

Recycling in Bogotá: A SWOT Analysis of Three Associations to Evaluate the Integrating the Informal Sector into Solid Waste Management

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Abstract—In emerging economies, recycling is an opportunity for the cities to increase the lifespan of sanitary landfills, reduce the costs of the solid waste management, decrease the environmental problems of the waste treatment through reincorporate waste in the productive cycle and protect and develop people's livelihoods of informal waste pickers. However, few studies have analysed the possibilities and strategies to integrate formal and informal sectors in the solid waste management for the benefit of both. This study seek to make a strength, weakness, opportunity, and threat (SWOT) analysis in three recycling associations of Bogotá with the aim to understand and determine the situation of recycling from perspective of informal sector in its transition to enter as authorized waste providers. Data used in the analysis are derived from multiple strategies such as literature review, the Bogota's recycling database, focus group meetings, governmental reports, national laws and regulations and specific interviews with key stakeholders. Results of this study show as the main stakeholders of formal and informal sector of waste management can identify the internal and internal conditions of recycling in Bogotá. Several strategies were designed based on the SWOTs determined, could be useful for Bogotá to advance and promote recycling as a key strategy for integrated sustainable waste management in the city.

Keywords—Bogotá, recycling, solid waste management, SWOT analysis.

I. INTRODUCTION

CITIES in developing countries show increases on waste amounts produced for different causes such as: *i.* the increase of number of people that live and work in the cities; *ii.* the values per capita of waste generated have grown by the increases in wealth; *iii.* business and service activities have increased the amount of wastes; and *iv.* the materials in waste are rising in diversity and complexity. These facts indicate that the solid waste management is one of biggest challenges of the cities and one of the key responsibilities of a government [1].

The foundations of integrated and sustainable (solid) waste management (ISWM) integrate the physical elements and the governance features (see Table I) that are keys to deliver a good function of the system and well waste governance [1].

In cities of developing countries, the waste management is characterized by an active informal sector recycling, reuse and repair system that contribute in the increase of recycling rates where it is important to develop several strategies to formalize this sector as a social inclusion policy. Recycling sector offer

livelihoods to important numbers of the urban poor and this sector has the potential to save 15%-20% of its waste management budget by decreasing the quantities of waste that would otherwise have to be collected and disposed of by the city [1].

TABLE I
THE PHYSICAL ELEMENTS AND THE GOVERNANCE FEATURES OF ISWM

Physical Elements	Governance Features
Public health: keeping healthy conditions in cities, especially through a good waste collection service.	Inclusive system: to provide transparent spaces for stakeholders to contribute as users, providers and enablers;
Environment: protection of the environment throughout the waste chain, particularly during treatment and disposal.	Financially sustainable waste system which means cost-effective and affordable.
Resource management: 'closing the loop' by returning both materials and nutrients to valuable use, through preventing waste and striving for high rates of organics recovery, reuse and recycling.	To consolidate sound institutions and pro-active policies.

Recycling is a key point within waste management planning because high levels of separate collection and improvements in sorting and recycling technologies generate several advantages as the reducing the landfill volumes and the negative impacts of waste and finding beneficial reuses [2], [3].

Studies on informal recycling sector and waste management have analysed different aspects. For example: [4] analysed social situation of the waste pickers in Indonesia through quantitative surveys determining several social, health and environmental problems for these population determining that waste laws and regulations should be appropriately applied to facilitate a socialization process of waste pickers and prevent child labour in informal recycling; [5] evaluated the production of household waste and how its segregation conserves the value of recyclable materials, allow the accessibility to recycling sector and reduce the overall waste streams in the context of Dhaka Bangladesh using several descriptive methods concluding that segregation is key to increase the value of waste to improve process is fundamental the integration of stakeholders establishing their needs and perceptions to determine the best public interventions; [6] analysed the role of informal recycling in solid waste management (SWM) in Indonesia applying material flow method and questionnaires finding positive and negative aspects of informal recycling within SWM where it should

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seek by policy makers alternatives to include informal recycling sector in the SWM as a strategy to achieve inclusive society; [7] evaluated from the planning of SWM the situation of the informal recycling sector in the city of Enugu in Nigeria using direct observation, interviews with stakeholders and review of relevant legislation, policy documents and reports related to SWM establishing that the recycling informal sector contributes from different perspectives in the city as the reduction of environmental problems, job creation and poverty alleviation. However, this sector has not been considered in the reforms of SWM, which is important to empower of people involved in this activity; and [8] analysed how achieve sustainable solid waste management systems in Mexicali, Mexico considered four types of actors (the municipal government, the formal private sector, informal sector and communities) describing the system and possibilities to recover recycling materials generating a proposal to improve waste management. These studies have demonstrated the importance of recycling informal sector and its inclusion in the formal sector as strategy to reduce poverty, improve of quality of life and environmental sustainability through the ISWM.

In the context of Colombia and especially in Bogotá, the recycling has been analysed taking into account the production of waste and potential to increase recycling rate, the role of waste pickers and their work to defend their rights and guarantee their work and improve conditions through the inclusion in solid waste management policies, strategies of education to achieve recycling culture and evaluation of different public policy instruments to achieve effective recycling program in the Colombian cities [9]–[12].

With this background, this study seek to analysis the possibilities and strategies to integrate formal and informal sectors in the solid waste management using a strength, weakness, opportunity, and threat (SWOT) analysis taking as case study three recycling associations in Bogotá. The main contribution of this research is to identify the main advantages and disadvantages of these associations in the transition from informal to formal sector where studies are limited and the research in Latin America is beginning as a strategy of social inclusion and sustainability development.

The remainder of the paper is organized as follows: Section II describes the research methodology applied in this study; Section III shows the main results and features of SWOT analysis of three recycling associations selected in Bogotá; Section IV explains the potential strategies to improve integrated sustainable waste management through the integration of informal sector as authorized waste providers in the city; and finally it explains the main conclusions.

II. RESEARCH METHODOLOGY TO ANALYSIS RECYCLING IN BOGOTÁ FROM SWOT ANALYSIS

The SWOT analysis tool is a strategic method to analysis recycling in Bogotá. This method has been widely applied in different fields related to environmental management. For example, [13] developed a sustainability SWOT as systematic tool that includes traditional SWOT tool, a strategic business planning and life cycle analysis to determine product

sustainability in the framework of business decision making in case of biodiesel demonstrating that this tool is easy for green business and present the overall product or process life cycle including the principal sustainability aspects; [14] used SWOT analysis to evaluate environmental management practices in the Greek Mining and Mineral Industry finding important policies implications related to support of state with specific financial funds, regulations, environmental training programs, among other where this practices could involve high cost in the long run. In case of waste management, [15] applied SWOT analysis integrating to community to formulate strategic action plans for municipal solid waste management in Lucknow (India) achieving to improve waste management and better collaboration between community and municipal company; [16] described industrial waste generation and management in Granada (Spain) with SWOT analysis generating various recommendations to improve industrial waste management.

These studies have demonstrated that SWOT tool is adequate to analysis waste management from several approaches integrating and incorporating different stakeholders with the aim to concern and better decision-making and to analysis problems from a strategic perspective. However, this tool only can be used to help decision-making and it is first approach of the situation and it should be used as a comprehensive and unique method [17], [18].

This study is developed in four stages: *i.* It analyses the situation of waste generation and recycling in Bogotá from different sources such as the compilation of statistics, government reports, laws and regulations related to recycling and interviews with public offices as UAESP (Special Unit Administrative of Public Services); *ii.* a set of research questions are designed and formulated to apply SWOT analysis and to define the strengths, weaknesses, opportunities and threats of the three recycling associations selected in Bogotá; *iii.* a specified SWOT analysis is executed based on the research questions designed with the aim to determine the possibilities to associations to enter as authorized waste providers. Answers of these questions are summarized through studying information obtained from a series of focus group meetings and interviews in associations and government's offices; and *vi.* According to results of the SWOTs identified, a number of recommendations are generated for improving the possibilities to inclusion of recycling informal sector in the formal waste management programs in Bogota from principle of maximizing strengths and opportunities and changing weaknesses to strengths and minimizing threats.

Three recycling associations were selected for study taking into account their localization, achieves and representativeness of recycling sector in Bogotá with the aim to determine the main features of SWOT analysis and establish the opportunities to inclusion as authorized waste providers. Table II shows the main features of recycling associations selected.

TABLE II
FEATURES OF RECYCLING ASSOCIATIONS SELECTED

Recycling association	Localization	Number of recyclers	Average rate of recycling (kg/month)	Main objectives
Give me your hand	Northwest zone of the city	269	86886	Organizational strengthening and economic consolidation To become self-sustaining and to improve welfare of recyclers
Ecoalianza	Downtown of the city	48	97390	To attach value of the waste
APREAM	South of the city	27	66098	

III. RESULTS AND DISCUSSION OF SWOT ANALYSIS IN THREE RECYCLING ASSOCIATIONS OF BOGOTÁ

In this section the main results of SWOT analysis are shown. In the first part, a description of waste generation and recycling in Bogotá is included and the second part, the SWOT analysis proposed and its results are described.

A. Solid Waste and Recycling in Bogotá

Bogotá is the main city of Colombia and it is selected as case study. This city contributed to 26% of the gross domestic product of Colombia in the last decade, where the main economic activities are construction sector, manufacturing and service industries, commercial sector, mining and quarrying sector and utilities [19]. Population in Bogotá has grown in the last decade on average 1.39% annually, which has a direct relationship with generation of solid waste [20].

Bogotá have produced annually on average in the last decade 2167129 ton being the household waste of the highest generation 69.3% [21]. Fig. 1 shows the categories of solid waste generated in this city and that are disposed in their totality in the landfill denominated Doña Juana.

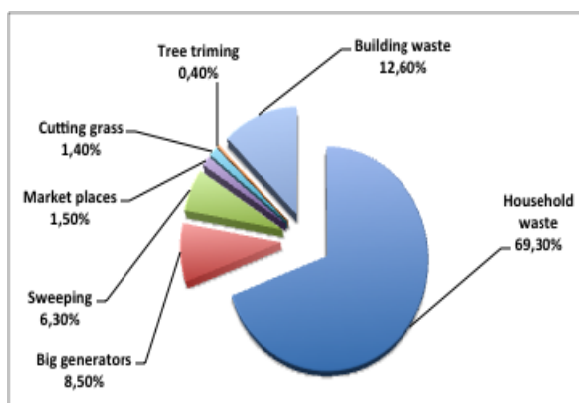


Fig. 1 Categories of waste generated in Bogotá and disposed in the landfill

Table III shows waste production per sector in Bogotá. On average the production of solid waste are the following: household sector - 234.566 kg/day; commercial sector - 77771 kg/day; institutional sector - 560 kg/day; and the big generators (especially manufacturing sector) - 505 kg/day. Waste generation per capita in this city is less of world

average that it is between 0,8 and 1,6 kg / person / day [22] indicating that it is important to develop adequate instruments to maintain or slow growth of the generation of waste.

In Bogotá recycling activities involves the extraction of recyclable and reusable materials from mixed waste. This sector is characterised by labour-intensive, low paid, low capital investments, unrecorded and unregulated work, low technology, and often completed by marginal population of society. In this city, it recycles 357 ton/day and the potential calculated is around 1000 ton/day [21] indicating the importance of this activity to achieve the recovery of waste, to increase landfill useful life, to inclusion of marginal population, to decrease poverty and to generate integrated sustainable waste management.

TABLE III
WASTE PRODUCTION IN BOGOTÁ PER SECTORS

Sector	Waste production
Generation per inhabitant	0,32 kg / person / day
Generation per household	1,66 kg / person / day
Generation per commercial sector	1,36 kg / establishment / day
Generation per institutional sector	0,604 kg / establishment / day

B. Formulation of Research Questions

The main research questions developed for performing the focus group meeting are presented and explained below.

Question 1: What are the strengths of recycling association to become and maintain as authorized waste providers in Bogotá?

This question allows recognizing major strengths of recycling associations in the transition to informal to formal sector within waste management framework. In the focus group meeting, the participants were requested to get their ideas on questions such as: i. What are the advantages to be in the formal sector as recycling association? and ii. What are the factors that assure long-term viability of the recycling associations as authorized waste providers?

Question 2: What are the weaknesses of recycling associations to achieve consolidate as authorized waste provider?

This question aims to determine the weaknesses that recycling associations to consolidate as formal sector. Particularly, the participants might be asked questions like: i. What could be improved in the transition? ii. What barriers prevent in the consolidation of recycling associations? and iii. Which aspects should improve or strength in the process from informal to formal sector?

Question 3: What are the opportunities that recycling associations can exploit to develop as authorized waste provider?

This question is proposed to obtain information about what opportunities recycling associations might externally face to be a formal sector of waste management. Similar questions include: i. what possibilities that recycling associations can take advantage, as formal sector would occur? and ii. What benefits would occur to be formal sector within waste management system?

Question 4: What are the threats that recycling associations

might face as authorized waste provider?

This question studies the threats that would prevent recycling associations from improving their inclusion in the formal sector. The question can be further described by some questions listed as follows: i. What are the external obstacles that recycling association might face as formal sector? and Are the supporting facilities for an improved recycling association available?.

C. SWOT Analysis of Three Recycling Associations in Bogotá

SWOT analysis of three recycling associations in Bogotá helps further the understanding about both the external and internal conditions that recycling associations would face to convert to authorized waste providers. Principally, the internal conditions are related to the strengths and weaknesses and the external conditions refer to the opportunities and threats. Table IV summarizes SWOT analysis from the main results of the focus group meeting.

TABLE IV

RESULTS OF SWOT ANALYSIS ON TRANSFORMATION FROM FORMAL TO INFORMAL SECTOR OF RECYCLING ASSOCIATIONS IN BOGOTÁ

Internal conditions	External conditions
Strengths <ul style="list-style-type: none"> ▪ Leadership and capacity to convoke ▪ Improvements on labor conditions and the recycling process ▪ Application of accounting processes from inputs and outputs ▪ Recycling of different materials 	Opportunities <ul style="list-style-type: none"> ▪ Recognition of recycler work ▪ Potential to increase recycling rate ▪ Alliances with industrial sector for sale of recycling materials with value added
Weaknesses <ul style="list-style-type: none"> ▪ Recycling associations do not have working capital ▪ Limited investments to improve process to valorize recycling materials ▪ Features of recycler to be marginal population ▪ Low and insecurity labor conditions 	Threats <ul style="list-style-type: none"> ▪ New private companies should provide recycling service ▪ Lack of awareness on the importance of separation and recycling on the source by population in Bogotá ▪ Legal instability ▪ Failure to achieve to eliminate the poverty trap in these vulnerable population

D. Strengths

Recycling associations shows several strengths related especially with features of this population that has achieved that their work is recognized and valued for government and society and the strengthening of the processes to achieve the capture, recovery and valorization of different recyclable materials trying to consolidate the recycling as a profitable business that allow to eliminate the poverty trap.

Recycling associations are conformed by waste pickers who have been very active to defend and fight by their labour rights as recyclers with the aim to improve working conditions, to achieve recognitions and inclusion in the waste management system in the city. Waste pickers have demonstrated leadership, perseverance and high organization that have allowed the formulation of policies, strategies, programs, and local and national laws generating the recognize of recycler labour, wages, possibilities to conform authorized waste providers, and the participation in the design of the Integral Solid Waste Management Plans in the cities. However, for

recycling association, government and policy makers the practice and application of these instruments of public policy are challenges to achieve the inclusion of vulnerable population.

Recycling association have understood that the recycling is a businesses that require a range of processes to valorise and process different materials to sell to industry raw materials from recycling, where it is important to improve technology and to have accounting books to determine viability of the business and to get profitability, which allow to improve living conditions of recyclers and their families. Fig. 2 shows the profit percentage by material recollected.

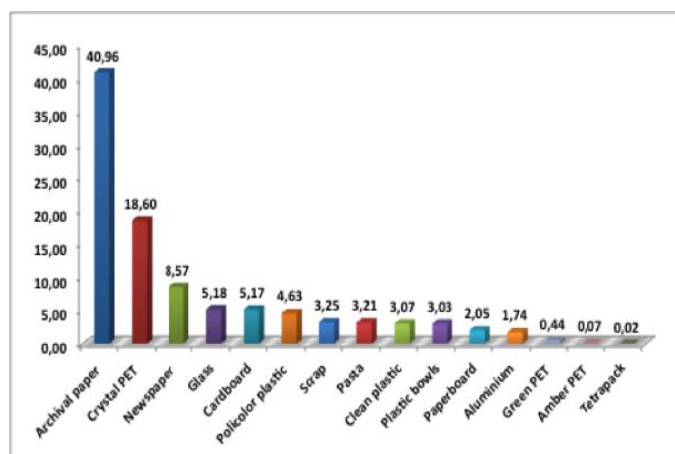


Fig. 2 Profit percentage by material recollected in the recycling associations selected

E. Weaknesses

The main weaknesses identified in the recycling associations are related to financial resources, cultural patterns of population and labour conditions, which should undermine the consolidation of recycling as business and strategy of social inclusion.

Recycling associations should overcome different obstacles that constrain their growth and sustainability. In general, waste pickers have low levels of education, insufficient financial resources or limited access to credit and minimal or nothing business experience. However, it is important the support of private and public sector to achieve overcome these weaknesses.

In this point, it is fundamental that waste management systems recognize the work and effort of recyclers through financial remuneration that achieve to improve their labour conditions and the recycle will be recognized as any work. Moreover, cultural patterns of the recycling population generate problems in the strategies of associativity by conflicts and the anxieties of power where it is fundamental training courses in conflict resolution.

Today, every waste picker get as wage 10 cents per kg of recycling material, that is a low wage. Recycling associations have often not liquidity and resources to pay their expenses and to make investments to improve the business through the increase capacity, new technology and transport equipment. These elements generate in the associations an aim of survival

related to achieve break-even point and in the near future profitability.

F. Opportunities

Multiple opportunities have recycling associations to become authorized waste providers. In Bogotá, recycler work has begun to be recognized, it has designed some programs to increase recycling rates through separation at source by the population and generating a recycling culture, and recycling associations have achieved consolidate alliances with the industrial sector to sell recycling materials as raw materials for different industrial process.

Recycling sector has achieved gradually and through legal battles the recognition from public authorities and civil society, decent working conditions and inclusion in the waste management system. However, wages for recycler are still low and it requires higher support for these associations with the aim to be a profitable and effective business.

Bogotá has a low recycling rate, where is fundamental to promote in the citizens source separation waste and recycling culture with the aim to reduce the amount residuals that arrive to the landfill, alleviate the health risk that waste pickers undergo when sorting reusable or recycling materials from loads of mixed waste, decrease environmental problems of inadequate waste management processes, exploitation and valuation of residual waste.

Recycling associations have achieved to conform alliances with industrial sector with the aim to reduce intermediation in the sale of recyclable waste and stabilize of prices of materials and obtain better incomes that improvement the conditions of business and recyclers.

G. Threats

The incursion of private companies to provide recycling service, the lack of a recycling culture of population, legal instability and failure to achieve to eliminate the poverty trap are the main threats of recycling associations from SWOTS analysis.

Private companies find a business opportunity in the recycling that it is an option for public sector to make activities of recycling in the society. However, this option will be disadvantaged for waste pickers to continue being marginal population and failure in the inclusion of these population that it is key to eliminate the poverty trap.

The formulation of waste policy and laws has been instability in Bogotá, which generate mistrust between recycler populations. However, policymakers have achieved formulate policies that obligate the inclusion of waste pickers, as associations that in the future become authorized waste providers.

Citizens in Bogotá have not recycling culture, which decrease the potential of recollection and processing of recycling materials and possibilities of recycling associations to achieve profitable business and increase environmental problems by inadequate waste disposal.

IV. STRATEGIES TO PROMOTE THE INTEGRATION OF INFORMAL SECTOR AS AUTHORIZED WASTE PROVIDERS

Based on the SWOTs identified above, critical strategies for transition from recycling informal sector to authorized waste providers can be proposed taking into account the basic principle of designing strategies to improve inclusion in the recycling sector that is 'maximizing strengths and opportunities, transforming weaknesses to strengths, and minimizing threats'.

To achieve effective inclusion of recycling population in the waste management system it is important: i. social acceptance, ii. development of adequate policies that respond to needs of stakeholders, iii. mobilizing and integrating of recycling associations, iv. strategic alliances with industrial sector, v. training on techniques and tools of management, negotiation and conflict resolution, among other [23]. These aspects should be flexible and take account local conditions and contexts to develop and empower recycler population.

To achieve the inclusion recycling associations and to become authorized waste providers should work mainly in the following strategies: i. **Trade union management** allows the participation of recycling associations in the design and application of waste policy and recycling with the aim to achieve their inclusion through laws, regulations and programs that promote recycling culture and adequate labour conditions for the waste picker population as strategy to decrease poverty and environmental problems of waste management, ii. **Business management** is important to achieve economic consolidation through business model more productive that allow to increase the recollection of materials and to valorize wastes by their reinstatement to value chain. In this point, it is key to promote recycling culture and separation at source of garbage, which generate multiples benefits for environment, recyclers and business model, iii. **Social management** is a key factor to empower recyclers and to achieve their integration as association to facilitate recycling business and teamwork. To improve welfare and life quality of recyclers should promote programs on education (training in communication abilities, conflict resolution, high school, waste technology, among other), health, household, recreation and labour conditions that allow human development of this population through better interpersonal relationships, to build strategic alliances between public and private sector that support to recycling associations, and iv. **Process and technology management** is a strategy that generates the possibilities to seek new transformation process and technologies to valorize recycling materials achieving productivity and sustainability of recycling associations. Moreover, it is important to design and apply selective recyclable routes to increase recycling rata and promote culture of source separation of waste and recycling in the population. In this point, it is important that the government and private sector promote financial programs and instruments that allow to recycling associations to access credits or possibilities of financing for their productive undertakings that achieve of recycling an effective business.

All findings of these studies are important to determine good strategies and policies that promote the inclusion of

waste pickers in the integrated sustainable waste management of the city and to allow that these populations achieve to eliminate the poverty trap through an effective business from recyclable that generate benefits for society to decrease environmental problems and reintegrate raw material in the productive process.

V. CONCLUSIONS

Through carrying out a thorough SWOT analysis, the internal and external conditions of the transition from informal sector to authorized waste providers in Bogotá were presented. The results suggest that the main strengths of recycling associations are leadership and capacity to convoke and mechanism to improve process and labor conditions of recyclers, whereas the main weaknesses are focalized in the lack of economic resources, cultural patterns of waste pickers and low and insecurity labor conditions.

External conditions of SWOT analysis indicate that the main opportunities of recycling associations are the recognition of recycler work, potential to increase recycling rate in Bogotá and alliances with productive sector to stabilize the prices of recycling material and improve the incomes. In contrast, the main threats are the possibilities that private companies provide recycling service, the lack of recycling culture and separation at source of garbage by Bogota's citizens and failure to achieve to eliminate the poverty trap in these vulnerable population.

The findings also present some major opportunities that recycling association can exploit to become authorized waste providers and to build an integrated sustainable waste management in Bogotá through a profitable business that achieve to increase recycling rate and to make of waste a productive process in the generation of new materials and decrease environmental problems whereas improve welfare and living conditions of recyclers.

Based on the SWOTs identified, some strategies for improving the transition from informal sector to authorized waste providers were proposed, where it is important guarantee legal stability and promote improvements on trade union management, business management, social management and process and technology management.

Results of this study are important to understand the actual situation of recycling associations in Bogotá with the aim to design new instruments and programs that allow that these associations achieve the integration and recognition by their labor in the integrated sustainable waste management in the city.

ACKNOWLEDGMENT

The authors are grateful to the anonymous readers for their constructive comments and suggestions. The Bavaria Foundation and University of El Rosario sponsored this research.

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