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Improvement Of Solid Waste Recycling Management For The Conditions Of The Republic Of Colombia

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Abstract

Solid waste management is a global issue that has led to the implementation of different strategies and approaches at the international level. In a global context, several cities and countries have faced challenges similar to those faced by Bogotá in the field of sustainable waste management. The study of practices and strategies implemented in other countries can provide valuable lessons and innovative approaches to effectively address the problem of solid waste in Bogota. To understand the methodology used and the results obtained, some international studies are presented below.

Key words: *solid waste, recycling, ecology, environmental pollution.*

Introduction:

(Álvarez, 2023) "Eco-efficient management of municipal solid waste for the sustainable development of the Quevedo Canton". [1]

Considering the problem of solid waste management in the city of Quevedo, the authors set out to evaluate the environmental efficiency of solid waste management in order to form an environmental culture and reduce the level of environmental pollution. To this end, a quantitative methodology was used to identify the characteristics that have the greatest impact on each household and build a decision tree that will determine ways to achieve environmental efficiency in municipal solid waste management.

In terms of materials and methods, interviews were conducted to diagnose the environmental impacts and consequences of poor solid waste management. Statistical analysis of the results obtained through comparative tests showed that the average accuracy of residents' perceptions of solid waste management habits and attitudes was 79.6%.

The variable identified for effective segregation was the frequency of container filling, where 79.6% of people were reliable in separating waste by composition.

The study characterizes the level of municipal solid waste generation per capita in Quevedo and shows that on average per person there is 0.81 kg per day, which translates into 58,829 tons per week in 24 provinces. Statistical differences were found in the types of waste, with organic waste accounting for the highest average at 1,460 kg, followed by glass (0.198 kg), paper and cardboard (0.195 kg), plastic (0.161 kg) and metal (0.112 kg). The study concluded that the decisive factors influencing the efficiency of waste management are people's habits and attitudes towards waste separation.

(Segovia Olivares, 2023)[1] "Solid waste management and environmental culture of the inhabitants of the region of Pisco, Ica – 2023". [10]

In this study, the main objective was to establish the relationship between solid waste management and environmental culture, addressing the issue that begins on a national scale to

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highlight the growing concern about the increase in the amount of this waste and its negative impact on health and the environment.

The authors drew on a 2018 World Bank report that highlighted the challenges developing countries face in solid waste management, a problem exacerbated by population growth and demand for services and goods...

To carry out the study, a methodology was used that included the theoretical knowledge of the study variables, especially the variable "GRS" (municipal solid waste, MSW) and its relationship with the environment and culture. The hypothetical-deductive method was used and the environmental culture variable of MSW was demonstrated according to the study by Ventura (2017), which analyzed a population of 67,467 people. The sample was based on a sample survey with a 95% confidence level, taking into account margins of error and population size.

When analyzing the results of a study, two types of conclusions are distinguished: descriptive and inferential. In descriptive terms, in relation to the general objective, it is observed that 58.7% of citizens believe that they carry out periodic management in the field of environmental culture. For the first specific task related to the frequency of the solid waste management variable, 50.1% believe that environmental education and awareness are carried out on a regular basis.

For the second task, related to solid waste management and community participation, 41.3% consider this participation to be regular. Finally, for the third objective, 51.7% believe that social responsibility is perceived on a regular basis.

In conclusion, we observe that the results obtained indicate that 58.7% perceive the importance of solid waste recycling, and emphasize the need to improve the connection between investment projects and the quality of the services provided. Introducing an environmental culture to the inhabitants of the Pisco region can contribute to a more efficient management of solid waste, and in order to achieve an adequate classification of solid waste, it is proposed to increase the social responsibility of citizens.

(Sornoza Gutiérrez & García Rodríguez, 2023) "Environmental Education for Solid Waste Management in the Central Market of the Hipihapá Canton" [5]

The authors focused their research on the implementation of environmental education in the area of solid waste management. An inductive-deductive analysis was carried out through a survey of 63 operators in the central market. The assessment was divided into classes: the first class reflects knowledge in the field of solid waste management, the second represents knowledge but not application, and the third represents knowledge and application.

The results showed that among men, the general understanding about solid waste management reached 35.8%, while 26.7% of men are not involved in waste management and 8.3% have adequate knowledge about solid waste management. In contrast, for women this figure was 65.0%, while 60.0% do not participate in recycling, 5.0% have a positive perception about recycling and solid waste management.

In terms of management and elaboration, 8.3 per cent of men have no special knowledge, while 3.3 per cent are environmentally informed and educated. On the other hand, 91.7% of women do not have environmental education on solid waste disposal and processing, and only 10.0% have such knowledge.

Overall, only 8.3 per cent of men and 11.7 per cent of women have any idea about environmental education. These variables are considered critical for the selection of waste disposal sites and the achievement of effective solid waste management, demonstrating shortcomings in the perception of disposal, management and recycling, as well as in environmental education.

(García & Llauce, 2023) "Environmentally Sound Management of Solid Waste in the City of Babajoyo" [5]

In this study, the authors examine the problem of inadequate municipal solid waste management in cities, which constantly arises and affects the management of various factors in the country, especially highlighting the consequences for water resource management, which affects both the city's economy and the health of its residents. The research approach is descriptive-explorative, using a qualitative method that studies various aspects of people's social lives.

The sample is composed of 390 people and the variables are environmental awareness, theoretical framework, decentralized management and supply. The operationalization of the problem of municipal solid waste and environmental awareness is carried out through a survey of 175,281 residents of the city of Babajoyo through a questionnaire answered by men and women. Statistics show that among the respondents there were 200 men and 190 women. The volume of waste collected ranges between 12 and 14 tonnes per day, and both organic waste, such as food, paper and cardboard, and inorganic waste, such as plastic, glass, metal and aluminium, are recycled. However, only plastic is recycled, accounting for 4% in the central sector, 5% in the domestic sector and 3% in the marginal sector.

The results obtained allow us to conclude that there is insufficient management of municipal solid waste in this region, which is explained by the low and medium level of environmental awareness of the population and the lack of guidance on the municipal solid waste management model, which contributes to the formation of landfills in the region.

(Herrera-Uchalin et al., 2023) "Solid Waste Management in Municipal Government: A Systemic Review" [6]

This exploratory study with a quantitative approach reviewed 35 articles, 25 of which were selected based on specific criteria for inclusion in publications from 2007 to 2021. The results obtained indicate the urgent need to solve the problem of environmental awareness of the population in the context of solid waste management. Of greater interest are the results obtained in the study (Herrera-Uchalin et al., 2023).

First, Ojeda-Benítez (2019) emphasizes that solid waste management requires critical attention because it has significant impacts on the environment and public health in the State of Mexico. The study by Espinoza-Quispe (2022) observed a direct relationship between solid waste management and the GMH variable.

In addition, Gamboa-Cortez & Madueño-Lahoz (2016) provide evidence of government barriers to municipal solid waste management and highlight the need to collaborate with communities to change practices and seize opportunities to raise awareness about cleaning the area.

In conclusion, Nieto (2021), in a systematic review with a qualitative narrative approach, concluded that environmental education plays a key role in changing deficient practices and habits in solid waste management. We highlight that this study as a whole reflects the global concern for the problem of solid waste, aimed at increasing environmental awareness and promoting best practices to reduce waste from landfills in major cities, especially in relation to plastic, paper, glass and organic materials.

(Carlín, Solís, & Barboza, 2023) "The Importance of Environmental Management and Solid Waste Management." [2]

In this study, the main objective is to analyze research related to solid waste, tracing the evolutionary history in search of better results. The search focuses on key terms such as "solid waste", "environmental management" and their acronyms. An analysis of the study shows that most cities face problems with proper solid waste management and the effectiveness of dealing with open dumps is limited.

This environmental problem manifests itself gradually, affecting ecosystems and contributing to environmental pollution, including noise pollution. It is concluded that this is a general problem that covers a large region, where waste is not only a source of air and water pollution, but also of emission of polluting gases.

International studies indicate a global concern about inadequate solid waste management and the need for educational strategies.

(Durango, 2023) "Comprehensive Municipal Solid Waste Management Plan (PMIRS) for the Civic Center of the City of Urrao" [3]

This study examines the challenges associated with accelerated industrial development, urban sprawl, population growth, and consumption, along with a lack of environmental awareness. According to the World Bank's What a Waste 2.0 (2018) report, it is estimated that Latin America and the Caribbean generates approximately 2.1 billion tons of municipal solid waste annually, equivalent to approximately 1 kg per person per year.

The purpose of this study was to develop a comprehensive solid waste management plan with a focus on characterizing the current conditions in the administrative city of the municipality of Urrao. The methodology used included several stages, starting with data collection and ending with the implementation of specific strategies.

When analyzing the responses received, it can be observed that after the implementation of the solid waste management programs, a lack of cooperation and an insufficient action plan in the area of solid waste management was identified, especially with regard to items such as gloves, masks and bags. Specific measures have been proposed, such as an environmental education programme, the introduction of more environmentally friendly printing methods and selective internal collection of materials.

Although recyclable waste does not provide direct economic benefits, the implementation of solid waste management programs has reduced costs and utilized recyclable waste. The need to develop collaboration and improve environmental awareness was identified, highlighting the importance of active staff participation in sustainable solid waste management.

(Echeverri, 2023) "Solid waste management and its impact on environmental degradation associated with migratory phenomena on the beach of El Malecón in the municipality of Necoclí, Antioquia" [4]

The author identifies the increase in solid waste as a consequence of population growth and lack of environmental awareness. To address this issue, a descriptive quantitative methodology is proposed to visualize and understand the problems associated with municipal solid waste. With ever-increasing development, this situation has negative consequences that affect the quality of key areas such as the economy and tourism.

When examining some qualitative variables related to this area, the state of paved roads is striking, which, despite their existence, have deteriorated significantly. In addition, attention is drawn to the state of beaches to which there are no access roads, which contributes to increased waste pollution. In addition, attention is drawn to the problem of waste disposal, as the lack of adequate places to separate organic, inorganic and recyclable waste has a negative impact on the state of public spaces and facilities.

Finally, it draws attention to the clogging of the sewer system with solid waste, which causes the appearance of unpleasant odors and contributes to the spread of infection vectors. This qualitative analysis provides a comprehensive understanding of the challenges facing municipal solid waste management in the area, addressing key issues related to infrastructure, improper disposal, and its impact on quality of life and the environment.

(Morales & Montiel, 2023) "Environmental management proposal to promote the improvement of the activities of the Associative Company of Solid Waste Collectors ASOMUFAMEDIO in the municipality of Planadas Tolima, Colombia" [8]

This study highlights the critical role of solid waste management organizations in Colombia in promoting waste recycling and environmental stewardship, especially in areas experiencing decline due to inadequate waste management.

The main objective of the study (Morales & Montiel, 2023) is to analyze the process of solid waste management and recycling, providing support to participants through

environmental education to improve collection and recycling processes. The methodology adopted is descriptive and involves data collection through observations, surveys, and metrics.

The author points out the lack of information in Colombian municipalities on the proper management of solid waste and its final disposal in sanitary zones. This leads to environmental impacts derived from poor classification of urban waste, which motivates the creation of associations and organizations aimed at protecting and minimizing these impacts.

The results indicate that soil is the most significant impact factor and its environmental consequences are associated with changes in soil quality. Other impact factors are air, where the environmental aspect is noise and the impact is changes in air quality and people's lives; water, where the environmental aspect and impact are the generation of wastewater and changes in water quality, respectively; the use of non-renewable resources, where the environmental aspect is the consumption of electricity, and the impact is the deterioration of the state of the non-renewable natural resource.

Finally, an environmental management plan is proposed to minimize noise, promote the efficient use of water and energy, and develop training to increase awareness of effective solid waste management. This comprehensive approach aims to address various aspects of environmental impact and promote more sustainable waste management practices.

At the national level, it is clear that several regions of Colombia face similar challenges, highlighting the importance of an integrated approach to environmental education.

(Salazar, Gómez, & Velásquez, n.d.) "Environmental Education Strategy to Improve Solid Waste Management in the Kennedy District of Bogota, Colombia" [9]

The problems identified in Bogotá (Salazar, Gómez, & Velásquez, n.d.) are relevant to the present study: Bogotá is believed to face challenges, including flooding, due to poor solid waste management in the face of population growth and spatial distribution. With a population of more than seven million, improper waste management, especially in the Kennedy area, has created problems such as sewer failures, and a lack of environmental education makes the situation worse.

(León, 2023) "Development of a comprehensive solid waste management plan generated by the DYETEX SAS textile plant in Bogotá (District of Colombia)" [7]

The main objective of a textile company's solid and industrial waste management program is to reduce waste generation and ensure proper waste management and eventual disposal. Poor waste disposal is associated with social, environmental and economic problems.

In the context of the textile industry, known for being one of the most polluting industrial activities, it seeks to change the mentality of the global economy through consumer protection policies and special programs to reduce solid waste and ensure its proper disposal and recycling.

When it comes to identifying and characterizing environmental impacts, the most significant is landscape pollution, which is confirmed by the accumulation and improper classification of waste. There is also air pollution caused by the spread of vectors attracted by odours generated by waste processing, which negatively affects the surrounding population. In addition, there is an impact on public health: the increase in the number of respiratory diseases and the formation of leachate are factors that affect society.

The lack of knowledge and proper practices is reflected in the uncontrolled generation of waste, which negatively affects the quality of life and the environment. Therefore, it is necessary to develop effective educational programs that promote responsible solid waste management at all levels.

Thus, at the national level, Colombia is actively addressing the problem of solid waste management through various policies, regulations, and programs. The country faced unique challenges in different regions, resulting in significant differences in waste management strategies and outcomes. In this sense, studying the national situation of waste management

will provide insight into the specific policies, experiences and challenges faced by Bogota, thus providing an important contextual basis to more effectively address the problem at the local level.

A review of the history of the origin and development of the research problem and an analysis of the theoretical framework indicate a critical need for the implementation of comprehensive solid waste management strategies in Bogotá. Solving the landfill problem seems to require a combination of technological and environmental approaches, such as the construction of waste-to-energy plants.

Methodology

The methodology applied to diagnose the current situation of waste management in Bogotá provides an in-depth knowledge of the factors that contribute to the formation of landfills. A detailed analysis of the effectiveness of waste management, the level of environmental pollution and citizens' opinions provides a solid basis for the development of specific strategies.

The strategic proposal, focused on the implementation of waste-to-energy plants and other activities, aims to achieve positive environmental and social benefits. This approach goes beyond technical waste management and aims to raise public awareness and promote sustainable practices. The proposed strategy has the potential to bring significant changes to the solid waste management system in Bogota.

Results:

Solid waste is the result of daily activities in cities, departments, municipalities and towns, including businesses, industries and households. Dealing with all this waste is a daily challenge for healthcare and municipalities. Sanitation workers are typically responsible for sweeping, scooping, and cleaning public areas, but their job is complicated by overcrowding, requiring more people to control waste to maintain a healthy and clean environment.

According to Segura, Rojas, & Pulido (2020), [18] the definition of solid waste given by (Angelidaki et al., 2011): organic materials containing solids in a percentage of 10 to 40%. According to (Doble & Kumar, 2005), solid waste can be classified into household waste, hospital waste (health sector waste) and industrial waste.

According to Segura, Rojas, & Pulido (2020), [18] the classification of these wastes also varies by country, which may be due to regulatory requirements, quantity or type of waste; In Colombia (La Norma Técnica Colombiana, 2009) waste is divided into three categories: general, hazardous and special.

The idea of a consistent solution to this problem is to be able to control the amount of hazardous waste in a large city, looking at the stages of its reduction, use, conversion and final disposal. Thus, according to Jaramillo (2003), [19] "the growth of population, culture and current activities pose too great a risk to the environment and human health, making environmental management a great challenge" (González, 2016, p.103). [23]

Latin America faces challenges compared to countries that actively promote recycling. The region recycles only 4.5% of its waste, well below the global average of 13.5%. The UN highlights that Latin America lags behind countries belonging to the Organization for Economic Cooperation and Development (Montes, 2019). [24]

It is worth noting that in Colombia, "the proportion of solid waste in production (per capita) is approximately 55%" (Jaramillo Henao & Zapata Márquez, 2008, p. 21). [19] In addition, it is pointed out that ineffective solid waste management in Latin America and the Caribbean has negative consequences associated with various risks, especially at final disposal sites.

Cruz Sotelo and Ojeda Benítez (2013) [20] consider that technological progress is the cause of high environmental costs. While technology has given us many comforts both

personally and socially, especially in large industries, it has also brought us to a crossroads where we must continue with the modern culture of the disposable or know how to manage this culture and not neglect the protection of the planet, teach. It experiences the opposite effects and mitigates the consequences of the new technologies of the century and their conveniences.

Proper waste management involves recycling and reusing it. In addition, proper solid waste management helps maintain a healthy environment and promotes the responsible use of resources. Below is a report from capital cities on the topics identified in the 2021 Solid Waste Management Report:

Table1. Waste Recycled Annually, Tons – Largest Cities

Bogota	2.239.711,36
Cali	630.778,25
Medellin	682.987,22
Cartagena	467.848,83
Barranquilla	539.151,44
Santa Marta	206.311.27
Bucaramanga	192.873,77
Grass	121.837.78

Note: Own development, 2023 - according to (Superintendence of Residential Public Services (2023)). [4]

Data from Table 1 show that the annual volume of solid waste disposal is very high, which is confirmed by quantitative data that give a clear idea of the magnitude of the waste management problem in these cities. It should be noted that, in Bogota, which is the capital of the country, this figure is 2,239,711.36 tons, a figure significantly higher than that of other cities. Another concern is the end use or deletion of the data shown in Table 1.

Table2. Authorized and unauthorized solid waste disposal systems.

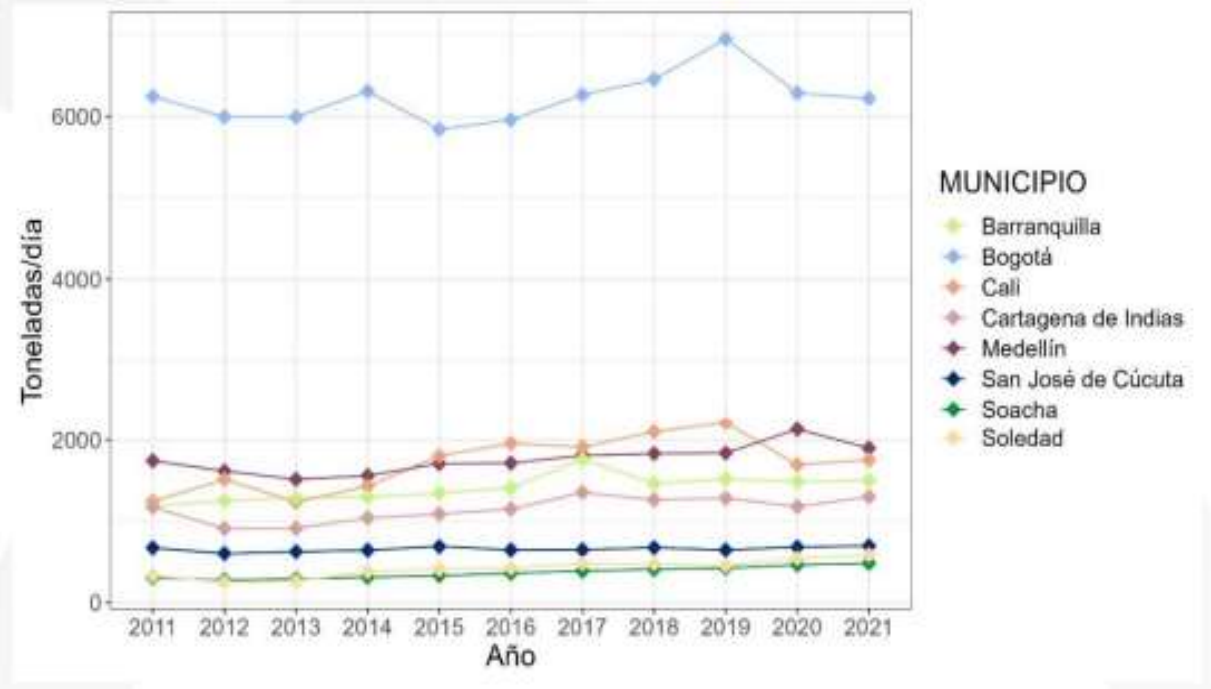
Authorized system	**Unauthorized system**
Treatment facilities 0.00%	Combustion - 0.00%
Emergency Cell 12 4.51%	Reservoirs - 0.00%
Waste landfill 165 62.03%	Burial - 0.00%
	Open burial 77 28.95%
	Flow Cell 12 4.51%

Note: in-house development, 2023

Figure 2 shows the authorized and unauthorized solid waste disposal and treatment systems in Colombia. It is also important to note that the lack of treatment methods, such as wastewater treatment plants, and the practice of unauthorized burning or dumping highlight the need for more sustainable and efficient solid waste management systems. [31]

Added to this is the problem of overcrowding, since for 2021 a 42.52% drop in total daily tonnage corresponds to cities with high populations, including Bogotá, DC, which in turn shows a drop since 2019 (-1.06%). Comparisons between cities with the same problems also need to be considered: [27]

Drawing1. Historical series 2011 - 2021 for the 8 most populous municipalities



Note: (Superintendence of Residential Public Services, 2023) based on (Superservices Disposal Reports valid 2019-2020; Disposal basis 2021; SSPD calculations). In original language: Spanish

As a result of the above, it can be determined that Bogota, which is the capital of Colombia, generates a higher amount of tons of solid waste compared to other overcrowded cities nationwide.

In general terms, "the average waste management indicators in all territorial areas indicate that the city of Bogotá is the city with the highest amount of waste at the national level, with more than 6 thousand tons per day" (Superintendence of Household Public Services, 2023). [21]

Therefore, according to the above indicators, it is necessary to find a solution to reduce the level of environmental pollution in the city of Bogotá (Colombia).

Integrated waste management in the country has focused its efforts in several areas. One of them is to reduce the amount of waste generated, encouraging its reuse and recycling (Superintendence of Household Public Services, 2023). [21]

The DANE study (DANE, 2022) [22] presents data on final waste disposal at the departmental level, according to which the highest volume of solid waste per day is found in the departments of Bogotá, Antioquia, Valle del Cauca, Atlántico and Cundinamarca. In addition, this indicator is related to the population density and economic activity of each area.

Another important aspect is the improvement of waste management, treatment and recycling systems. Priority is given to controlled disposal, ensuring strict compliance with environmental standards. In this regard, special instructions and policies have been developed to regulate this common practice. Examples include CONPES 3530 of 2008 and CONPES 3874 of 2016 (Superintendence of Residential Public Services, 2023). [21]

The study results in the project for the implementation of a comprehensive solid waste management system in Bogota, focused on the installation and efficient operation of recycling plants, in order to reduce the amount of waste sent to landfills, promote recycling, and improve the environmental and social impact in all locations of the city.

Strategy Design

Illustration 2 Impacts of variables

VARIABLES	PREVENTION	MITIGATION	CORRECTION
IMPLEMENTATION OF HARVESTING PLANTS	X	X	X
RECYCLING PROMOTION	X	X	-
IMPROVING COLLECTION INFRASTRUCTURE	X	X	X
COMMUNITY ENGAGEMENT	X	X	-
LEGAL AND REGULATORY ASPECTS	X	-	X

Note: Authors' own elaboration (2023)

Illustration 3 Integrated Solid Waste Management Program (PGIRS)

IMPLEMENTATION OF HARVESTING PLANTS	
Impact-generating activities	**Impacts to prevent, mitigate or correct**
Selection and construction of plants, operation of technologies.	Waste generation during construction, possible environmental impacts.
RECYCLING PROMOTION	
Impact-generating activities	**Impacts to prevent, mitigate or correct**
Carrying out educational campaigns, incentive programs and collaboration with waste pickers.	Alteration in the amount of waste generated and improper disposal.
IMPROVING COLLECTION INFRASTRUCTURE	
Impact-generating activities	**Impacts to prevent, mitigate or correct**
Route optimization, introduction of advanced technologies, and community engagement.	Alteration in the efficiency and coverage of the service, possible impacts on communities.
COMMUNITY ENGAGEMENT	
Impact-generating activities	**Impacts to prevent, mitigate or correct**
Formation of local committees, organization of awareness-raising events and volunteer programs.	Potential conflicts or community resistance.
LEGAL AND REGULATORY ASPECTS	
Impact-generating activities	**Impacts to prevent, mitigate or correct**
Evaluation of current legislation, proposals for adjustments, and ongoing alignment with regulations.	Failure to comply with current regulations and regulations.

Note: Authors' own elaboration (2023)

Illustration 4 General Details

OBJECTIVE:
Establish comprehensive strategies that successfully address solid waste management in Bogota, with special attention to the implementation of recycling plants, promotion of recycling, improvement of collection infrastructure, community involvement, and alignment with legal aspects.
JUSTIFICATION:
The program seeks to prevent, mitigate, correct, and offset the negative impacts associated with improper solid waste management by promoting sustainable practices and community engagement.
GOALS:
1. Establish an adequate management to minimize the environmental impact in the implementation of harvesting plants.
2. Reduce the amount of waste generated by promoting recycling and improving collection infrastructure.
3. Encourage community participation in solid waste management.
INDICATORS:
% reduction in environmental impact during the implementation of harvesting plants.
% reduction in the amount of waste generated.
% of community participation in solid waste management activities.

Note: Authors' own elaboration (2023)

Illustration 5 Weighting Results - Strategic Plan

CRITERION/VARIABLE	**WEIGHTING (%)**	**QUALIFICATION**	**WEIGHTED WEIGHTING**
A. Implementation of Harvesting Plants	30%	85/100	25,5
B. Promotion of Recycling	20%	90/100	18
C. Improvement of Collection Infrastructure	25%	80/100	20
D. Community Involvement	15%	95/100	14,25
And. Legal and Regulatory Aspects	10%	88/100	8,8
Total	100%		86,55

Note: Authors' own elaboration (2023)

Interpretation:

Criterion/Variable: Describe the specific aspect you're evaluating (e.g., each strategy in your plan).

Weighting (%): Indicates the relative importance of each criterion in the overall plan.

Grade: Represents the evaluation or performance obtained for each criterion (it can be a numerical or qualitative grade).

Weighted Weighting: This is the result of multiplying the weighting by the rating, indicating the relative impact of each criterion on the overall plan.

Total: The sum of all weighted weights, providing an aggregate measure of plan performance.

Presentation of results

Evaluation of the Results of the Strategic Plan with a Focus on Plants to Mitigate Garbage Parks in Bogota:

1. **Reduction of Garbage Polygons:**
   Indicator: Percentage decrease in the identification of garbage polygons.
   Expected Result: A significant reduction in the presence of garbage parks in strategic areas of the city is expected.
2. **Efficiency in Separation and Utilization:**
   Indicator: Solid waste utilization rate.
   Expected Result: Increase in the amount of waste separated and used, reflecting the effectiveness of the harvesting plants.
3. **Community Involvement:**
   Indicator: Level of community participation in recycling programs.
   Expected Result: Increase in citizen participation, evidenced by the increase in waste separation at source.
4. **Waste Reduction in Landfills:**
   Indicator: Decrease in the amount of waste sent to landfills.
   Expected Result: The implementation of harvesting plants should reduce the load of waste sent to landfills, minimizing their environmental impact.
5. **Improved Recycling Quality:**
   Indicator: Quality of recycled materials.
   Expected Result: Higher quality of recycled materials thanks to efficient separation in harvesting plants.
6. **Environmental Impact Assessment:**
   Indicator: Assessment of the general environmental impact of harvesting plants.
   Expected Outcome: Plants must operate within environmental standards, avoiding significant negative impacts.
7. **Plant Operational Efficiency:**
   Indicator: Operational efficiency of harvesting plants.
   Expected Result: Efficient operation of the plants, reflected in the proper management of waste and the minimization of emissions.
8. **Changes in Citizen Perception:**
   Indicator: Citizen perception surveys on waste management.
   Expected Result: Improvement in public perception of waste management, evidenced by positive surveys.
9. **Regulatory Compliance:**
   Indicator: Evaluation of the regulatory compliance of harvesting plants.
   Expected Result: Plants must comply with all environmental and waste management regulations.
10. **Reduction of Negative Environmental Impacts:**
    Indicator: Decrease in adverse environmental impacts associated with waste management.
    Expected result: Lower negative environmental impact compared to the situation prior to the strategic plan.

Discussion:

The implementation of an integrated approach, including the construction of organic waste processing plants and the introduction of innovative technologies, will not only reduce the level of waste accumulation, but will also contribute to a cultural shift towards responsible waste management. Successful international experiences, such as the use of advanced recycling

plants in European cities, demonstrate the effectiveness of such solutions in reducing waste accumulation and improving the quality of life of city residents. [28]

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