
	Student	2	2.0

***The frequencies and percentages should be adjusted according to the final cleaned dataset used in the analysis (n = 100).**

This study was conducted at ten Waste Bank Units (BSU) in Batam Kota Subdistrict, which varied in terms of the number of customers, activity levels, and institutional support. Observation results showed that all Units (100%) were still operational, though with varying levels of effectiveness. The average number of active members reached 36 households per unit, with the Perumnas BSU being the most active unit (>80 members). This variation indicates that the sustainability of Waste Banks is not solely determined by the existence of the program but is significantly influenced by institutional capacity, active management, and external support such as the Environmental Agency (DLH), the Central Waste Bank (BSI), and partnerships with the private sector.

In terms of community participation, the research findings indicate that 68% of respondents possess a good level of knowledge regarding household waste management; however, only 35% consistently sort waste at the source. This gap indicates that knowledge has not yet been fully internalized into actual behavior. This aligns with the Theory of Planned Behavior (Ajzen, 1991), which

asserts that individual behavior is influenced not only by knowledge but also by structural factors such as ease of access, social support, and availability of facilities. These findings are also consistent with the research by Solihin et al. (2019) and Wiludjeng and Rahayuningsih (2024), which show that community participation is significantly influenced by service quality, institutional support, and the ease of the operational system.

Furthermore, economic motivation is a dominant factor in driving community participation, with 61% of respondents stating that the resale value of waste is the primary reason for their involvement. This indicates that community participation remains instrumental (economically driven) rather than based on intrinsic environmental awareness. These findings reinforce the results of studies by Asteria and Heruman (2016) and Hasnam et al. (2017), which confirm that economic incentives are the primary drivers of the success of the Waste Bank program, particularly during the initial implementation phase. Empirically, household waste management practices at the field level show that although sorting has been carried out at the source, the effectiveness of subsequent management still depends heavily on the capacity of each unit.

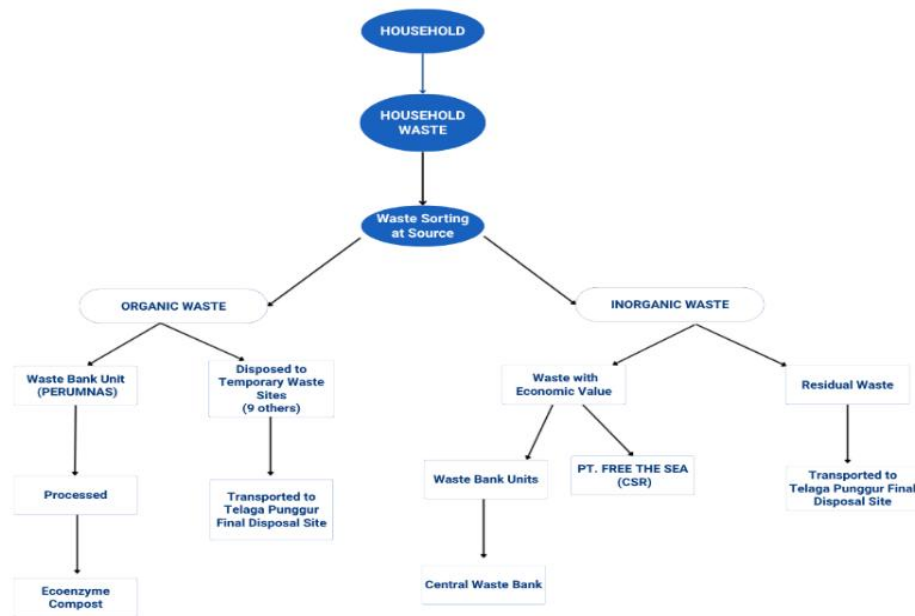


Figure 1. Illustrates the household waste management flow

Figure 1 illustrates the household waste management flow based on the Waste Bank system in Batam Kota District, starting from the source-separation process into organic and non-organic waste. In the organic waste stream, the majority of Waste Bank Units (9 out of 10 WBUs) lack processing capacity, so the waste is directly disposed of at collection points and ultimately ends up at the Telaga Punggur Final Processing Site (FPS). Only one unit, the Perumnas Waste Bank, has been able to process organic waste into valuable products such as compost and ecoenzymes.

In the non-organic waste stream, waste with economic value is channeled through Waste Banks to the Central Waste Bank or via direct partnerships with the private sector, such as PT Free The Sea. Meanwhile, non-organic waste with no economic value (residue) is still disposed of at the TPA. This situation indicates that although waste sorting has been implemented at the household level, a portion of the waste stream still ends up as residue due to limitations in processing capacity and distribution networks.

This model underscores that the effectiveness of waste management is determined not only by sorting behavior at the source but also by the technical processing capacity and the strength of partnerships held by each Waste Bank Unit.

In the management of non-organic waste, the majority of Waste Bank Units (8 out of 10 units) still rely on the Central Waste Bank (BSI) as their primary distribution partner, which under certain conditions leads to waste accumulation due to limited absorption capacity and selectivity regarding the types of waste accepted. Conversely, units with direct partnerships with the private sector, such as BSU Perumnas and Dasawisma Mutiara

with PT Free The Sea, demonstrate a more stable management flow and generate higher economic value. Additionally, a small portion of non-organic waste is repurposed into handicraft products, though still on a limited scale.

Overall, these conditions indicate that the current waste management system remains fragmented and has not yet been fully integrated into a circular economy framework. The effectiveness of management is not solely determined by source separation processes but also heavily depends on institutional capacity and the strength of partnership networks. These findings align with the research by Wiludjeng and Rahayuningsih (2024), which emphasizes that limited technical capacity and reliance on a single partner are the main constraints in Waste Bank management. Therefore, diversifying partnerships and enhancing processing capacity are key strategies for strengthening the sustainability of community-based waste management systems.

The quantitative findings revealed a notable participation gap among active Waste Bank customers. Although respondents demonstrated a relatively high level of knowledge regarding household waste management, as reflected by the high scores for waste sorting awareness, the actual level of participation in Waste Bank activities remained relatively low. This finding indicates that knowledge alone was insufficient to encourage consistent participation in household waste management practices.

The qualitative findings provide several explanations for this discrepancy. Interviews with representatives of the Batam City Environmental Agency (DLH), the Central Waste Bank (BSI), and Waste Bank Unit managers indicated that many community members

understood the importance of waste segregation and recycling but did not consistently implement these practices. Limited available time, competing household and work responsibilities, and irregular participation in Waste Bank activities were identified as important barriers to sustained engagement.

In addition, several informants explained that the economic incentives offered by Waste Banks were generally perceived as modest and were therefore insufficient to motivate continuous participation. Operational factors, including limited collection schedules and accessibility of some Waste Bank Units, also reduced the frequency of community participation. These findings suggest that participation is influenced not only by environmental awareness but also by practical, economic, and institutional factors that affect people's ability and willingness to engage in Waste Bank programmes.

Overall, the results demonstrate that improving public knowledge alone is unlikely to substantially increase participation. Greater community involvement requires supportive institutional arrangements, accessible Waste Bank services, consistent community engagement programmes, and incentive mechanisms that encourage sustained participation in household waste management.

Waste Bank Management Strategies Based on SWOT Analysis

The results of the weighting and evaluation on the IFAS matrix yielded a total score of approximately ± 3.15 . This value is above the scale average (2.5), indicating that internally, the Waste Bank in Batam Kota Subdistrict has relatively strong conditions. The largest contributions stem from institutional support from the DLH and BSI, as well as the CSR partnership with PT Free The Sea (each scoring 0.60), which are dominant factors in sustaining operational sustainability. Nevertheless, several weaknesses—such as the suboptimal processing of organic waste and dependence on BSI—continue to exert pressure on the unit's performance at the operational level.

Meanwhile, the EFAS matrix yields a total score of ± 2.95 , which is also above the midpoint of the scale and indicates that external opportunities outweigh threats. Increased public awareness of the 3R principles is the most significant opportunity with the highest score (0.80), followed by national policy support and the potential of the recycling market. On the other hand, threats such as increased waste generation and fluctuations in selling prices still need to be anticipated. Overall, the combination of IFAS and EFAS scores places Waste Bank management in a sufficiently strategic position to be developed through a strategy of leveraging strengths to capture available opportunities.

Table 5.
IFAS and EFAS Tables

INTERNAL FACTORS	WEIGHT	RATING	SCORE
STRENGTHS (S)			
Support From DLH And BSI	0.15	4	0.60
'S Active Management in Several Bsu	0.10	3	0.30
Csr Partnership (PT Free The Sea)	0.15	4	0.60
Orderly Unit Administration System	0.10	3	0.30
WEAKNESSES (W)			
Organic Processing Not Yet Optimal	0.15	2	0.30
Reliance on Bsi	0.15	2	0.30
Limited Infrastructure	0.10	2	0.20
Inconsistent Participation	0.10	2	0.20
TOTAL	1.00		3.10 – 3.20 (≈ 3.15)
EXTERNAL FACTORS	Weight	Rating	Score
OPPORTUNITIES (O)			
Increased Awareness of The 3rs	0.20	4	0.80
Recycling Market Potential	0.15	3	0.45
National Policy Support (Jakstranas)	0.15	3	0.45
Csr Partnership Opportunities	0.10	3	0.30
THREATS (T)			
Increase In Waste Generation	0.15	2	0.30
Fluctuations In Selling Prices	0.10	2	0.20

Partner Dependency	0.10	2	0.20
Landfill Overload	0.05	2	0.10
TOTAL	1.00		2.90 – 3.00 (≈2.95)

The results in Table 5, show a total IFAS score of approximately 3.15 and an EFAS score of approximately 2.95, both of which are above the midpoint of the scale (2.5). Numerically, an IFAS score exceeding 3.0 reflects that the internal strengths of Bank Sampah particularly institutional support from DLH and BSI, as well as structural CSR partnerships—are more dominant than existing weaknesses. A deviation of +0.65 from the midpoint indicates that the system has a relatively solid internal foundation for development. On the other hand, the EFAS score of +0.45 above the midpoint indicates that the external environment still offers greater opportunities than threats. This means that challenges such as increasing waste generation and price fluctuations have not yet reached a level that significantly weakens the strategic position. When both scores are projected onto a SWOT diagram, their coordinates place the Waste Bank management in Quadrant I. This position is not merely descriptive but strategically recommends an aggressive approach (SO Strategy), namely leveraging internal strengths to the fullest to capture available external opportunities before potential threats escalate further. Thus, both quantitatively and strategically, the management of the Waste Bank in Batam Kota Subdistrict is in a phase suitable for expansion and policy strengthening.

Based on the results of the IFAS and EFAS calculations, the management of the Waste Bank in Batam Kota District falls into Quadrant I (SO Strategy). This position indicates relatively dominant internal strengths supported by significant external opportunities. Consequently, the recommended development direction is an aggressive strategy (*growth-oriented strategy*), which involves leveraging institutional strengths and partnership support to optimize opportunities for the sustainable development of community-based waste management.

The weighted score for each factor was calculated by multiplying its assigned weight by the corresponding rating. The total weighted scores obtained from the IFAS and EFAS matrices were subsequently used to determine the strategic position of Waste Bank management and to formulate priority development strategies using the SWOT matrix.

The SWOT analysis was conducted to determine the strategic position of community-based household waste management through Waste Banks in Batam Kota District. The Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) matrices were developed by calculating the weighted scores of all identified internal and external strategic factors. The total weighted scores obtained from both matrices are presented in Table 6.

Table 6.
Summary of IFAS and EFAS Scores

Matrix	Total Weighted Score	Interpretation
Internal Factor Analysis Summary (IFAS)	3.15	Strong internal condition
External Factor Analysis Summary (EFAS)	2.95	Favorable external condition

As shown in Table X, the total weighted score for the Internal Factor Analysis Summary (IFAS) was 3.15, while the External Factor Analysis Summary (EFAS) yielded a score of 2.95. These values were obtained by summing the weighted scores of all internal and external strategic factors identified through the integration of quantitative survey results, qualitative interviews, field observations, and document analysis. Unlike score ranges, the reported values represent the final calculated totals of the IFAS and EFAS matrices.

The IFAS score indicates that the Waste Bank programme possesses stronger internal strengths than weaknesses, reflecting favourable institutional capacity

and community support for household waste management. Similarly, the EFAS score demonstrates that external opportunities outweigh potential threats, suggesting that the programme operates within a supportive external environment. Based on these final scores, the strategic position of the Waste Bank programme is located in Quadrant I, indicating that a growth-oriented (SO) strategy is the most appropriate strategic direction. This strategy emphasizes maximizing existing strengths to capitalize on available opportunities while further strengthening community participation and institutional collaboration in sustainable household waste management.

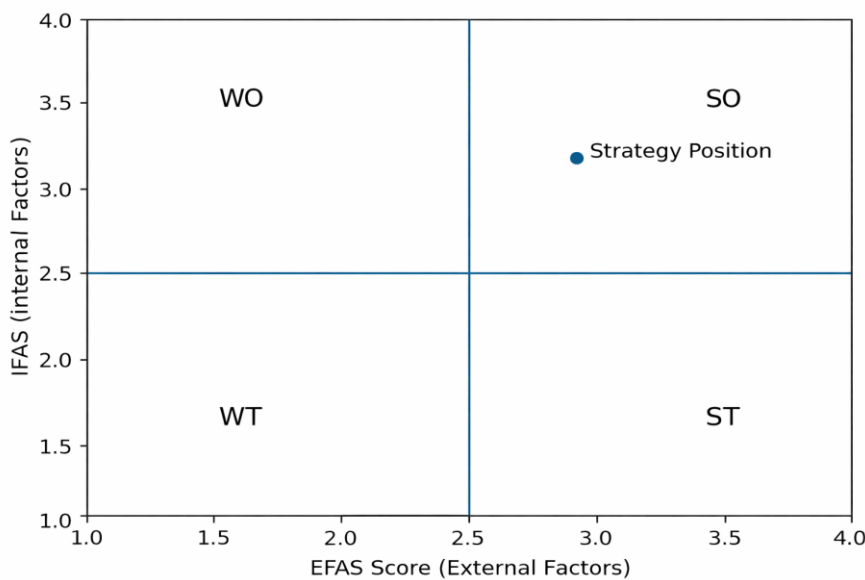


Figure 2. Quadrant 1 (*Strengths-Opportunities*)

The position of the Waste Bank management in Batam Kota Subdistrict in Quadrant I (SO Strategy) indicates that the program’s strengthening is based on a sufficiently solid internal foundation and is supported by a clear local regulatory framework. Batam City Regulation No. 11 of 2013 on Waste Management emphasizes the local government’s obligation to implement integrated waste reduction and management, while Batam Mayor Regulation No. 5 of 2023 reinforces the technical and operational aspects of its implementation. In this context, the aggressive strategy (SO) can be directed toward optimizing institutional support from the DLH, strengthening the capacity of Waste Banks, and expanding cross-sectoral partnerships to support the goal of waste reduction at the source. By leveraging existing internal strengths and available policy opportunities, the Waste Bank has the potential to become the primary implementation instrument of local policies in reducing the burden on the Telaga Punggur Landfill and driving the transformation of waste management toward a more sustainable and participatory system in Batam City.

The SWOT analysis in this study indicates that the management of the Waste Bank in Batam Kota District falls into Quadrant I (SO Strategy), with an IFAS score of approximately 3.15 and an EFAS score of approximately 2.95. These values are above the midpoint of the scale (2.5), meaning that internal strengths relatively dominate over weaknesses, and external opportunities still outweigh threats. This position indicates a progressive condition, where the organization possesses sufficiently strong internal capacity to optimally leverage external opportunities through an aggressive strategy (*growth-oriented strategy*).

These findings share similarities and differences with several previous studies. Putri et al. (2023), in their study on the sustainability of the Padang City Waste Bank using SWOT analysis, also identified an opportunity (SO),

recommending institutional strengthening and the integration of industrial partnerships as off-takers within the *Alternative Fuel and Raw Material* (AFR) scheme. The primary strengths in that study lie in stakeholder support and an established distribution network, making a collaborative expansion strategy a rational choice. Meanwhile, Hasnam et al. (2017) in their study of the WPL Depok Waste Bank obtained an IFE score of 2.713 and an EFE score of 2.489, placing the organization in Position V of the IE Matrix (*hold and maintain*). This position indicates a stable condition but one that is not yet strong enough for aggressive expansion; therefore, the recommended strategy is more gradual in nature, such as market penetration and step-by-step product development. These differences in strategic position demonstrate that the dominance of internal factors and the magnitude of external opportunities are crucial in determining the direction of the policies adopted.

Furthermore, the SWOT approach, combined with network strengthening and business planning as discussed by Hasnam et al. (2017), emphasizes the importance of managerial capacity, partner diversification, and a focus on social entrepreneurship in ensuring the sustainability of the Waste Bank. This perspective positions the Waste Bank not merely as an environmental management tool, but also as a socio-economic entity requiring collaborative and adaptive strategies. In the context of Batam City, the existence of a CSR partnership with PT Free The Sea, along with regulatory support through Batam City Regulation No. 11 of 2013 and Mayor’s Regulation No. 5 of 2023, serves as a differentiating factor that strengthens internal positioning and expands external opportunities. This combination drives the IFAS and EFAS scores into the “strong” category and places Waste Bank management in Quadrant I, which comparatively indicates a more

progressive position compared to studies still in the stabilization phase.

Conceptually and empirically, this study makes an original contribution by integrating an analysis of institutional effectiveness and SWOT strategies with the dynamics of community participation. Unlike previous studies that emphasized institutional aspects or business strategies, this study simultaneously examines the relationship between levels of knowledge, economic motivation, and consistency of community behavior with the organization's strategic position within the SWOT matrix. Thus, the resulting Quadrant I position reflects not only structural strengths but also indicates sufficient social capital and participatory support to drive system development. In the context of Batam as an industrial city and MICE hub with high waste generation pressures and an overloaded landfill, these findings enrich the literature on Waste Bank management by demonstrating that the integration of local policies, CSR partnerships, and community participation can drive a more progressive, collaborative, and sustainable management model.

The SWOT analysis was conducted by integrating the quantitative survey findings, qualitative interview results, field observations, and document analysis to identify the internal and external factors influencing community participation in household waste management through Waste Banks. Internal factors were classified into strengths and weaknesses, whereas external factors were classified into opportunities and threats.

The weighting and rating procedures followed the Internal Factor Analysis Summary (IFAS) and External Factor Analysis Summary (EFAS) framework proposed by David (2011) and Rangkuti (2017), which has been widely adopted in strategic management and Waste Bank studies (Putri et al., 2023; Sari & Safitri, 2021; Viareco et al., 2024). The initial SWOT factors were identified from the empirical findings obtained through questionnaires, in-depth interviews, field observations, and document analysis.

Each internal and external factor was subsequently assigned a weight according to its relative importance and a rating reflecting its current condition in the study area. The weighting and rating process was conducted by the researchers through analytical judgement based on the convergence of evidence obtained from multiple data sources rather than relying solely on individual judgement. Factors that consistently emerged across the quantitative findings, qualitative interviews, field observations, and supporting documents were assigned higher weights than factors with limited empirical support. This triangulation approach was intended to minimise subjective bias and ensure that the assigned weights reflected the overall empirical findings while remaining consistent with the IFAS and EFAS evaluation procedures described in previous studies (David, 2011; Rangkuti, 2017; Putri et al., 2023; Sari & Safitri, 2021; Viareco et al., 2024).

CONCLUSIONS

The research results indicate that community participation in household waste management through the Waste Bank in Batam Kota Subdistrict remains suboptimal. Although the majority of the community has a good level of knowledge (68%), only a small portion consistently practices source separation of waste (35%). This situation indicates a gap between knowledge and behavior, suggesting that raising awareness alone is insufficient to promote sustainable waste management practices. Community participation tends to be influenced by external factors, particularly economic incentives, accessibility of facilities, and institutional support.

Based on the SWOT analysis, Waste Bank management in Batam Kota Subdistrict is in Quadrant I (SO Strategy), indicating that the system possesses relatively dominant internal strengths and significant external opportunities for development. Thus, the Waste Bank has the potential to become a strategic instrument in supporting the implementation of community-based waste management policies and reducing dependence on the Final Processing Site (FPS) in Batam City.

SUGGESTION

Future researchers should expand the scope of study by including multiple cities or regions to enable comparative analysis of socio-economic, cultural, and institutional factors influencing waste bank effectiveness and participation levels. In addition, researchers are encouraged to incorporate quantitative and longitudinal approaches to better assess changes in participation behavior and program effectiveness over time, while also examining behavioral and social factors such as environmental awareness, incentives, and community norms that shape public engagement.

Furthermore, future studies should analyze the economic and financial sustainability of waste banks, including cost-benefit aspects and long-term viability, while also exploring the integration of digital technologies to improve management efficiency and participation. It is also important to assess the role of policy and governance frameworks, as well as stakeholder collaboration involving government, private sector, and community actors. Lastly, more attention should be given to innovation in waste processing methods and their integration within waste bank systems to support sustainable and circular waste management practices.

REFERENCES

- Anyanwu, L. E., Felix, O. O., Ejike, I. W., & Onyewuchi, I. (2025). *Community-based waste management strategies and their impact on urban sustainability through citizen participation and local government collaboration*. [Publisher]
- Dhifira, F. (2025). *Efektivitas Pengelolaan Bank Sampah Inspirasi Madani di Pekanbaru*. 5(1), 228–240. [Publisher]

- Fitrianto, A. R., Nawangsari, A. T., & Agustin, R. (2024). *ASEAN Journal of Community Revitalizing the On-Campus Waste Bank: Promoting Community Environmental Awareness and Improving Waste Management Efficiency Revitalizing the On-Campus Waste Bank: Promoting Community Environmental Awareness and Improving Waste Management Efficiency*. 8(1), 24–44. [[Crossref](#)] [[Publisher](#)]
- He, Y., Zaremohzzabieh, Z., Rahman, H. A., Norkhadajah, S., & Ismail, S. (2024). *Applying participatory research in solid waste management: A systematic literature review and evaluation reporting*. 8(5), 1–28. [[Crossref](#)] [[Publisher](#)]
- Koko, I. W., & Lee, C. (2024). Achieving zero waste for landfills by employing adaptive municipal solid waste management services. *Ecological Indicators*, 165(June), 112191. [[Crossref](#)] [[Publisher](#)]
- Margaretha, R. (2025). *Strategic SWOT Analysis of Municipal Solid Waste Management and Waste Bank System in Bandung City: Toward a Circular and Sustainable Urban Future*. 146–157. [[Crossref](#)] [[Publisher](#)]
- Prabawati, A., Frimawaty, E., & Haryanto, J. T. (2023). *Strengthening Stakeholder Partnership in Plastics Waste Management Based on Circular Economy Paradigm*. 1–14. [[Crossref](#)] [[Publisher](#)]
- Thanh, T., Phan, T., Nguyen, V. V., & Lee, C. (2023). *Establishing an evaluating framework under integrating adaptive capacity for community-based plastic waste management*. October, 1–13. [[Crossref](#)] [[Publisher](#)]
- Ulhasanah, N., Suhardono, S., Hung, C., Sabila, A., Alisha, F., & Wayan, Z. I. (2025). Modelling participation in waste bank initiatives at public transport hubs to advance circular economy development. *Discover Sustainability*. [[Crossref](#)] [[Publisher](#)]
- Valentina, T. R., Putera, R. E., & Salsabila, L. (2025). *International Journal of Sustainable Development and Planning Collaborative Governance in Handling the Waste Crisis: A Systematic Literature Review*. 20(2), 761–770. [[Publisher](#)]
- Zahra, P. Al, & Shohibuddin, M. (2025). *A Community-Driven Approach to Urban Waste Management: Insights from the Kenanga Waste Bank , Bogor , Indonesia*. 13(1), 306–327. [[Crossref](#)] [[Publisher](#)]
- Zahra, P. A., & Shohibuddin, M. (2025). *A Community-Driven Approach to Urban Waste Management: Insights from the Kenanga Waste Bank* (Vol. 13, Issue 1, pp. 306–327). [[Crossref](#)]