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Sustainable waste management strategy based on circular economy in Pangkalpinang City

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Abstract
Purpose: This study aims to formulate a circular economy-based waste management strategy to support the achievement of the Sustainable Development Goals (SDGs) in Pangkalpinang City.
Research Methodology: This research employs a descriptive quantitative approach using the Analytic Hierarchy Process (AHP). It involves 15 stakeholders from the Pentahelix sectors (government, business actors, academics, community organizations, and media) to evaluate five criteria—government policy, infrastructure, community participation, recycling technology, and economic impact—as well as five strategic alternatives: enhancing recycling facilities, environmental education, strengthening regulations, implementing automation technology, and providing economic incentives.
Results: The study findings indicate that strengthening government regulations (weight: 1.469) emerges as the highest priority, signifying that regulatory reinforcement is considered the cornerstone of an effective and sustainable waste management system. Enhancing recycling facilities (weight: 0.901) and implementing automation technology (weight: 0.899) follow closely, emphasizing the importance of infrastructure and technological advancements. Community participation is identified as the most influential criterion in the successful implementation of the strategy (27.01%), underscoring the crucial role of public engagement in waste sorting and recycling programs. This study highlights that government efforts to strengthen regulations and policies should effectively drive active community participation in waste management toward a circular economy.
Limitations: This study is limited to waste management within the administrative area of Pangkalpinang City.
Recommendations: The findings provide practical recommendations for policymakers in designing and implementing more effective policies. This study advocates for multi-sectoral collaboration to comprehensively address waste management challenges in Pangkalpinang City, thereby supporting more sustainable urban development and delivering greater environmental, social, and economic benefits.
Keywords: *Circular Economy, Waste Management, SDGs, AHP, Pangkalpinang City*
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1. Introduction

Waste management is a key issue in achieving the Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities) and SDG 12 (Responsible Consumption and Production). The significant population growth in various cities worldwide, including Pangkalpinang, has led to emerging environmental and social challenges, especially due to suboptimal waste management, exacerbated by increasing waste generation (Firdausi, 2024). Effective waste management is crucial for maintaining environmental cleanliness and public health in every province. Inefficient waste management can lead to various environmental problems (Darmaraja, Casini, Jalilah, & Aropah, 2024; Maskur, Basir, & Dewi, 2024; Setyawan & Siallagan, 2024).

Poorly managed waste has the potential to contaminate soil and water, generate harmful greenhouse gas emissions that contribute to climate change, and pose health risks to humans. Open burning of waste, a common practice among communities in handling waste, can produce dioxins and furans, which pose significant health and environmental risks (Sadat et al., 2024).

Pangkalpinang is a city located in Bangka Belitung Province that has an important role in the Indonesian economic process. Its natural beauty and cultural diversity make it a potential center for sustainable economic growth (Reniati et al., 2023). According to the Environmental Agency, Pangkalpinang City has only one final disposal site (TPA) called Parit Enam Bacang, located in Bukit Intan District, covering an area of 4.7 hectares. This landfill is already over capacity, struggling to accommodate the city's daily waste production, which ranges between 150 to 200 tons. The excessive waste volume often leads to overcapacity at the Parit Enam landfill, resulting in potential environmental pollution, including air and water contamination (Marlianto, 2022). The waste is predominantly organic and household waste, causing various issues affecting community well-being, in addition to environmental problems such as unpleasant odors for nearby residents (ANTARA, 2024).

Waste management at Parit Enam landfill is still carried out using the sanitary landfill system, where waste is buried in a trench, compacted, and covered with soil. This method leads to unpleasant odors in the area, especially during the rainy season (Marlianto, 2022). The circular economy approach is considered an effective solution to urban waste problems, as it minimizes landfill disposal while maximizing recycling (Blomsma et al., 2019).

The circular economy aims to create a sustainable resource utilization cycle by reducing the consumption of raw materials and repurposing used products (Ghisellini, Cialani, & Ulgiati, 2016). As a developing city, Pangkalpinang has significant potential to adopt circular economy-based waste management strategies. This approach is expected to reduce the volume of waste ending up in landfills while improving resource efficiency at the local level (D'Adamo, Daraio, Di Leo, Gastaldi, & Rossi, 2024).

2. Literature Review

2.1 Circular Economy Theory

The circular economy is an economic concept focused on maintaining the value of products, materials, and resources for as long as possible by creating a closed-loop system, in contrast to the traditional linear economy model, often referred to as "take, make, dispose" (Ghisellini et al., 2016). The linear economy relies on the continuous use of raw materials, ultimately generating large amounts of waste, which negatively impacts the environment. In contrast, the circular economy aims to minimize waste through a sustainable usage cycle (Blomsma et al., 2019; Ebuka, Emmanuel, & Idigo, 2023).

The implementation of the circular economy seeks to convert waste into economically valuable resources, reduce dependence on new natural resources, and lower greenhouse gas emissions. Applying circular economy principles to waste management can generate significant economic benefits and support the achievement of the Zero Waste 2050 target (Kurnia, Alamsyahbana, Chartady, Arifin, & Sesaria, 2023). Waste is no longer perceived as the end of the cycle but rather as a new beginning—a material that can be reused or converted into new products or energy. This approach enables the closing, slowing, and narrowing of resource loops, significantly reducing waste and enhancing environmental sustainability (Mwosi, Eton, Olupot, & Ogwel, 2024; Sinaga, 2021).

2.2 Sustainable Development Theory

The sustainable development theory emphasizes the importance of meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. This concept was first introduced in the Brundtland Report (1987) and aims to create a balance between its three main pillars: economic, social, and environmental (World Commission on Environment and Development, 1987). In Indonesia, the principles of sustainable development have been integrated into various national policies, such as the National Long-Term Development Plan (RPJPN) and Law No. 32 of 2009 on Environmental Protection and Management. These efforts reflect the government's commitment to implementing sustainable development holistically, although challenges in execution remain (Leontinus, 2022; Smith, 2019).

The economic dimension focuses on the efficient use of resources to support growth without degrading the environment, while the social dimension aims to promote social justice, inclusion, and community well-being. Meanwhile, the environmental dimension emphasizes ecosystem preservation and sustainable waste management. Additionally, the institutional dimension plays a crucial role, as it highlights the importance of policies and governance in ensuring the successful implementation of sustainable development (Mondal, Akter, & Polas, 2023; Wijaya, 2022).

2.3 Waste Management Theory

Waste management theory is a conceptual framework that encompasses the processes of waste collection, transportation, processing, and disposal, with the primary goal of protecting public health and the environment (Harris et al., 2023). The waste management hierarchy serves as the principal guideline in this theory, prioritizing prevention, reduction, reuse, recycling, energy recovery, and safe disposal (Hsu, Chen, & Feng, 2024; Sapanli et al., 2023).

In Indonesia, waste management continues to face significant challenges, particularly due to the high volume of waste generation, which reached 38.6 million tons per year in 2023. Of this total, 60% originated from households, yet only 9.8% was successfully recycled (Ministry of Environment and Forestry [KLHK], 2023). The waste management system in Indonesia remains dominated by an end-of-pipe approach, which primarily focuses on waste collection, transportation, and final disposal without an effective waste sorting mechanism (Amegayibor, 2023; Sapanli et al., 2023).

2.4 Community Participation in Waste Management

Community participation is a key element in achieving effective and sustainable waste management. Active citizen involvement not only helps reduce waste volume but also raises environmental awareness and encourages eco-friendly lifestyles. Public participation in waste management based on the 3R principles (Reduce, Reuse, Recycle) is essential for achieving efficient waste management goals (Hernawati, 2013).

One of the most effective forms of community participation is through the waste bank program. Waste banks enable residents to exchange sorted waste for economic incentives, encouraging them to actively engage in waste separation practices (Ameliah & Jatnika, 2024). A study by Qomariah (2021) found that the establishment of a waste bank in Pondok Pucung, South Tangerang, significantly improved community participation in waste management while also providing economic benefits to the participants.

3. Research Methodology

3.1 Type of Research

This study employs a descriptive quantitative research approach using the Analytical Hierarchy Process (AHP) method. The objective is to systematically and accurately describe the investigated phenomenon, which, in this case, is the circular economy-based waste management strategy in Pangkalpinang City**.** This research utilizes quantitative data collected through questionnaires, which are then analyzed to determine the priority ranking of key criteria influencing circular economy-based waste management.

The descriptive quantitative approach enables the researcher to explore the main criteria contributing to the successful implementation of the circular economy in waste management and to establish the priority ranking of various criteria using the AHP method. The hierarchical model used in this study **is** designed with three main levels to support decision-making based on the Analytic Hierarchy Process (AHP) **for** sustainable waste management strategies within a circular economy framework**, as** illustrated in the following figure:

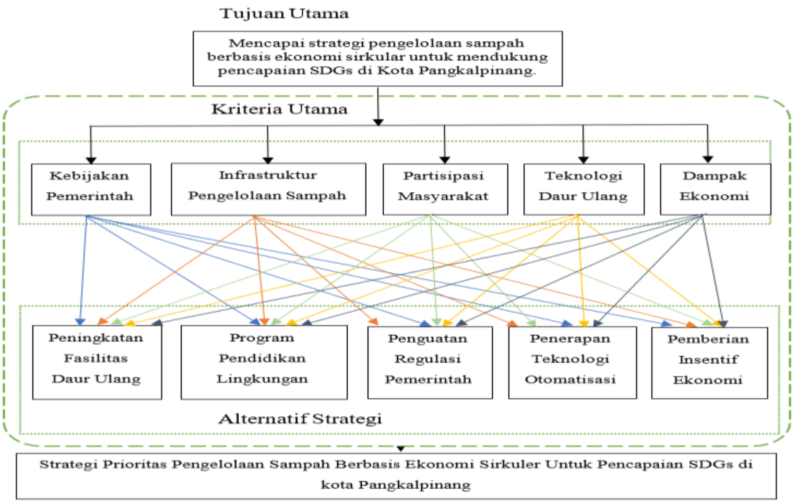

Figure 1: Research Conceptual Model
Source: Processed by the researcher

3.2 Population and Sample

The population in this study includes all stakeholders who play a crucial role and are directly or indirectly involved in waste management in Pangkalpinang City. The research sample consists of **15** respondents selected from the Pentahelix framework, which includes representatives from the government, business sector, academia, community organizations, and media. The government sector is represented by five respondents from the Department of Environmental Affairs of Pangkalpinang City, Department of Environmental Affairs of Bangka Belitung Province, Bapperida Pangkalpinang City, BPDAS Bangka Belitung Province, and the Acting Mayor of Pangkalpinang**.** The business sector is represented by two respondents from MSME Pondok Kreasi Anca Pangkalpinang and KSM Sahabat Farm Pangkalpinang. The academia sector includes one respondent, namely the Rector of Muhammadiyah University of Bangka Belitung. The community sector is represented by five respondents from Bank Sampah Papin Pangkalpinang, LAZIS Muhammadiyah Pangkalpinang, Forum DAS Bangka Belitung, WALHI Bangka Belitung, and TP PKK Pangkalpinang City. Meanwhile, the media sector is represented by two respondents from Antara Babel and Babel Pos.

3.3 Research Variables

This study consists of two main variables, namely criteria variables and alternative variables. The criteria variables include five factors: government policy, community participation, waste management infrastructure, recycling technology, and economic impact. Meanwhile, the alternative variables consist of five strategic alternatives: strengthening government regulations, enhancing recycling facilities, implementing automation technology, providing economic incentives, and conducting environmental education programs.

3.4 Data Collection

The data collection process in this study involves multiple techniques to ensure comprehensive and accurate data acquisition. First, interviews are conducted to gather qualitative data from key stakeholders involved in waste management. Additionally, questionnaires are distributed to collect quantitative data, allowing for the assessment and prioritization of waste management criteria and strategies. Furthermore, document analysis is performed by collecting relevant documents from stakeholders related to waste management policies, infrastructure, and community initiatives in Pangkalpinang City. These combined methods ensure a holistic approach in evaluating the implementation of a circular economy-based waste management strategy.

3.5 Data Analysis Techniques

The data collected in this study is analyzed using the Analytic Hierarchy Process (AHP) method, which is designed to support systematic multi-criteria decision-making. This technique allows for the identification of the relative weights of various criteria and strategic alternatives to determine the top priorities for circular economy-based waste management in Pangkalpinang City. The AHP analysis consists of several key steps, including: constructing a pairwise comparison matrix, calculating relative weights, performing a consistency test, and determining the final priorities.

a. Constructing the Pairwise Comparison Matrix

The first step in the AHP analysis is developing a pairwise comparison matrix based on values assigned by respondents. These values are obtained from questionnaires, where respondents compare the level of importance between two elements, such as main criteria and strategic alternatives. The matrix is constructed in a diagonal format, where the diagonal values are always 1 (since each element is equally important to itself). Other values are assigned based on the ordinal scale of 1–9, where a higher value represents greater importance of one element over another.

b. Calculating Relative Weights

The next step in AHP is determining the relative weight of each element (criteria or alternative) in the hierarchy. The relative weights are calculated from the pairwise comparison matrix obtained from respondents' assessments. This process involves:

1. Summing the values in each column of the matrix.
2. Normalizing the matrix by dividing each matrix element by the total of its respective column.
3. Calculating the average value in each row to obtain the relative weight of each element.

These relative weights indicate the priority level of each criterion or strategic alternative, where a higher weight signifies greater importance in the context of circular economy-based waste management.

c. Consistency Test

AHP requires a consistency test to ensure that respondents' pairwise comparisons are logically coherent. The Consistency Index (CI) and Consistency Ratio (CR) are used to evaluate the logical consistency of the comparisons. The Consistency Index (CI) is calculated using the formula:

$$CI = \frac{\lambda \max - n}{n-1} \qquad (1)$$

where λ_max is the largest eigenvalue of the matrix, and n is the number of elements in the matrix.
The Consistency Ratio (CR) is calculated by comparing CI with the Random Index (RI), which is a standard reference value for different matrix sizes. The formula is:

$$CR = \frac{CI}{RI} \qquad (2)$$

If CR < 0.1, the comparison results are consistent and valid for further analysis.
If CR > 0.1, respondents are asked to revise their comparisons to improve logical consistency.

d. Determining the Final Priorities

The final step in AHP analysis is determining the priority ranking based on the relative weights obtained for each criterion and alternative. This process involves:

1. Combining the Criterion Weights with the Alternative Weights: The weight of each strategic alternative is calculated based on its contribution to each main criterion. The result provides the total weight for each alternative.

2. Identifying the Highest-Priority Alternative: The strategic alternative with the highest weight is considered the top priority for implementation in circular economy-based waste management.

This systematic approach ensures that the most effective and impactful waste management strategy is identified, providing a scientific basis for decision-making in sustainable waste management planning.

4. Analysis and Discussion

4.1 Existing Waste Management Conditions in Pangkalpinang

According to the Environmental Agency (DLH) of Pangkalpinang City, the average daily waste production in 2024 reached 105.87 tons. During certain periods, particularly on major religious holidays, the daily waste volume significantly increased by 40–45%, reaching up to 184 tons per day (Wulandari, 2023). The waste composition in Pangkalpinang City demonstrates a significant proportion of food waste, which accounts for 45% of the total waste generated. This is followed by wood, branches, and leaves, which contribute 19%, and plastic waste, making up 16%. Additionally, paper and cardboard waste represent 7%, while metal/cans, fabric and textiles, rubber and leather, and glass each account for 2%. The remaining 5% consists of residual waste (others). This data highlights the potential for waste-to-compost initiatives and enhanced recycling efforts, particularly targeting food and plastic waste, to improve waste management and promote sustainability in Pangkalpinang City.

Waste management in Pangkalpinang City faces numerous structural challenges, including the lack of waste segregation at the source, limited collection and processing facilities, and an overburdened landfill (TPA) that has exceeded its capacity. The development of the landfill is further hindered by land scarcity and suboptimal site conditions that fail to meet ideal standards. Additionally, the landfill lacks adequate waste processing facilities capable of significantly reducing the volume of accumulated waste. Currently, the only form of waste reduction at the landfill comes from the informal sector, particularly scavengers who collect waste with economic value.

The previously operational Solid Recovered Fuel (SRF) program, which converted waste into energy through collaboration with PLN, has also ceased operation. As a result, no active waste-to-energy conversion system is currently in place (Environmental Agency of Pangkalpinang City, 2024). This has further increased the burden on the Parit Enam Landfill, which continues to struggle with rising waste volumes. Therefore, a more effective waste management strategy is urgently needed. Without adopting a more sustainable system, the challenges in managing waste in Pangkalpinang City will become increasingly complex (Environmental Agency of Pangkalpinang City, 2024).

4.2 Policies and Regulations on Waste Management in Pangkalpinang City

Waste management in Pangkalpinang City is governed by several regulations aimed at creating a more effective, sustainable, and circular economy-based waste management system. These include Regional Regulation No. 6 of 2013 on Waste Management, Regional Regulation of Pangkalpinang City No. 1 of 2024 on Local Taxes and Levies, and Mayor Regulation No. 70 of 2022 on Policies and Strategies for Waste Management in Pangkalpinang City (Jakstrada). These three regulations provide a comprehensive policy framework for waste management in the city, although each faces challenges in implementation. The technical agency (regulator) responsible for environmental affairs at the regional level is the Environmental Agency (Dinas Lingkungan Hidup). This agency oversees various environmental responsibilities, including waste management, hazardous and toxic waste (B3), and pollution control. Despite the existence of these regulatory frameworks, achieving an integrated and efficient waste management system remains a challenge due to issues in policy implementation and operational constraints.

4.3 Financial Analysis of Waste Management in Pangkalpinang City

The budget management for the waste sector in Pangkalpinang City demonstrates a positive trend, with a high level of effectiveness in achieving waste retribution targets and an increasing program realization ratio. While the targets and actual revenue from waste retribution continue to grow, its contribution to the region's own-source revenue (Pendapatan Asli Daerah) remains relatively small. Therefore, a more precise and comprehensive strategy is required to enhance revenue generation from the waste management sector.

4.4 Waste Banks in Pangkalpinang City

Waste banks, as part of Pangkalpinang City's waste management strategy, play a crucial role in reducing the amount of waste that ends up in the landfill, raising community awareness about waste segregation, and providing economic benefits to participating residents. Optimizing the waste bank program can be a viable solution to support the achievement of sustainable waste management targets and reduce plastic waste in urban areas. Active waste banks in Pangkalpinang include Bank Sampah Pondok Kreasi, Bank Sampah Tua Tunu Indah, Bank Sampah Bahagia, Bank Sampah Kawa Begawe, Bank Sampah Berkah, Bank Sampah Opin Pelangi, and Bank Sampah Induk. These initiatives demonstrate the potential for community-driven efforts to complement municipal waste management strategies effectively.

4.5 Data Analysis

The data analysis was conducted using the Analytical Hierarchy Process (AHP) method to determine the priority of strategic alternatives in supporting sustainable waste management. Respondents were selected based on their roles in waste governance in Pangkalpinang City, ensuring that the results reflect a comprehensive perspective from various stakeholders. This diversity represents different viewpoints on the criteria deemed most important in waste management strategies.

The analysis processed pairwise comparison data provided by each respondent for five main criteria: government policy, waste management infrastructure, community participation, recycling technology, and economic impact, as well as five strategic alternatives: enhancing recycling facilities, environmental education programs, strengthening government regulations, implementing automation technology, and providing economic incentives.

The priority weights for each criterion and alternative were calculated, ensuring that the Consistency Ratio (CR) remained below 10%. This was followed by data aggregation across all respondents to derive the final priority results, which can serve as a foundation for designing more focused and data-driven waste management strategies. The calculations were conducted using the following formulas:

$$Rata - rata\ A1 = \frac{Bobot\ A1\ dari\ R1 + A1\ dari\ R2 + \ldots + A1\ dari\ R15}{15} \qquad \mathbf{3}$$

The results of the average calculation of the total priority weights for the waste management strategy criteria in Pangkalpinang City indicate that each criterion has a relative importance weight compared to the others, as illustrated in the table below.

Table 1. Priority Weights of Criteria for Strategies

Respondent	Economic Impact	Waste Management Infrastructure	Government Policy	Community Participation	Recycling Technology
R1	0,18365	0,06514	0,30343	0,35966	0,08812
R2	0,17782	0,07388	0,26858	0,3749	0,10482
R3	0,11525	0,15407	0,40324	0,2229	0,10453
R4	0,29208	0,04463	0,03332	0,49114	0,13883
R5	0,11092	0,02787	0,07975	0,54473	0,23673
R6	0,34162	0,08588	0,03475	0,17007	0,36768
R7	0,22481	0,35358	0,02498	0,17181	0,22481
R8	0,03707	0,26623	0,45605	0,18065	0,05999
R9	0,15976	0,16846	0,44147	0,17117	0,05914

Respondent	Economic Impact	Waste Management Infrastructure	Government Policy	Community Participation	Recycling Technology
R10	0,05031	0,23742	0,25731	0,21753	0,23742
R11	0,03955	0,2074	0,58492	0,04277	0,12537
R12	0,11208	0,13675	0,18856	0,36633	0,19629
R13	0,0389	0,53851	0,25229	0,11309	0,05721
R14	0,03579	0,39529	0,21491	0,26789	0,08612
R15	0,1662	0,10536	0,05745	0,35724	0,31375
Average	**0,139054**	**0,190698**	**0,240067**	**0,270125**	**0,160054**

Source : primary data, 2025

Table 1 presents the priority weights of criteria for circular economy-based waste management strategies. Based on the average calculations, community participation has the highest weight (0.270125), indicating that public involvement is considered the most critical factor for the success of the strategy. In second place, government policy holds an average weight of 0.240067, highlighting the importance of the government's role in supporting effective waste management. Recycling technology and waste management infrastructure have average weights of 0.160054 and 0.190698, respectively, suggesting that while these aspects are important, they are considered less of a priority compared to community participation and government policies. Economic impact has the lowest average weight (0.139054), indicating that while economic benefits are relevant, they are given lower priority than other factors. The ranking of the average criterion weights from all respondents is illustrated in the following figure.

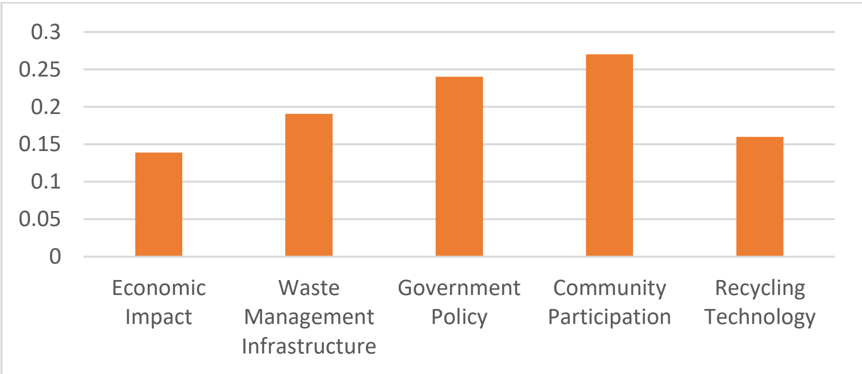

Figure 2. The Ranking Of The Average Criterion Weights
Source : primary data, 2025

Based on the data analysis results using the AHP method, as shown in Figure 2, the community participation and government policy criteria have higher weights compared to other criteria. This indicates that these two factors play the most crucial role in selecting alternative circular economy-based waste management strategies in Pangkalpinang City.

The high weights assigned to community participation and government policy suggest that the successful implementation of a circular economy relies heavily on public awareness, commitment, and active engagement in waste management, as well as strong policy support from the government. Community participation serves as a key element in promoting a more sustainable waste management system, reducing dependence on landfills (TPA), and increasing the reuse of waste as an alternative energy source or new value-added products.

While community-led initiatives for waste sorting and segregation before disposal at landfills have begun to emerge, public awareness remains relatively low. Moreover, waste bank programs and recycling initiatives have yet to be systematically integrated into the city's waste management system. The collaboration between the private sector, academic institutions, and the government remains weak, limiting the full potential of community-based waste reduction. Enhancing public participation in waste management requires government policies that provide regulatory and institutional support, ensuring that public awareness efforts are effectively implemented by all residents of Pangkalpinang City in advancing a circular economy-based waste management system.

The next step involves calculating the priority weights for each alternative waste management strategy that influences the waste management approach in Pangkalpinang City. This calculation is performed through pairwise comparisons between each criterion and alternative strategy, resulting in the priority weight values presented in the following table. The strategic alternatives are as follows A1: Enhancing Recycling Facilities, A2: Providing Economic Incentives, A3: Environmental Education Programs, A4: Strengthening Government Regulations, A5: Implementing Automation Technology

Table 2. Priority Weights of Alternatives for Each Criterion

Respondent	Alternative	Government Policy	Waste Management Infrastructure	Community Participation	Recycling Technology	Economic Impact
R1	A1	0,08912	0,09852	0,06525	0,21699	0,11222
	A2	0,06394	0,07548	0,23226	0,18400	0,18423
	A3	0,13135	0,13784	0,11519	0,08966	0,18445
	A4	0,62615	0,61328	0,47110	0,21372	0,33488
	A5	0,08945	0,07488	0,11621	0,21699	0,18423
R2	A1	0,07103	0,17018	0,09743	0,29097	0,10702
	A2	0,04289	0,15293	0,31020	0,15222	0,16750
	A3	0,21091	0,14014	0,17638	0,09286	0,17924
	A4	0,05523	0,33980	0,27971	0,18539	0,38714
	A5	0,05523	0,16475	0,13628	0,27857	0,13911
R3	A1	0,07662	0,04408	0,10496	0,13906	0,04615
	A2	0,14922	0,14014	0,30232	0,28877	0,51552
	A3	0,09870	0,14014	0,21328	0,23873	0,11228
	A4	0,58292	0,53550	0,22312	0,16745	0,28093
	A5	0,09254	0,14014	0,15631	0,16599	0,04511
R4	A1	0,21698	0,07440	0,36442	0,18216	0,22232
	A2	0,05503	0,03058	0,10727	0,03664	0,03068
	A3	0,39039	0,52363	0,19134	0,61996	0,50354
	A4	0,24249	0,27165	0,10876	0,09851	0,16422
	A5	0,09510	0,09974	0,22820	0,06273	0.07952
R5	A1	0,11907	0,53924	0,25087	0,18678	0,06965
	A2	0,23597	0,08056	0,13762	0,34827	0,61523
	A3	0,33336	0,23047	0,13762	0,19993	0,09526
	A4	0,22239	0,12226	0,26316	0,19682	0,10961
	A5	0,08921	0,02747	0,21073	0,06820	0,11025
R6	A1	0,09847	0,19825	0,09415	0,37949	0,21679
	A2	0,26416	0,20434	0,48509	0,03914	0,28430
	A3	0,15507	0,14022	0,28207	0,06166	0,03458
	A4	0,04635	0,17786	0,03750	0,10181	0,07868
	A5	0,43595	0,27932	0,10120	0,41789	0,38565
R7	A1	0,16093	0,16093	0,25522	0,19415	0,14687
	A2	0,19415	0,19415	0,22343	0,19415	0,19415

Respondent	Alternative	Government Policy	Waste Management Infrastructure	Community Participation	Recycling Technology	Economic Impact
	A3	0,19415	0,19415	0,10585	0,19415	0,36523
	A4	0,25663	0,19415	0,19206	0,25663	0,14687
	A5	0,19415	0,25663	0,22343	0,16093	0,14687
R8	A1	0,07764	0,07924	0,14454	0,13058	0,09801
	A2	0,04179	0,04082	0,12214	0,04946	0,26647
	A3	0,20273	0,27563	0,13138	0,22996	0,05827
	A4	0,56347	0,47995	0,50427	0,50633	0,41965
	A5	0,11436	0,12437	0,09767	0,08366	0,15759
R9	A1	0,26962	0,25966	0,09168	0,16218	0,12821
	A2	0,09418	0,13947	0,27042	0,42177	0,54108
	A3	0,27555	0,11854	0,28740	0,10367	0,08213
	A4	0,29482	0,40664	0,29264	0,25373	0,20014
	A5	0,06583	0,07569	0,05787	0,05865	0,04845
R10	A1	0,22255	0,20795	0,21607	0,20217	0,11338
	A2	0,03307	0,03286	0,04257	0,04776	0,03043
	A3	0,26727	0,22003	0,21607	0,29577	0,35179
	A4	0,35671	0,39314	0,38605	0,35138	0,43490
	A5	0,12040	0,14602	0,13925	0,10292	0,06950
R11	A1	0,03369	0,02943	0,03887	0,03522	0,04040
	A2	0,34598	0,40203	0,19056	0,14424	0,16961
	A3	0,11257	0,05391	0,06482	0,08024	0,07771
	A4	0,20424	0,15462	0,19710	0,28315	0,24160
	A5	0,30352	0,36000	0,50865	0,45714	0,47067
R12	A1	0,12916	0,20000	0,18089	0,11004	0,11156
	A2	0,18714	0,20000	0,31247	0,11438	0,37369
	A3	0,20386	0,20000	0,26513	0,31291	0,05120
	A4	0,31178	0,20000	0,11548	0,10869	0,23062
	A5	0,16806	0,20000	0,12603	0,35398	0,23294
R13	A1	0,35259	0,46719	0,50394	0,54275	0,48670
	A2	0,03296	0,03602	0,03796	0,03993	0,03818
	A3	0,14394	0,05909	0,06157	0,06531	0,06098
	A4	0,29122	0,32122	0,28669	0,22297	0,28097
	A5	0,17930	0,11648	0,10984	0,12904	0,13318
R14	A1	0,12358	0,46719	0,17401	0,10602	0,10726
	A2	0,03112	0,03602	0,02754	0,02995	0,02967
	A3	0,26390	0,05909	0,27327	0,24309	0,30706
	A4	0,52333	0,32122	0,47343	0,56616	0,50429
	A5	0,05807	0,11648	0,05175	0,05479	0,05173
R15	A1	0,17512	0,21714	0,20533	0,20533	0,20533
	A2	0,17512	0,26196	0,20533	0,20533	0,20533
	A3	0,13894	0,08732	0,08626	0,08626	0,08626
	A4	0,09401	0,08732	0,08626	0,08626	0,08626
	A5	0,41682	0,34627	0,41682	0,41682	0,41682

Source: primary data, 2025

Based on the priority weight data of alternatives for each criterion from all research respondents in Table 2, the average priority weight for each alternative was calculated. This resulted in the ranking of waste management strategy alternatives in Pangkalpinang City, with the values presented in the following table.

Table 3. Aggregation (Average) of Priority Weights for Strategic Alternatives

Alternative	Government Policy	Waste Management Infrastructure	Community Participation	Recycling Technology	Economic Impact
A1	0,147745	0,214227	0,185842	0,205593	0,147458
A2	0,129781	0,135157	0,200479	0,153067	0,243071
A3	0,195164	0,146898	0,172592	0,163871	0,146174
A4	0,321309	0,324706	0,266661	0,274697	0,282672
A5	0,170030	0,174993	0,174313	0,195426	0,183755

Source: primary data, 2025

After calculating the average priority weights of the strategic alternatives, the next step in determining the best overall strategy is to calculate the total alternative weight. This is obtained by summing the priority weight values across all criteria for each alternative. The calculation results are presented in the following table.

Tabel 4. Total Priority Weights of Strategic Alternatives

Alternative	Total Priority Weights
A1	0,147745 + 0,214227 + 0,185842 + 0,205593 + 0,147458 = 0,900865
A2	0,129781 + 0,135157 + 0,200479 + 0,153067 + 0,243071 = 0,861555
A3	0,195164 + 0,146898 + 0,172592 + 0,163871 + 0,146174 = 0,824699
A4	0,321309 + 0,324706 + 0,266661 + 0,274697 + 0,282672 = 1,469711
A5	0,170030 + 0,174993 + 0,174313 + 0,195426 + 0,183755 = 0,898517

Source: primary data, 2025

Based on the average calculation of the total priority weights for the criteria and strategic alternatives in waste management, a visualization of the aggregated priority weights for the five criteria and five strategic alternatives in Pangkalpinang City's waste management strategy can be created. Each criteria and alternative has a weight value that represents its relative importance compared to the others, as shown in the figure below.

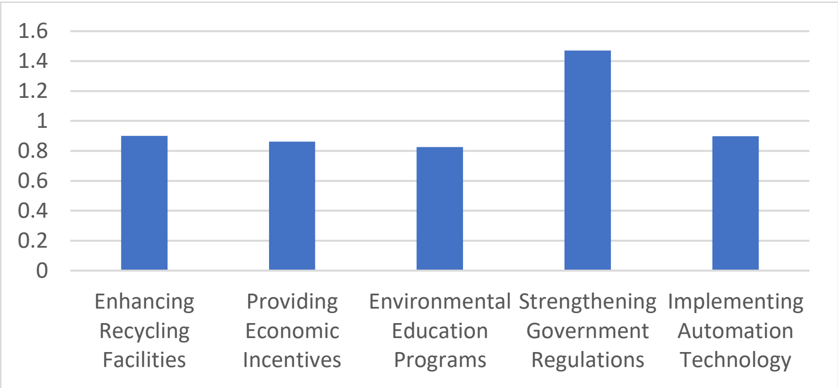

Figure 3. Priority Ranking of Strategic Alternatives
Source : primary data, 2025

From Figure 3, it is evident that each strategic alternative has varying priority weights in waste management in Pangkalpinang City, as explained below:

a. Strengthening Government Regulations

Strengthening government regulations emerges as the top-priority alternative, with a priority weight of 1.469711. This indicates that regulatory enforcement is considered the fundamental pillar in establishing an effective and sustainable waste management system. Regulations may include the implementation of regional regulations (Perda), strict penalties for waste management violations, and integrated incentive policies to ensure compliance and effectiveness.

b. Enhancing Recycling Facilities
This strategic alternative has a priority weight of 0.900865, making it the second most important strategy, ranking just after A4 (Strengthening Government Regulations). This suggests that improving recycling facilities is regarded as a significant factor in supporting efficient waste management. This strategy is crucial as it can increase processing capacity for both organic and inorganic waste, reduce pressure on landfills, and support the circular economy. Its implementation requires adequate infrastructure support and active community participation. Currently, Pangkalpinang City lacks sufficient recycling facilities, both for organic and inorganic waste management.

c. Implementing Automation Technology
This alternative has a priority weight of 0.898517, placing it in third position. The implementation of automation technology, such as automated recycling machines or technology-based waste collection systems, is expected to enhance efficiency in waste management, particularly in sorting and transportation processes. This technology is essential to reduce dependence on manual systems and increase productivity. The weight assigned to this alternative indicates that while automation technology holds great potential, it is not yet considered a top priority compared to strengthening government regulations or enhancing recycling facilities. The successful implementation of automation technology requires strong regulatory support and substantial investment. The modernization of waste management in Pangkalpinang City has yet to incorporate advanced technological solutions.

d. Providing Economic Incentives
This alternative holds a priority weight of 0.861555, placing it fourth in priority. The strategy focuses on providing financial incentives, such as subsidies for recycling businesses or rewards for individuals actively participating in waste segregation. Economic incentives aim to increase motivation among the community and private sector in supporting waste management initiatives. However, this strategy requires significant budget allocation from the government and a clear regulatory framework to ensure its effectiveness.

e. Environmental Education Programs
This alternative has a priority weight of 0.824699, making it the fifth priority. The strategy aims to raise public awareness on the importance of waste management through education in schools, community engagement, and environmental campaigns. However, environmental education is perceived to have a limited immediate impact on waste management. This places environmental education programs as a supportive strategy, which is important but not a primary priority in achieving effective waste management in Pangkalpinang City.

5. Conclusion

Based on the research analysis using the AHP method on circular economy-based waste management strategies to support the achievement of the Sustainable Development Goals (SDGs) in Pangkalpinang City, the following key conclusions can be summarized:

a. Community Participation and Government Policy are the two most important criteria in determining waste management strategies, contributing significantly compared to other criteria.
b. Five strategic alternatives can be implemented for circular economy-based waste management to achieve sustainable development in Pangkalpinang City: Strengthening Government Regulations, Enhancing Recycling Facilities, Implementing Automation Technology, Providing Economic Incentives, and Environmental Education Programs**.**
c. Strengthening Government Regulations emerges as the highest-ranked alternative, indicating that supportive policies and regulations play a crucial role in ensuring the effective implementation of circular economy-based waste management. The government’s efforts to enhance regulations and policies should actively promote community participation in waste management initiatives**.**
d. The Pangkalpinang City Government needs to reinforce waste management regulations that encourage greater public awareness and active participation. Additionally, educational programs

and campaigns involving households, communities, and schools should be strengthened to foster sustainable waste management practices.

e. Further research is needed on the role of community participation and social groups in circular economy-based waste management in Pangkalpinang City, particularly in understanding community engagement models and their effectiveness.

5.1 Limitations and Directions for Future Research

This study has certain limitations. The population scope is limited to a sample of stakeholders from the Pentahelix components related to waste management regulations in Pangkalpinang City. The broader public was not directly involved in the decision-making process within this research. Future studies could incorporate the behavioral aspects of the community in the circular economy framework, enabling a deeper understanding of the factors influencing the adoption of recycling practices and waste management initiatives. Additionally, future research could combine the AHP method with other approaches, such as Multi-Criteria Decision Making (MCDM), for further validation and robustness of the findings.

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References

Amegayibor, G. K. (2023). Work-life balance practices and employee job satisfaction: A case study of Ghana's security industry in Greater Accra. *Annals of Human Resource Management Research, 3*(1), 41-54.

Ameliah, A. D., & Jatnika, R. (2024). Descriptive Study of College Student's Career Adaptability with An Internship Experience. *Annals of Human Resource Management Research, 4*(1), 1-11.

ANTARA. (2024). Pemkot Pangkalpinang prioritaskan penanganan sampah. Retrieved from https://www.antaranews.com/berita/3950181/pemkot-pangkalpinang-prioritaskan-penanganan-sampah

Blomsma, F., Pieroni, M., Kravchenko, M., Pigosso, D. C., Hildenbrand, J., Kristinsdottir, A. R., . . . Jönbrink, A.-K. (2019). Developing a circular strategies framework for manufacturing companies to support circular economy-oriented innovation. *Journal of cleaner production, 241*, 118271.

D'Adamo, I., Daraio, C., Di Leo, S., Gastaldi, M., & Rossi, E. N. (2024). Driving EU sustainability: Promoting the circular economy through municipal waste efficiency. *Sustainable Production and Consumption, 50*, 462-474.

Darmaraja, A. P., Casini, C., Jalilah, D. N., & Aropah, S. S. (2024). Peningkatan Kesadaran dan Keterampilan Masyarakat dalam Pengelolaan Sampah Organik Melalui Pelatihan Pembuatan Pupuk Kompos di Desa Sindanglaya. *Archive: Jurnal Pengabdian Kepada Masyarakat, 4*(1), 121-129.

Ebuka, A. A., Emmanuel, D., & Idigo, P. (2023). Artificial Intelligence as a catalyst for the Sustainability of Small and Medium Scale Businesses (SMEs) in Nigeria. *Annals of Management and Organization Research, 5*(1), 1-11.

Firdausi, E. (2024). Implementasi Pengelolaan Sampah Berkelanjutan: Studi Kasus Bank Sampah di Kelurahan Kotabaru, Kota Yogyakarta. *Jurnal Ekologi, Masyarakat dan Sains, 5*(1), 60-65.

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *Journal of cleaner production, 114*, 11-32.

Hernawati, D. (2013). *Partisipasi Masyarakat Dalam Pengelolaan Sampah Berbasis 3r (reduce, reuse dan recycle)(studi pada tempat pengelolaan sampah terpadu di desa Mulyoagung kecamatan Dau Kabupaten Malang).* Brawijaya University.

Hsu, C.-c., Chen, S.-H., & Feng, X.-c. (2024). Analysis of Product Quality and Customer Satisfaction: A Case Study of the Automotive Parts Industry. *International Journal of Financial, Accounting, and Management*, *6*(2), 245-259.

Kurnia, S., Alamsyahbana, M. I., Chartady, R., Arifin, S. V., & Sesaria, M. I. (2023). Circular Solutions for Decent Work and Economic Growth: Lessons from Sustainable Development Goals (SDG) 8. *Academia Open*, *8*(1), 10.21070/acopen. 21078.22023. 26657-21010.21070/acopen. 21078.22023. 26657.

Leontinus, G. (2022). Program dalam pelaksanaan tujuan pembangunan berkelanjutan (SDGS) dalam hal masalah perubahan iklim di Indonesia. *Jurnal Samudra Geografi*, *5*(1), 43-52.

Marlianto, C. (2022). Krisis Lahan Untuk TPA, Begini Upaya Pemkot Pangkalpinang Tangani Sampah. Retrieved from https://bangka.tribunnews.com/2022/04/06/krisis-lahan-untuk-tpa-begini-upaya-pemkot-pangkalpinang-tangani-sampah

Maskur, F., Basir, A., & Dewi, S. R. (2024). Influence of job satisfaction and management information systems on employee performance in PT. Pawnshop in Palopo City. *Journal of Multidisciplinary Academic and Practice Studies*, *2*(3), 325-334.

Mondal, M. S. A., Akter, N., & Polas, M. R. H. (2023). Factors influencing the environmental accounting disclosure practices for sustainable development: A systematic literature review. *International Journal of Financial, Accounting, and Management*, *5*(2), 195-213.

Mwosi, F., Eton, M., Olupot, S. P., & Ogwel, B. P. (2024). Employee retention and organizational performance in Kabale District Local Government, Uganda. *Annals of Management and Organization Research*, *6*(1), 1-12.

Sapanli, K., Putro, F. A. D., Arifin, S. D., Putra, A. H., Andamari, H. A., & Anggraini, U. (2023). Pengelolaan Sampah Rumah Tangga Berbasis Circular Economy di Tingkat Desa: Pendekatan Sistem Dinamik. *Jurnal Wilayah dan Lingkungan*, *11*(2).

Setyawan, R. B., & Siallagan, M. (2024). Strategic decision analysis to enhance labor productivity affected by sick leave absenteeism in the manufacturing industry. *Journal of Multidisciplinary Academic Business Studies, 1*(4), 483-504.

Sinaga, E. E. (2021). Pembentukan ASEAN Regional Action Plan for Combating Marine Debris Tahun 2021. *Politik Global*, *1*(01), 73-93.

Smith, J. S. (2019). International trade promotion methods for SMEs in low and lower-middle-income economies. *International Journal of Financial, Accounting, and Management*, *1*(3), 131-145.

Wijaya, G. H. A. (2022). Tiga Pilar Keberlanjutan: Lingkungan, Ekonomi, dan Sosial. Retrieved from https://www.talksustainable.com/tiga-pilar-keberlanjutan-lingkungan-ekonomi-dan-sosial/