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Analysis of the Application of the Virginia Solid Waste Management Hierarchy Concept on Urban Waste Management in Cirebon City, Indonesia

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ABSTRACT

Effective and sustainable waste management is a challenge faced by many cities worldwide, including Cirebon City. This study aims to analyze the effectiveness and sustainability of waste management strategies in Cirebon City using the Virginia Solid Waste Management Hierarchy Concept as the primary reference. The method consisted of field surveys, interviews with relevant stakeholders, and collection of secondary data regarding waste management in Cirebon City. Additionally, the Delphi method was employed to collect opinions and perspectives from a panel of experts and stakeholders regarding waste management strategies and programs. The analysis results of Delphi method reveal that short-term and medium-term programs will focus on socialization and study activities, then in the long-term program, strict regulations and incinerator construction will begin to be implemented. Based on the results of Simple Additive Weighting (SAW) analysis, which compared the implementation value of the Virginia Solid Waste Management Hierarchy Concept with that of the existing management concept, it is revealed that the implementation value of the Virginia Solid Waste Management Hierarchy Concept is greater, namely 2.15, thus demonstrating the potential for its application in waste management in Cirebon City.

1. Introduction

Cirebon City, as one of the municipalities in West Java Province, acts as a center of economic and trade activities. This city attracts many migrants looking for better economic opportunities, which has an impact on increasing consumption and the amount of waste generated (Prihatin, 2020). With a population growth rate of 1.18% per year (Central Statistics Agency of Cirebon City, 2023), this city will face serious challenges in waste management in the near future.

Since Kopi Luhur landfill site began operating in 1998, various challenges have arisen, especially the ones concerning the service life of the landfill, which is estimated to have only 6.6 years left from 2020. Thus, a new landfill site is needed (Isni et al., 2020). An analysis results by Widiarti et al. (2020) using the integrated risk-based approach (IRBA) showed that Kopi Luhur landfill site bears a medium risk level, with a total risk index of 575.3536, close to the high risk scale (600) according to the Regulation of the Minister of Public Works of the Republic of Indonesia No. 03/PRT/M/2013 (RM No. 3, 2013). The plan to expand the landfill area by 1,800 m² will only extend the service life of the landfill site for 5 years (Natalia, 2021). Moreover, waste management implementation using collect-transport-dispose system in this city has only generated a waste reduction rate of 6% (Environmental Office of Cirebon City, 2020). In fact, the expansion of the landfill area will only extend the service life of the landfill site, but not improve the waste management for the better according to the Government Regulation of the Republic of Indonesia No. 81/2012 (GR No. 81, 2012). Therefore, a proper upgrade is required in waste management system in Cirebon City to prevent the continuance of environmental problems.

The waste management concept in the state of Virginia, United States, can be adopted as a model for addressing the current situation in Cirebon City. In Virginia, the 9VAC20-130-30 regulation has established a waste management hierarchy concept that complied by all cities. This hierarchy concept prioritizes waste reduction, reuse, recycling, resource recovery, incineration, and burial. In Fairfax City, the implementation of this concept successfully reduced the amount of waste by 45.80% in 2013 (Fairfax County Department of Public Works and Environmental Services, 2015).

Fairfax's success shows that an approach that emphasizes reduction and recycling can significantly reduce the negative impact of waste on the environment. Adopting a similar waste management hierarchy concept could be a strategic step for Cirebon City in addressing waste management issues in a comprehensive and sustainable manner, as well as supporting environmental sustainability and community welfare. Therefore, to reduce the burden of waste accumulation in Kopi Luhur landfill site, the government and community of Cirebon City can consider adopting the Virginia Solid Waste Management Hierarchy Concept. Thus, based on this background, this study aims to analyze the effectiveness and sustainability of waste management strategies in Cirebon City using the Virginia Solid Waste Management Hierarchy Concept as the primary reference.

2. Methods

This study aims to thoroughly analyze the application of the Virginia Solid Waste Management Hierarchy Concept in urban waste management in Cirebon City. The methods used included SWOT analysis and the Delphi method to obtain a deeper understanding of the application of the concept.

2.1 Preparatory stage

This stage was carried out with the aim to understand the specific problem being studied, namely the waste management system in Cirebon City. Activities carried out included formulating research questions and research objectives, conducting literature studies, and identifying the data needed and techniques to be used.

2.2 Initial stage

This stage aims to understand the waste management problem in Cirebon City. Initial activities included the formulation of research objectives, literature studies, and the identification of data and methods. Primary data were collected conducted through discussions and interviews with related stakeholders, such as environmental office (*DLH*) officials and waste activist communities, while secondary data were collected through surveys concerning the sanitation strategies, waste management regulations, and waste master plan in Cirebon City.

Next, several questionnaires were conducted using the KAP survey approach and theory of planned behavior to identify the condition of temporary problems in the waste management in Cirebon City. The population size required in the questionnaires was calculated using the Slovin formula as follows:

$$n = \frac{N}{1+Ne^2} \quad (1)$$

where:
n = sample size
N = population size
e = margin of error (using 5% by assumption).

The population studied were the people of Cirebon City who are included in the high and medium risk zones of waste based on Cirebon City Sanitation Working Group (2015). Using the cluster random sampling method, the number of respondent needed from each ward in the city are presented as follows:

Table 1. Number of respondent required from each ward in Cirebon City.

No.	Ward	Polulation Size (Person)	Number of Sampel (Rounding)
1.	Pulasaren	7,948	6
2.	Kasepuhan	16,971	12
3.	Lemahwungkuk	8,802	7
4.	Argasunya	24,660	17
5.	Kalijaga	36,671	26
6.	Harjamukti	22,122	16
Total		117,174	84,00

Source: Central Statistics Agency of Cirebon City (2023)

Furthermore, validity and reliability tests were carried out to design a questionnaire that would be addressed to respondents so that the questionnaire results were able to represent the actual situation. The data validity was tested using Pearson's Bivariate correlation (Pearson's Product Moment), while the data reliability was tested using the Cronbach's Alpha method (Dewi, 2018).

2.3. Data collection Stage

2.3.1 Strategy identification based on Virginia Solid Waste Management Hierarchy Concept

The formulation of household waste management strategies in Cirebon City was carried out using the SWOT analysis, consisting of internal and external analysis. External analysis aims to identify and explain the various factors that are seen as opportunities and threats (David, 2015), while internal analysis aims to identify various factors that are seen as strengths and weaknesses (Arda et al., 2020). By conducting internal and external analysis, important threats and opportunities can be identified, both within and outside the competitive environment (Gürel, 2017).

2.3.2 Respondent selection and questionnaire distribution using the Delphi method

In order to suport the strategy formulation, an analysis was carried out using the Delphi method. Validation of barriers based on the literature review is very important, because these barriers come from various situations, such as geography, prevalence, incidence, and other diverse factors (Engelman et al., 2018). The Delphi method was used as an approach to achieve the validation. This method involves the use of an iterative technique to collect and analyze feedback, with standardized questions addressed to a panel of experts (Wang et al., 2022) The steps in the Delphi method are described as follows (Marimin, 2004):

1. Develop the Delphi questions.
2. Questions are made in the form of a program plan based on the strategy and the existing conditions of the targeted community.
3. Establish a working team.
4. Select and contact the respondents.
   The criteria for respondents here are the experts who know the problems and can disclose the right information properly. According to Rowe and Wright (1999), the respondent selection based on the Delphi method must meet the following criteria: they must possess good knowledge in related fields, they must belong to various groups/organization, and the total number ranges from 5 to 20 persons.

Based on this criteria, the respondents' profile in this study are displayed as follows:

Table 2. Respondents' profile based on the Delphi method's criteria.

Group/ Organization	Position	Work Experience	Respondent	
			Amount	Percentage (%)
Government	Head of field	> 25 years	2	10
	Sub-coordinator chairman	> 15 years	3	15
Community	Community leader in waste issues	> 5years	5	25
Consultant	Expert	> 5 years	5	25
University	Academic	> 5 years	5	25
Total			20	100

5. Distribute the first questionnaire.
6. Analyze the results of first questionnaire. If there are a lot of input obtained outside the scope of the planned program, a new questionnaire needs to be created so as to adapt the new questions to the input from the experts.
7. Distribute the second questionnaire.
8. Analyze the results of second questionnaire.
9. Repeat steps 6 and 7 until the results obtained are stable.
10. Summarize all of the analysis results from the experts to reach the final decision.

2.3.3 Risk analysis between the existing management concept and the Virginia Solid Waste Management Hierarchy Concept

The Simple Additive Weighting (SAW) analysis is one of the common approaches in multi-attribute decision making (MADM). The weight and rating of each attribute used in this method are determined by the selected experts during the implementation of Delphi method.

The following are the steps of the SAW analysis based on fishburn diagram proposed by Utari & Agustriani (2019):

1. Determine the criteria for decision making (C).
2. Assess the suitability of each alternative on each criterion (C).
3. Create and normalize the decision matrix (R) based on the attributes.
4. Rank the alternatives by summing the multiplication result between the matrix (R) and the weight vector (C) for each parameter, then select the alternative with largest value as the best solution (A).

2.4. Overview and existing conditions

2.4.1 Research location

This study was conducted in Cirebon City, West Java Province, Indonesia. This city was chosen as research location because it is an urban area that has a dense population and has been facing serious challenges in terms of waste management. Cirebon City is the main focus in this study to analyze the application of the Virginia Solid Waste Management Hierarchy Concept in urban waste management.

Cirebon City has dynamic demographic conditions and continues to grow rapidly. In addition, it is also estimated by the Environmental Office of Cirebon City that the population of this city during the day can reach 2 million people, because it also acts as a center for offices and industries.

Table 3. Population of Cirebon City based on subdistrict.

No.	Subdistrict	Number of Resident (Person)	Area (Ha)	Population Density (Person/Ha)
1.	Kejaksan	50,309	361	139
2.	Pekalipan	31,131	156	200
3.	Lemahwungkuk	60,135	651	92
4.	Kesambi	78,939	806	98
5.	Harjamukti	124,043	1,772	70
	Total	344,557	3,746	599

Source: Central Statistics Agency of Cirebon City (2023)

2.5 Existing conditions of waste management in Cirebon City

The flow of waste services in Cirebon City still adopt the collect-transport-dispose system. Starting with the waste collection from houses or containers, it is then transported to the waste temporary shelters (*TPS*), which are scattered in various areas of Cirebon City. These temporary shelters are equipped with containers or adequate storage areas to temporarily store waste before further transportation to the landfill site.

2.5.1 Waste generation

Based on the 2023 data from the Environmental Office of Cirebon City, waste generation based on subdistrict are listed in Table 4.

Table 4. Waste generation data in Cirebon City based on subdistrict.

No.	Subdistrict	Volume of Waste Generated (Tons/day)	Waste Entering the Landfill (Tons/day)	Percentage of Waste Entering the Landfill (%)
1.	Kejaksan	27.62		
2.	Pekalipan	17.58		
3.	Lemahwungkuk	34.57	176	86
4.	Kesambi	46.39		
5.	Harjamukti	76.20		

No.	Subdistrict	Volume of Waste Generated (Tons/day)	Waste Entering the Landfill (Tons/day)	Percentage of Waste Entering the Landfill (%)
	Total	202.37		

Source: Environmental Office of Cirebon City (2024)

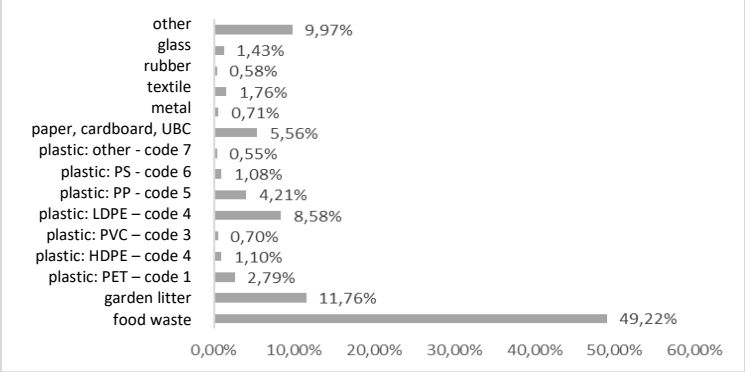


Figure 1. Composition of waste generation in Cirebon City
Source: Environmental Office of Cirebon City (2023)

2.5.2 Technical aspects

There are several types of temporary shelters in Cirebon City, namely 14 units of Hangar temporary shelters, 1 unit of depot transfer, and 4 units of mobile temporary shelters. Currently, waste reduction in Cirebon City has been carried out through waste banks and recycling center (*PDU*). The waste bank is managed by the community. There are 15 operation units of waste bank, each of which generates an average total reduction of 0.134 ton/day. Meanwhile, PDU is managed by the Enviromental Office of Cirebon City. It consists of just 1 unit with an average reduction of 0.05 ton/day.

2.5.3 Regulations

Waste management in Cirebon City refers to Regional Regulation No. 4/2018 concerning Waste Management. The regulation is strengthened by Cirebon Mayor Regulation No. 6/2019 concerning Cirebon City Policies and Strategies on the Management of Household Waste and Household Waste in 2018–2025. Meanwhile, further statement regarding the waste retribution is enacted in Regional Regulation No. 5/2018 concerning the Retribution of Public Services.

2.5.4 Institutionalization

Waste management in Cirebon City is conducted by the Environmental Office of Cirebon City under the surveillance of Division of Waste Management and Hazardous Waste as a regulator, while a Technical Implementation Unit (*UPT*), namely TIU Waste Management (*UPT PS*), acts as the operator.

2.5.5 Finance

Cirebon City is supported by the Regional Government Budget (*APBD*) as well as retribution imposed on the community. The retribution for domestic waste is based on the retribution of the Regional Drinking Water Company (*PDAM*) of Cirebon City. Meanwhile, for non-domestic waste financing, there is a cooperation agreement with the Cirebon City Waste Management Technical Implementation Unit.

The current service coverage of Cirebon City *PDAM* is 58.37%, which means the current waste management retribution in Cirebon City has only reached 58.37%, where in reality, the coverage of

waste management services in Cirebon City is 86%, meaning that there are still around 27.95% of retribution that have not yet been collected. The retribution received from each *PDAM* payment for Cirebon City waste management is IDR 7,500 (Environmental Office of Cirebon City, 2024) for each *PDAM* customer. As for non-domestic waste, *UPT PS* of Cirebon City currently has collaborated through a memorandum of understanding (MoU) with 60 business units with variations in retribution based on the waste generated.

The targeted budget and the realized budget for waste management program in Cirebon City are presented as follows:

Table 5. Targeted budget and realized budget for waste management program in Cirebon City.

Type of Budget	2022	2023
Targeted Budget	IDR 4,000,000,000	IDR 4,000,000,000
- MoU	N/A	IDR 1,445,368,750
- *PDAM*	N/A	IDR 2,554,631,250
Realized Budget	IDR 2,538,306,250	IDR 3,618,374,002
- MoU		IDR 1,055,658,502
- *PDAM*		IDR 2,562,715,500

Source: Environmental Office of Cirebon City (2024)

2.5.6 Community's participation

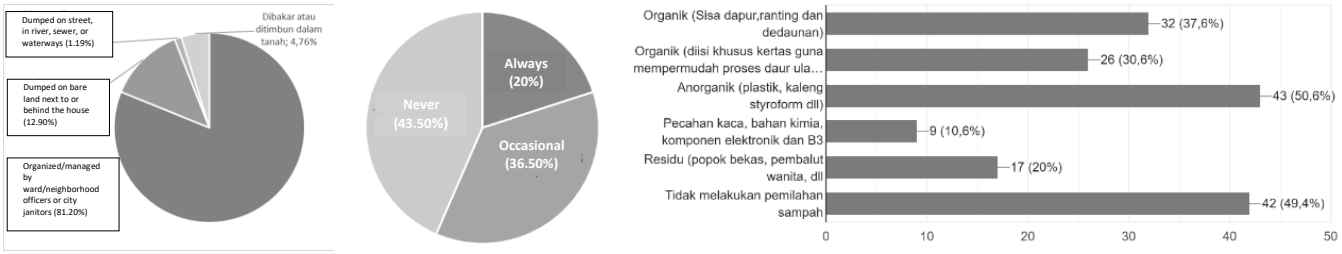
Currently, waste reduction activities by the community of Cirebon City are still minimal. This can be seen from the waste reduction efforts that have only reached around 6% based on the 2020 Cirebon City Waste Masterplan. In addition, minimal efforts can also be seen from the limited operation of waste banks in the community. One of the waste banks that has been operating for quite a long time is the Amanah Waste Bank in Neighborhood 6 of North Simaja, Drajat Village, Kesambi Subdistrict. It serves only 70 houses out of 536 houses. The total incoming organic waste is 40 kg/day, in which 3 kg/day is processed using maggot and the rest is set aside as animal feed. Meanwhile, inorganic waste is processed into handicrafts. However, due to limited area and budget, it is difficult to increase the capacity of the existing waste bank.

3. Results and discussion

3.1 The first questionnaire distribution

The initial stage of evaluating and improving waste management in Cirebon City was carried out by distributing questionnaires to identify the existing conditions. This questionnaire had been tested for validity and reliability. The validity test results show that all question items are valid, with a Sig. (2-tailed) smaller than 0.05 and r-count greater than r-table (r = 0.361). This shows that the instrument (question items) used are valid, meaning that they are significantly correlated to the total score. Meanwhile, the reliability test generated a Cronbach's Alpha value of 0.859. Cronbach's coefficient of 0.70 is considered sufficient, but values between 0.80 and 0.95 are preferred for better psychometric quality (Ivziku et al., 2024). Thus, it can be inferred that the research instrument used is reliable.

There are several important points in the results of the questionnaire given regarding waste management, namely the community's attitudes, how to reduce and handle the waste, and how to involve other parties.



(a) (b) (c)

Figure 2. (a) Waste handling manner by the community in Cirebon City; (b) Waste sorting frequency by the community; (c) Types of waste sorted by the community

As seen in Figure 2(a), around 81.2% of the community of Cirebon City stated that waste handling is managed directly by the surrounding parties. This shows a good opportunity because the community is handling waste more than dumping waste on empty area without handling. Next, based on Figure 2(b), it is seen that waste sorting activity has been conducted at least 20%. Based on these results, it is necessary to conduct a more intense socialization to the community regarding the importance of waste sorting. In addition, it is seen in Figure 2(c) that the community generally sorted non-organic waste, such as plastics, cans, and styrofoam, and similar materials that have high economic values.

3.2 Development strategies of waste management system in Cirebon City

Strategies were developed based on an inventory of waste management data from the Cirebon City Government and the results of community questionnaires. This data were employed in SWOT analysis to formulate waste management policies and strategies, which were then grouped into technical and financial aspects. The results of the formulated strategies are shown in Table 6.

Table 6. Development strategies of waste management system in Cirebon City based on SWOT analysis results.

S-O	**S-T**
1. Educate the public on the reduce-reuse-recycle (3Rs) concept to increase understanding and practice of reuse and recycling of waste. 2. Improve waste management infrastructure around the community's living environment	1. Encourage the government to give a more active appeal about waste sorting and provide incentives for residents who sort the waste. 2. Conduct participatory programs with communities to plan and implement the effective waste management strategies. 3. Establish a master waste bank as a recipient of proceeds from community-managed unit waste banks 3.
W-O	**W-T**
1. Increase the *APBD* allocation for improve the waste management based on achievement targets 2. Change the method of retribution payment, which is currently conducted under the regional drinking water company (*PDAM*). 3. Maximize the role of waste temporary	1. Create a waste management program that takes into account the time constraints of the community by colaborating with the informal sector. 2. Integrate aspects of retribution payment with tangible benefits for the community, such as improved environmental health and quality of life.

shelters and waste recycling centers using 3Rs system.
4. Build new and more reliable infrastructures to facilitate the reduction of waste entering Kopi Luhur landfill site.

3.3 Cirebon City waste management program

Based on the distribution of the second questionnaire, the assessment results of each respondent's responds have shown the consistency of each program offered, as seen in Table 7.

Table 7. Cirebon City waste management program.

Aspect	Phase	Program
Reduce	Short term (2025)	Socialize the ban on the use of plastic bags to shopping centers and modern stores.
		Socialize the restrictions on the use of plastic bags in the community through social media, banners, as well as activities at the neighborhoods and school levels.
	Medium term (2026–2030)	Socialize the restrictions on the use of plastic cutlery to restaurants in Cirebon City through social media, banners, and direct visits to the field.
		Socialize the restrictions on the use of plastic cutlery to the community through social media, banners, as well as activities at the neighborhood and school levels.
		Socialize the use of gadget technology (mobile phones, laptops, tablets), and email in every school and office activity to reduce the use of paper.
	Long term (2031–2046)	Establish the regulations of prohibiting the use of plastic spoons, forks, and other cutlery in every large and small restaurant.
		Make rules for limiting the use of paper in school and office activities.
		Continue the programs that have been carried out in the previous stage.
		Conduct supervision and sanctions to every actor who violates the rules of limiting waste generation.
Reuse	Short term (2025)	Socialize the use of non-disposable items, such as tumbler bottles, to the community, also encourage them to bring their own eating or drinking utensils, and cloth shopping bags.
		Socialize the usage dangers of disposable goods through school activities.
	Medium term (2026–2030)	Provide the sorted waste containers in high and medium risk areas based on the Cirebon City's sanitation strategy (*SSK*).
		Socialize regularly to the community on how to sort and separate waste based on the types of waste in high and medium risk areas.
		Hold learning at every school level to ingrain the practical knowledge on waste sorting and separation techniques.
		Establish 30 waste bank units in scattered neighborhoods in Cirebon City.
		Held clothing and household appliance bazaar (preloved).
		Establish a village clean waste competition at neighborhood scale.
	Long term	Provide the sorted waste containers in low and very low risk areas based

Aspect	Phase	Program
	(2031–2046)	on the Cirebon City's sanitation strategy.
		Socialize regularly to the community on how to sort and separate waste based on the types of waste in low and very low risk areas.
Recycle	Short term (2025)	Establish a master waste bank managed by the waste's regional public service agency (*BLUD*).
		Provide training to the community on managing the waste bank unit regarding the processed waste products that have selling values.
		Establish standards for processed waste products to make them more attractive and have selling values.
	Medium term (2026–2030)	Increase the waste recycling business by routinely holding exhibitions of processed waste products in schools, shopping centers, and public parties.
		Establish rules on the obligation of waste sorting and waste recycling independently or through colaboration with other parties for building managers, such as large shopping centers, offices, and industries.
		Cooperate with micro, small, and medium enterprises (MSMEs) regarding the use of recycled materials and provide incentives to attract their interest.
		Conduct the coding of waste types to facilitate the waste recycling process.
		Schedule the waste collection based on the types of waste.
	Long term (2031–2046)	Continue the programs that have been carried out in the previous stage.
		Conduct research and testing on the use of recycled materials as construction materials through collaboration with universities and research institutions.
		Encourage the use of recycled materials in construction activities, such as road construction, as a mixture of asphalt, bricks, etc. through collaboration with developers and contractors.
		Establish regulations that necessitate goods producers to retract their waste. If the producers are unable to do it, they must compensate the waste management fund to the Cirebon City's waste managers.
		Procure plastic bottle-receiving machines in supermarkets/minimarkets. The community will receive money from each bottle put into the machine. The money comes from the bottle manufacturer. Each bottle sold to the public already contains the price of the bottle. Thus, in essence, people will obtain a refund if the bottle is returned to the manufacturer.
		Conduct market research study for recycled products that suit the local market.
		Adjust the procurement of recycling units based on the waste volume demand that can be met.
Resource Recovery	Short term (2025)	Cooperate and establish long-term contracts with offtakers from refuse-derived fuel (RDF) activities.
		Create the detailed design planning of integrated waste treatment plant (*TPST*) using RDF system.
		Build a TPST with capacity of 20 tons/day in the area near Kopi Luhur landfill site using RDF system.

Aspect	Phase	Program
	Medium term (2026–2030)	Study the various concepts that can enhance both the effectiveness and efficiency of the TPST operation using RDF system.
	Long term (2031–2046)	Continue the programs that have been carried out in the previous stage.
		Establish a used cooking oil collection program. The implementation at initial stage can cooperate with large restaurants/malls/hotels. In the next stage, the community can submit the used cooking oil to waste banks/third parties to be exchanged for money.
		Establish a processing plant for used cooking oil to be processed into biodiesel. This can be conducted through collaboration with Pertamina EP Asset 3 of Cirebon City.
Incineration	Medium term (2026–2030)	Conduct a feasibility study on incinerator construction.
		Conduct an environmental assessment on the incinerator construction.
		Implement a public consultation regarding incinerator construction.
		Prepare a detailed design of the incinerator.
	Long term (2031–2046)	Build an incinerator with capacity of 100 tons/day in the area near Kopi Luhur landfill site.
Disposal	Short term (2025)	Rehabilitate the supporting buildings of Kopi Luhur landfill site.
		Clean and tidy up the landfill area to prevent landslides and fires.
	Medium term (2026–2030)	Implement a waste mining activity using RDF system.
		Clear the land in areas that are still empty as the preparation to construct a residual waste land (*LUR*).
	Long term (2031–2046)	Build a residual waste land (*LUR*) as a shelter for RDF and incinerator residues.
		Transform the former landfill site into a green area or green open spaces (*RTH*).
Financial	Short term 2025	Conduct an outlook study on waste retribution by assuming that waste management in Cirebon City adopts the Virginia Solid Waste Management Hierarchy Concept.
		Establish cooperation with all neigborhoods in Cirebon City in the form of MoU regarding the value of waste retribution, which is based on the amount of waste generated by each neighborhood.
		Apply for assistance/grants both to the central government and to other parties for the construction of TPST using RDF system.
	Medium term (2026–2031)	Socialize the understanding that retribution payment for domestic waste is no longer based on PDAM, but based on MoU cooperation with each neighborhood in Cirebon City.
		Expand the cooperation with non-domestic parties in the form of MoU regarding the obligation to pay retribution.
		Maximize the sales of recycled waste and RDF.
		Cooperate with industries and companies in waste management through CSR activities.
	Long term (2031–2046)	Increase the ability of creative funding to achieve surplus in waste management.

3.4 Selection of waste management concept in Cirebon City

Two waste management concepts were compared in this study using the Simple Additive Weighting (SAW) analysis, namely the Virginia Solid Waste Management Hierarchy Concept (1st alternative) and the current existing management concept in Cirebon City (2nd alternative). The comparison results of these two alternatives are displayed in Table 8.

Table 8. SAW analysis results regarding the waste management concept alternatives.

No.	Parameter	Weight (%)	Value		Weight (%) x Value	
			1st Alternative	2nd Alternative	1st Alternative	2nd Alternative
1.	Waste reduction load	25	3	1	0.75	0.25
2.	Waste processing expenses	25	3	1	0.75	0.25
3.	Investment cost	10	1	3	0.1	0.3
4.	Ease of operation and maintenance	15	2	3	0.3	0.45
5.	Operational and maintenance costs	25	1	2	0.25	0.5
	Total	**100**			**2.15**	**1.75**

Based on the SAW analysis results, the 1st alternative, namely the Virginia Solid Waste Management Hierarchy Concept, exhibits the higher value (2.15) compared to that of the 2nd alternative, namely the existing waste management concept. The 1st alternative shows a fairly high score because of the high level of waste reduction and processing. The adoption of the Virginia Solid Waste Management Hierarchy Concept can enhance the effectiveness of waste reduction activities at the community level and city-scale waste management. Moreover, the implementation of 3Rs as well as resource, recovery, and incineration phases can meet the target of Cirebon City's regional policies and strategies (*Jakstrada*), namely reducing waste entering the landfill site by 80%. In addition, through the implementation of integrated waste treatment plant (*TPST*) using refuse-derived fuel (RDF) system and incinerators, it is hoped that the waste entering the landfill site or residual waste land will be only in the form of residue, namely 10% of total waste mass. However, based on the analysis results, several parameters are also seen as the obstacle to realize the adoption of this system, namely investment costs and operational costs. A system that is expected to have high effectiveness will definitely have an impact on the amount of costs that must be incurred, such as in the case of implementing the Virginia Solid Waste Management Hierarchy Concept. Therefore, to address this challenge, careful financial studies must be conducted in advance before building new infrastructures or implementing this system. Financial studies can be conducted by third parties who have experience in the field of waste financing.

4. Conclusions

Based on the above results, several important points as the conclusions are described as follows:

1. Based on the results of Delphi method, three most determining factors regarding the success of waste management are the level of waste reduction load, the waste processing load, and the maintenance of operational costs.
2. Based on the results of potential identification, the Virginia Solid Waste Management Hierarchy Concept (1st alternative), compared with the existing concept (2nd alternative), has the potential to be applied in Cirebon City. Based on SAW analysis results, the value of the 1st alternative is 2.15, while that of the 2nd alternative is only 1.75. However, there are several obstacles encountered, the most important of which is the high investment and operational costs. Therefore, a financial study is necessary to be conducted before implementing this system.
3. Based on the analysis results of the Virginia Solid Waste Management Hierarchy Concept, there are two main strategies to achieve the waste reduction target in Cirebon City, namely (a) implementing a more structured master waste bank and (b) establishing waste processing activities through integrated waste treatment plant (*TPST*) using refuse-derived fuel (RDF) system as well as through incinerator and waste mining.

5. References

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