

Case Report

Assessment of the Current Situation of Informal Recyclers and Recycling: Case Study Bogotá

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Abstract: The contribution of recyclers to the environment and the local economy is not recognized and they are not remunerated for the service they provide to the city. It is well known that informal collection contributes to the recycling of resources in a positive way, but it is also associated with several environmental, health, and social problems. In Colombia, these recyclers work informally. In 2016, Decree 596 was issued, which regulates the utilization of the public cleaning service and the transitory regime for the formalization of informal recyclers. The objective of this work is to evaluate the social and technical impact of recycling in the city of Bogotá three years after the regulations were issued. A study was carried out in order to study how recyclers have been affected by the new regulations after three years of validity as well as understand their perceptions of the evolution of recycling in the city. The study consisted of a series of surveys of recyclers from a statistical sample with 0.05 error that applied a mixed approach. Qualitative and quantitative analysis were included. This analysis was done in order to mix statistical results with deep analysis. The survey indicated that a low percentage of users (good 28%) performed good processes of separation at the source, which lowers the recovery of materials and prevents the potential use of many others. Likewise, it was evidenced that for a material to be sold or commercialized it depends significantly on the separation at the source. In addition, according to the perception of the respondents, society tends to discriminate against them, which leads to the conclusion that discrimination still exists between both the government and society. Finally, the current legislation has not been effective in its implementation and court declarations regarding recyclers as people with inherent rights have not yet been applied in Colombia.

Keywords: recyclers; informal recyclers; solid waste; regulations; labor conditions

1. Introduction

In developing countries like Colombia, there are both formal and informal means of waste collection, which is collected with varying frequency and efficiency and does not serve all residents. In particular, the inhabitants of shantytowns and areas on hillsides that are difficult to access, do not have regular collection of waste. Many developing countries do not have selective collection systems, which further complicates separation and recycling processes from the source. This means that MSWM (Municipal Solid Waste Management) systems in developing countries are generally inefficient, because they lack adequate administrative and financial structures, good regulations, infrastructure, and adequate human resources [1,2]. According to some researchers, the collection of recyclable waste by recyclers is a partial solution to the problems of waste management; yet, this activity is negatively perceived by the population [3]. Likewise, it is estimated that 1% of the world's urban population is

involved in the recovery of potentially usable materials. In Latin America, Asia, and Africa, the work of these people represents almost 30% of the recovery process of the usable fraction of waste [4].

In recent decades, work in developing countries has been done on integrated waste management, due to economic growth which has led to an increase in the consumption of goods and products [5]. It is estimated that by the year 2025 the amount of waste produced will reach 2.2 billion tons, and that the annual cost of managing this waste will be more or less 375.5 billion dollars [6]. In addition, solid waste in developing countries will increase dramatically, since the proportion of global solid waste coming from non-OECD (Organization for Economic Co-operation and Development) countries is expected to increase from 55.7% in 2010 to 71.3% in 2020 [5]. Botello-Alvarez et al. [1] argued that to achieve sustainability in modern societies, the recycling of municipal solid waste (MSW) is essential. Therefore, it is necessary that MSWM systems are oriented to strengthen markets and recycling industries. Despite this, recyclers in developing countries are marginalized social groups who are poor and, therefore, often vulnerable to various occupational health risks and diseases [7–10]. The contribution of recyclers to the environment and the local economy is not recognized and they are not remunerated for the service they provide to the city [11].

In recent years, Colombia has been immersed in a war that has caused the forced displacement of many people. According to the victims unit of the national government, there was a maximum peak of almost 770,000 displaced people in 2002 and this decreased until it reached approximately 86,000 in 2018 [12]. A large percentage of displaced people arrive in large cities, mainly Bogotá, Medellín, and Cali, where they seek new opportunities for life and work. These people are located in shantytowns, which are generally high-risk areas. They are mostly people who have not finished high school, so access to a job to support a family becomes very difficult. For this reason, many of them become recyclers. In other cases, recycling has been the livelihood from generation to generation and becomes a family tradition. Therefore, this activity becomes the common form of income generation for socioeconomically marginalized people that involves the collection of discarded material to reuse, resell, or recycle for money [13–17].

According to Xue et al. [18] the integration of informal collection has been observed in many countries, but there are few successful cases. It is well known that informal collection contributes to the recycling of resources in a positive way, but it is also associated with several environmental, health, and social problems [18–21]. Recyclers are considered the informal basis of the process and are mostly excluded from policies and programs in the broader waste management system [10,22–24].

In Colombia, these recyclers work informally and in 2016 an attempt was made to regulate this activity into formalized recycling work. This formalization was established through the application of eight phases that take approximately five years to complete. These phases were divided as follows: (i) single registry of providers; (ii) definition of the area of provision, registration of the area of provision and, the tons collected, recovery, and marketed; (iii) uniform conditions of the basic public service; (iv) portfolio of services and user database; (v) weighbridges calibration; (vi) micro-collection and provision of the service program; (vii) registration of requests, complaints, resources, and emergency plans; and (viii) financial information and provision of the service map. The decree was carried out in order to improve the working conditions of the recyclers and to remove them from their informality, through associations that allow access to health and pensions, as well as other benefits that come with being associated. Therefore, the objective of this work is to evaluate the impacts that three years of regulation have had on recycling in the city of Bogotá. This evaluation will include analyses of city policies as well as the perceptions of recyclers about the effect of new regulation on recycling associations markets.

2. Colombian Regulations

In the 1970s, the concern for the proper handling and management of solid waste led to the first legislation in Colombia in this matter. The Decree 2811 of 1974, “National Code of Renewable Natural Resources and Protection of the Environment”, known as the National Sanitary Code, established

technical standards for the proper handling of waste, aiming to minimize the environmental impact that poor waste management could cause. Subsequently, Law 9 of 1979, took some sanitary measures to protect the environment and manage solid waste, among these were standards for the discharge of waste and materials that could affect health and environmental conditions.

The concern for the conservation of the environment was present in the political pact that led to the Constitution of 1991. Part of the constitutional text, recognized as the “Ecological Constitution”, established budgets to regulate the relations between the community and nature, advocating for its conservation and protection. The new constitutional framework granted the environment the character of constitutional good, higher interest, principle and collective right. In this sense, it established a set of mandates that ensure that human beings can live in an adequate environment to develop their existence in decent conditions and have a quality life [25–30].

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The achievement of the collective right to the environment, implied the presentation of the public cleaning service, which included the management of waste. Among the norms that develop the constitutional contents, we find Law 142 of 1994, known as the General Regime of basic public services. This law regulates the provision of public services, which includes aspects such as extension, coverage of basic public services, subjects responsible for its provision, and conditions to ensure its quality and effectiveness (including the powers of inspection, control, and surveillance). This norm attributed the management and use of solid waste to the public sanitation service. This service has to be guaranteed by the municipal entities [32].

For the purpose of developing the provisions stated in Law 142 of 1994, regarding the management and use of solid waste, different rules have been issued at the national and local levels. Among them we find Decree 2981 of 2013, which regulates the provision of the public service of hygiene. This law recognizes the use of waste as a complementary activity of the public service, comprised by the collection of usable waste, its separation at the source, and the integral management of solid waste to reduce its generation. In addition, it promotes the use and commercialization of residues according to their characteristics. It establishes the duty of the municipal and district entities to create the Integrated Solid Waste Management Plan (ISWMP), a technical planning instrument that defines the objectives, goals, programs, projects, activities, and resources for traditional and integrated waste management. In the formulations of the ISWMP and in its implementation or update, it is mandatory to guarantee the participation of full-time recyclers in the planning process [33].

In addition, Decree 2981 of 2013 defined an operational scheme for the use of residues in the public sanitary service in the territory, granting jurisdiction to the territorial entities for the creation of ISWMP. The ISWMP was conceived as a planning instrument that sets objectives, goals, programs, activities, and resources defined by one or more territorial entities for the management of solid waste [33]. There are other norms which establish guidelines to formalize full-time recyclers and the creation of organizations for the provision of the public service of cleaning and the use of waste [34]. These are Decree 1077 of 2015, the Regulatory Decree of Housing, City, and Territory Sector (RDHCTS), and Decree 0596 of 2016, that modifies and adds to the RDHCTS [34].

3. Materials and Methods

3.1. Study Area

At present Bogotá has a significant problem with waste management. The waste in its entirety is taken to the Doña Juana landfill, located in the town of Usme south of the city. In Bogotá there is no culture of separation and this process is carried out by independent people called informal recyclers. It is estimated that they manage to separate up to 3% of the total waste generated, but there is no calculation and/or statistics on the part of the municipal administration or government entity. Also, according to figures from the municipal government there are about 13,771 active recyclers in the city.

In order to study how recyclers have been affected by three years of new regulations and how they see the evolution of recycling in the city, a study was carried out that applied a mixed approach. Qualitative and quantitative analysis are included [35,36]. This analysis was done in order to mix statistical results with the analysis of multiple perspectives [35,36]. The mixed analysis corresponds to a concurrent mix, in which the collection of qualitative and quantitative data occurs simultaneously from the same research tool [35,36]. For this work, the research tool was a survey designed to understand the perspectives of full-time recyclers.

3.2. Survey

First, a pilot survey was designed for 80 recyclers with nine questions about social and technical parameters. After a pilot test, it did not meet the study objective, so researchers proceeded to create a new application, in which some questions were reformulated, and twelve more questions were added. The survey was designed with 21 open questions and divided into six categories (Appendix A Table A1). The psychosocial context, conditions of the work, technical context, economic sustainability, and normative parameters were evaluated (Appendix A Table A2). This survey was applied to recyclers in the city of Bogotá from a non-probabilistic sampling. The data was analyzed in two stages: a quantitative phase and a qualitative phase.

3.3. Selection of the Sample and Application of the Survey

The survey was applied between the months of August and September 2018 in Bogotá, Colombia (Appendix A Table A2). The sample was selected by non-probabilistic sampling with a confidence level of 95%; the sample size was defined according to Equation (1).

$$n = \frac{k^2 * p * q * N}{(e^2(N - 1)) + k^2 * p * q} \quad (1)$$

where N is the recycler population, k is the confidence level (95.5%), p is equal to 0.4, q is equal to 0.6, and e is the sample error which for this study was 7.5%. The sample error for the recycler population was relatively large because many of the poorest recyclers, such as homeless, are difficult to contact. Of the 13,500 recyclers that exist in the city, 169 surveys were applied to full-time recyclers from various parts of the city for this study (Appendix A Table A2).

3.3.1. Quantitative Stage

The quantitative stage consisted of applying descriptive statistics to 13 survey questions. It was made using Stata statistical software. The data was processed according to the type of variable. The survey contained categorical and continuous variables. The categorical variables were sex, labor difficulties, and knowledge of the regulations, among others (Table 1). The continuous variables were the people in charge and the experience as a recycler.

Table 1. Categories of analysis applied in the survey.

Evaluated Parameter	Analysis Categories
Psychosocial context	Dependents
	Residence
	Gender
	History
	How does it feel to be a recycler?
	How does society see it?
Labor conditions	Perceptions among recyclers
	Labor difficulties
	Contribution of the recyclers to society
	Future of recycling
Regulations	Knowledge of the regulations
	Membership in an association

To analyze the variables, numerical values were defined according to the answers of each category. In Table 1, an example of the assignment of numerical values for two categories is shown. Regarding the continuous variables, the numerical value of the open answer was considered, and the alphabetic characters were excluded. Descriptive statistics was calculated according to the type of variables. For the categorical variables, the frequency was calculated and for the continuous variables the mean, standard deviation, and frequency were calculated.

3.3.2. Qualitative Stage

The qualitative stage consisted of a phenomenological study. Participant responses were obtained and from these responses the authors were able to understand what the individuals have in common according to their experiences with the phenomenon of study [36]. Therefore, the experience of recyclers was explored with respect to their work and the impact of the transitory regime for the formalization of recyclers. The NVivo software was used and the methodology presented by Saldaña [35] was followed, dividing the analysis of the data into two cycles. The first was an approximation and grouping of information from grammatical, elementary, affective, and procedural methods, among others. In the second, the information was reorganized and reanalyzed. Methods such as pattern coding, focal coding, and axial coding were used [35].

For the first cycle, the structural coding that is part of the elementary methods was selected. This allowed for a particular analysis of selected segments with larger datasets. Three parameters to be evaluated were defined and they were divided into categories of analysis as shown in Table 2. For the second cycle, a method of coding by patterns that is appropriate to search for rules, provides the causes and explanations of the behavior of the data selected. It also allowed us to examine social networks and behavior patterns in human relationships [35]. Simultaneous to the coding process of the first and second cycle, annotations were made in which patterns, concepts, and emerging topics were reported, and questions and decisions, among others, were taken. This process was done in order to have a detailed record of the analysis of the information and facilitate the development of the conclusions [35].

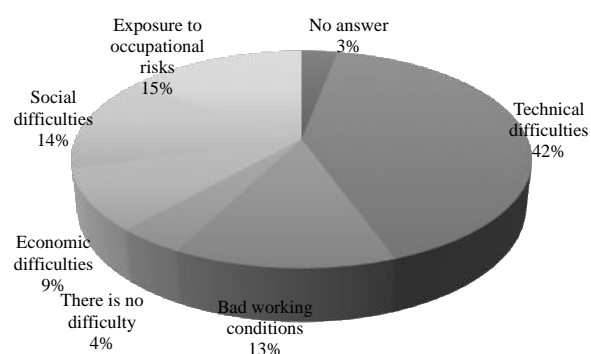
Table 2. Assignment of numerical values to categorical variables.

Categorical Variable	Answer	Number
Separation of garbage in each zone	Does not respond	0
	Good	1
	Regular	2
	Bad	3
	There is no separation	4
Improvement in separation	Does not respond	0
	Got better	1
	Still the same	2
	Got worse	3

4. Results

4.1. Quantitative Stage

Colombia has informal recyclers in all cities, some of them have spent their entire lives in this field of work and have been a part of the culture of recycling on a daily basis. They have seen how this recycling activity in Colombia has changed over the years in society. Bogotá as a capital does not escape these issues, and with more than 8 million inhabitants, recycling processes are more complex. According to the survey applied, Figure 1 shows that the recyclers' main difficulties, in order of importance are: technical difficulties, exposure to risks in their work, social difficulties, and poor working conditions; these results are similar to those found by other authors [7,37]. It is evident that technical difficulties are the most important for recyclers and these are associated with social difficulties and exposure to occupational hazards. This is because recyclers are seen by Colombian society as destitute, and thus not contributing to society. Another factor associated with this problem is that there are no selective waste collection routes in the city, which makes the activity of recyclers more complex. The culture of separation does not exist in the city and the lack of selective collection routes or incentive programs for recycling in homes influences the bad practices of separation that are associated with the three main difficulties found in the survey applied. This culture leads to recyclers being exposed to occupational hazards (Figure 1), because they usually always go behind a collection truck trying to recycle some of the garbage that is generated in their work zones, only recovering the recyclable waste which is 3% of the total waste generation by the city, a percentage similar to those found in Delhi, India, in which only 2% of the population recycle [38,39].

**Figure 1.** Main difficulties in the recycling process.

The results found in this work contrast with those found by other authors [40], which the same results are shown that some of the recyclers have an intermediate school level and many of them have begun to work from children in the streets, and are even affected families. In the same way, as demonstrated by Figures 1 and 2 and verified by other authors, solid waste management

systems in Colombia are inefficient because they lack adequate administrative and financial structures, good regulations, and human resources. In Colombia, despite having regulations for the proper management of solid waste, to date, this activity has not improved, as shown in Figure 2. It is observed that people do not separate at the source and other authors argue that informal recyclers are a partial solution to the problem of garbage, in addition to the fact that this activity has a negative social perception [1,3].

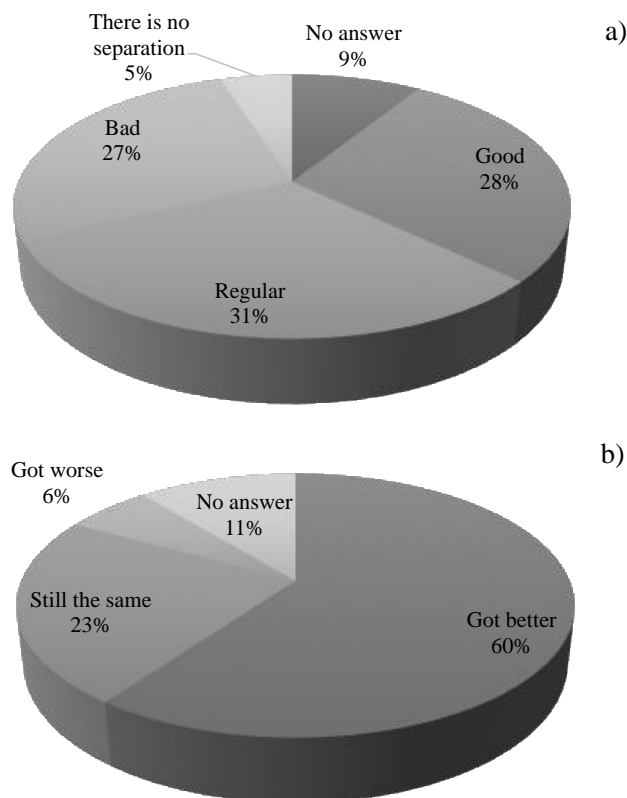


Figure 2. Separation and improvement of household recycling: (a) separation of solid waste and (b) improvement of the separation process in homes.

The separation at the source of waste plays an important role in the recycling of materials. When applying the survey, it was found that very few users perform good separation processes at the source (Figure 2a), leading to the recovery of many potentially usable materials being lost. It can be observed in Figure 2b that recyclers perceive a bad separation at the source of waste, but that the separation process has also improved. This improvement can be attributed to the environmental awareness of users and not to education processes by companies or the government itself. Currently, the government pays per ton disposed in the sanitary landfill and not by processes of exploitation and/or transformation. Figure 2 shows that although the recycler plays an important role in the value chain of solid waste, it is the consumers who do not do their part in the separation of waste. Likewise, collection routes, and housing and residential complexes are also not prepared for separation processes. This is because although there are storage rooms for waste in buildings and residential complexes, users do not take the task of separating, arguing that since there are no separation routes, all waste goes to the same site.

Similarly, in Figure 2a, the current waste separation in the city is shown, in which for the case of good it is considered that the process is not excellent but at least separates the waste into two bags (white recycling and black the rest). For the case of the regular item it is a medium level, where the user tries to do it but does not have much knowledge of the separation process and finally the bad one, in which they deliver the two bags (white recycling and black the rest) but everything is

mixed. Likewise, in Figure 2b it is evidenced how from regulations, recycling has improved by 60% according to the perception of recyclers, while 23% remains the same, for which they argue that it has not. There are selective routes because they will not improve your separation process.

Figure 3 shows the percentages of sale of recovered materials. As can be observed in Figure 3a, among the best-selling materials, metals stand out. Other materials that are very well marketed are white paper and cardboard. These three materials have the best price in the market and therefore are the ones that recyclers seek to recover. The price of one kilogram of metal in the market is around 0.082 to 0.63 U.S. dollars depending on the type of material (aluminum, copper, scrap). Although recyclers try to look for this type of waste in garbage, they also try to recycle a large part of other materials, such as those shown in Figure 3b. Recyclers do not manage to sell them due to the conditions of the recovered material or because, for example, as with glass, the market for the purchase depends on the factories that receive the material, and this demand fluctuates over time.

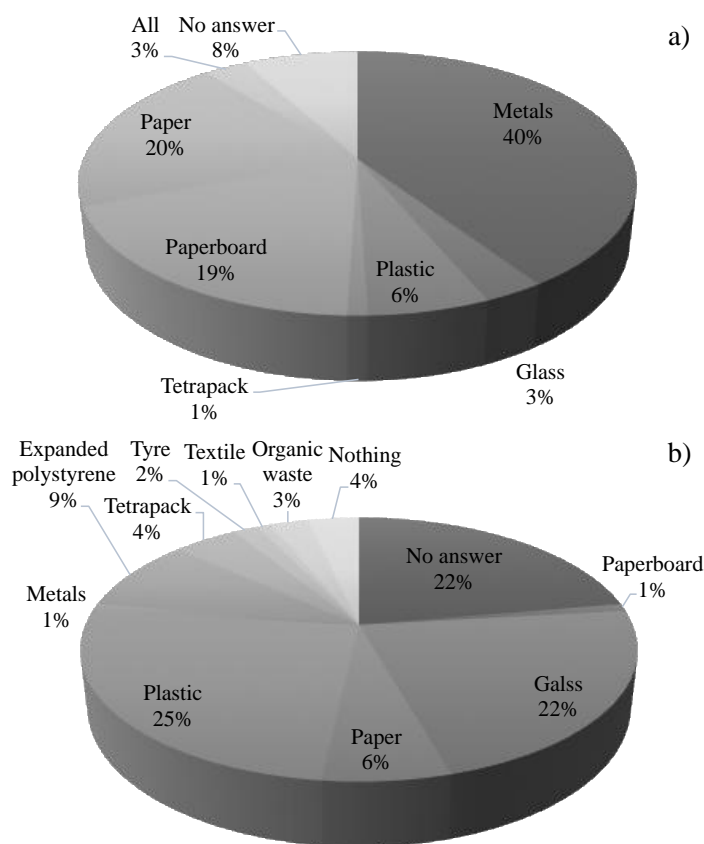


Figure 3. Percentage of respondents (a) who could sell particular materials and (b) who could not sell particular materials.

These factories production is based on supply and demand, so if the market is saturated with green or amber glass it is not bought and therefore the recycler cannot make a sale for this type of material. This happens because in Colombia recycling is still managed as a minimarket of hierarchy, in which a few companies buy the recovered material and are the ones that set the market conditions. On the contrary, 4% of the respondents answered that they manage to sell absolutely all the recovered material. This may be because they are better organized and with more experience, and they only collect the material they know they will be able to sell in the market.

Figure 4 shows a cluster analysis of the variables considered important in the recycling process. It is observed that the improvement in separation and classification are associated in the first group and that they are the most important factors in the recycling process. Similarly, it can be seen that for a material to be sold or marketed depends significantly on the separation at the source. Therefore,

the difficulties of the recycler are associated with the culture and education of separation at the source by the users of the sanitation service.

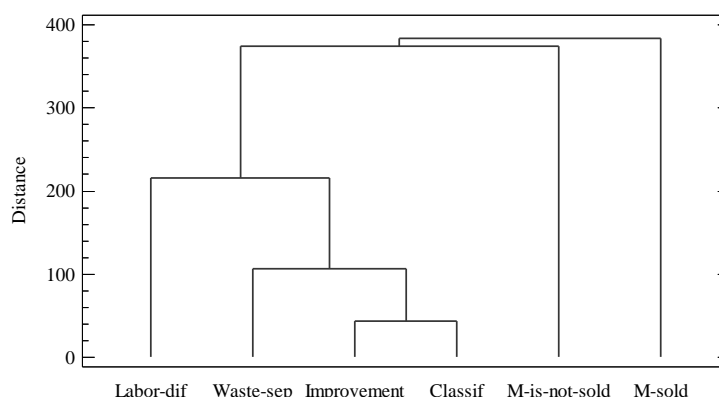


Figure 4. Cluster analysis for the main variables.

4.2. Qualitative Stage

4.2.1. Psychosocial Context

In order to understand the current situation of recycling in Bogotá, the set of circumstances that determine the situation and the reality of recyclers was observed. This was understood in a psychosocial context and was divided into seven categories of analysis (Table 2). The recyclers interviewed lived in neighborhoods located mainly in the towns of Suba, Ciudad Bolívar, Santa Fe, and San Cristóbal. These areas are characterized by low-income populations, most of whom are displaced people and immigrants [41,42].

The survey showed that many full-time recyclers are responsible for their immediate family, which is made up of their children (adoptive or biological) and spouse. In addition, many recyclers reported economically helping their parents or siblings. With regard to the association among recyclers, is evidence of networks of cooperation, organization of work, and a sense of responsibility towards members of their group. This association is usually presented among family members, which implies that joint efforts can support extended street families. In contrast, the phenomenon of homelessness was also observed, in which some recyclers do not to support economically for anyone else and work independently.

According to the survey, the task of recycling is done by both men and women (78% men and 22% women). Women recyclers expressed feelings of fear caused by abuse they have suffered during work and the machismo they observe in their environment. Some female recyclers stated that, during working hours, men in a state of intoxication or under the influence of psychoactive substances have hit, insulted, and tried to disrespect them. They also expressed that the street was a hostile environment and that their work lacked guarantees of security and equality. Furthermore, some men recognized that the work is more complicated for women than for them because of the demand in strength and the abuses to which women were exposed. This problem has led women to organize themselves in associations as a way to reduce the risks and difficulties associated with their gender.

Many of the stories of the respondents showed that their entry into the job as recyclers was influenced by family tradition. From an early age, the participants worked and learned the work of recycling from their parents. Also, it was found that some recyclers have been exposed to conditions of forced displacement, drug consumption, unplanned pregnancies, loss of work, and homelessness. Under these conditions their access to work opportunities was limited. These factors led to recycling becoming a job opportunity that allowed them to obtain resources to meet their basic needs. Some recyclers appreciate their work for sustaining their family; recycling work has become a tradition in many families. For example, some of them use the activity to feed themselves and give

their children an education, since they want them to study and have more opportunities than the previous generation.

When asked how they felt about their work, the results showed that recyclers have both negative and positive feelings about their work. It was found that for each negative reference there were around five positive references (Figure 5). Negative feelings were commonly associated with the difficulties of working on the street, such as the insecurity and physical effort involved in their work. Another negative point was the treatment they receive from society, which considers their work degrading and difficult. As previously mentioned, positive perceptions are related to gratitude for the work, which allows them to get money to supply their basic needs. It is also evident that they feel positive sensations for the environmental function of reducing solid waste that reaches the landfill.

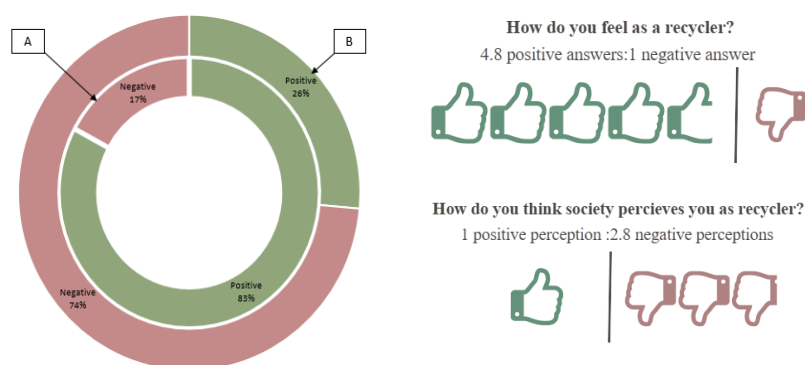


Figure 5. Positive and negative perceptions of how recyclers feel and how society sees them.

According to the perception of the respondents, society tends to discriminate against them, which is carried out, mainly, with looks of contempt and disapproving actions such as changing curbs or ignoring their presence. It was found that for each positive perception there were 2.8 negative perceptions (Figure 5). The recyclers consider that this is because people believe that they are street dwellers because of the clothes they wear, or they are afraid of them because they believe they are thieves. However, the recyclers say that there are many people who treat them in a friendly way and respect their work. These positive interactions usually occur when they have been recycling for a long time in the same area and people who live in the sector recognize them as part of the community. The recyclers said that when they have a positive relationship with the community, they can even teach people in the neighborhood how to separate materials better; this helps validate the work of the recyclers and promotes better working conditions for them.

The last category of analysis in this parameter corresponds to perceptions among recyclers. This category was identified from the qualitative analysis process, given the amount of references in the interview transcripts. It was observed that there is an internal discord between recyclers who are homeless and other recyclers. This consists in the fact that recyclers who are not homeless consider that the practices of recyclers who live on the streets delegitimize their work. For instance, sometimes homeless recyclers break up garbage bags, disperse waste on sidewalks and streets with non-recyclable waste, use money to buy drugs, or dress inadequately.

4.2.2. Labor Conditions

This was analyzed from three categories: the difficulties of exercising recycling, the contribution of this work to society, and the perceptions about the future of recycling in Bogotá. The analysis of the difficulties showed an important prevalence of technical problems and labor risks, as well as social and economic problems. Technical problems were related to weather conditions such as rain. Occupational risks were related to exposure to offensive odors and the possibility of injury with a sharp object. For the respondents, these difficulties hurt the efficiency of their work and the dignified conditions of it.

The poor treatment received by the recycler from the population, has led recyclers to avoid interaction with people in the area where they recycle. Likewise, competition among recyclers has generated isolation among them and favored working individually or as a family.

Regarding the economy, the recyclers said that they must invest a lot of time to obtain a remuneration that allows them to cover their expenses. With respect to the perceptions of the social value of the work, it is observed that the majority of recyclers consider their work to be an aid to the environment and society. They recognize local and global problems of waste management and see their work as a contribution to the solution to these problems. The recyclers are clear about the importance of recycling to carry out sustainable production processes and to reduce negative impacts of overproduction and extraction of virgin materials. Also, they recognize that reducing the waste disposal in sanitary landfills increases the useful life of the landfill. Despite this, it was evident that other recyclers do not perceive any social value in their work and consider that it is a common trade that is exercised only to obtain economic sustenance.

The last category of the labor condition parameter corresponds to the future of recycling in Colombia. Several of the respondents expressed that the future of their work is uncertain due to the economic and political dynamics that are being presented in Bogotá. The recyclers state that large recycling companies are emerging that act as monopolies, so that independent recyclers are affected because the market share is reduced and there are few connections for them in emerging companies. It was observed in some testimonies that the recyclers have positive perceptions of their work in the future; some people mentioned that the separation will improve at the source by the sensitization of the people about recycling and the work that they carry out. Finally, some recyclers feel apathy about political initiatives regarding recycling and consider that the aid offered by government institutions is not intended to benefit recyclers.

In this category, additional information was shown that illustrates the types of alliance between recyclers and companies. It was found that they make alliances with companies of two types: institutions that generate large-scale recyclable waste and processing companies. In the alliance with the first type of companies, the recycler obtains greater volumes of recycling than when looking in residential areas. This alliance allows access to more material without looking in garbage bags, material with better separation at the source, and reduces search times. The alliance with processing companies consists of making a direct agreement between the recycler and the company. It allows the recycler to increase his income since the transaction is carried out without intermediaries such as the collection centers of the associations. The current Colombian regulation, which obliges the recycler to associate, could have two effects: first, it could favor the alliances with recycling generating companies, and second it could complicate the operation of the alliances with processing companies since no recycler could be independent.

4.3. Social Impact of the Current Regulation

Regarding the perception of full-time recyclers with respect to current regulations, information was obtained about the processes of disclosure, benefits, and disadvantages of the formalization. It was observed that the process of dissemination of the regulations is characterized by having been taught in associations and transmitted orally among associated recyclers. This type of process shows that the effectiveness of the standard has not been as expected by the government, since informal recyclers are completely unaware of it. This situation is reflected in the recyclers who are street dwellers or are independent workers, who could be excluded from the disclosure process because they are not part of the associations. Another important limitation that was obtained from the respondents is the lack of information on the process of formalization and obligations of being associated. The recyclers attribute this to the fact that the information spreads through rumors, which implies that it is incomplete and either focuses on benefits or drawbacks.

Recyclers that belong to an association express that they have had economic benefits, training, and organization of their work. However, others who have belonged to cooperatives believe that

the benefits are not sufficient, and are sometimes null, considering the time they had to invest in attending meetings and meeting the obligations of the cooperative, which caused them to withdraw. On the other hand, others have a predisposition to mistrust the regulations since the recyclers value the independence that this work offers them and consider that the association could limit it. The recyclers that do not belong to an association showed an aversion to membership since they expressed the difficulty in procedures related to the access to the association, restriction by age, lack of time and adequate benefits that encourage them to join a cooperative.

4.4. Relationship between Parameters Evaluated

Figure 6 shows the relationships between the three parameters analyzed and their respective categories. For this, the inductive and deductive approach for the interpretation of qualitative data of Fereday and Muir-Cochrane [43] was considered. The larger circles represent the evaluated parameters, the size of them is determined by the number of categories, and the importance in explaining the phenomenon of interest. The categories have colors according to the parameter in which they are located. Their sizes were determined from the number of references and subcategories they had, as well as the relevance to explain the phenomenon.

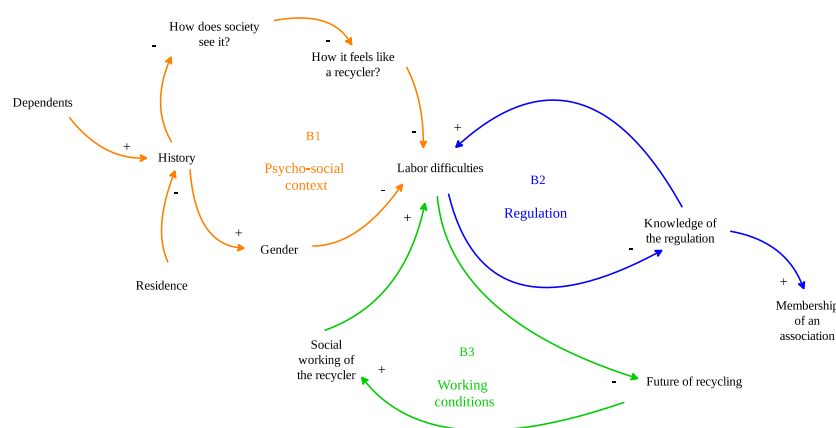


Figure 6. Relationship between parameters and analysis categories.

The history category had seven subcategories with an average of 39 references each, so its size is larger than the knowledge of the regulations that has four subcategories and on average 15 references. Regarding the social value of recycling compared to belonging to an association, it was observed that they are not relevant but belonging to an association explains to a greater extent the process of formalization and the experience of recyclers regarding their work.

Figure 6 shows an interrelation between the three parameters from the categories of belonging to an association, difficulty of the work, how recyclers are seen by society, and recyclers' perceptions of the value of their work. This shows that the experience and formalization process of the recycler includes several aspects of their psychosocial context, the conditions under which recycling is carried out in Bogotá, and the characteristics of the regulations. It is also observed that the gender variable is related to the difficulties in their work; for women, this work represents greater dangers and risks, including those linked to the preservation of their sexual integrity. This places them in a condition of greater vulnerability and marginalization.

5. Discussion

The purposes of the Colombian regulations have been to ensure the provision of the public sanitation service through efficient procedures that do not endanger health or the environment and the promotion of sustainable programs and projects by territorial entities. To achieve these purposes, the regulation has established basic principles for the presentation of public sanitation service and for

the integral management of solid waste, including the provision of efficient, continuous, and quality public service and the development of “a culture of non-waste”. This is intended to encourage the use and minimize the impacts that the generation of solid waste can produce on health and the environment.

It has been considered as purposes for the use of materials and solid waste, rationalization in the use of energy and raw materials and with it the recovery of energy values used in production processes, the use of recycled materials to reduce the impacts of environmental factors in the processes of final disposal and the increase of the useful life of landfills [33]. The achievement of these purposes is possible through the activities carried out by the recyclers which benefit the community and protect the environment. However, their unavoidable contributions to the environment and to society are still invisible in certain social sectors, which discriminate and marginalize them, as concluded in the study carried out in the city of Bogotá.

The antecedent of the legal recognition of the recyclers is Law 511 of 1999. It instituted March 1st as the national day of the recycler and recycling. In addition, it created the “Decoration of the recycler”, to be granted by the Ministry of the Environment and by the municipal authorities to individuals and organizations, distinguished by their activities in the process of recovery of waste for treatment and use. This regulation was the first legislative attempt to achieve a culture of recycling and ordered actions in favor of recyclers, as a social group in a condition of marginality. It included for its benefit the duty of the state to create educational programs, the promotion of special housing programs, and specific health and nutrition programs for children and women recyclers.

Subsequently, the Colombian legislation has progressed, firstly, by recognizing the full-time recycler as a relevant subject in the provision of the public cleaning service, and then by recognizing them in the jurisprudence as a subject of special constitutional protection. They are recognized as full-time recyclers, those who regularly carry out recovery, collection, transport, or solid waste classification, for their subsequent reincorporation into the productive economic cycle as raw materials. This group of people is characterized by the fact that they earn their livelihood from this activity, whether they are formally organized or not [33,34,44].

The recognition of recyclers as people with of rights because of their work, has resulted in the establishment of obligations to state entities to ensure their participation in recovery and utilization activities. In order to productively consolidate the activities carried out by them and improve their living conditions, this recognition has forced municipalities and districts to adopt and strengthen affirmative actions in favor of the recycler population. Other measures guarantee the participation of full-time recyclers in the formulation, implementation and updating of the ISWMP, which should be incorporated into the municipal and district development plans with assigned resources. It will promote the formalization of the full-time recycler population, so that they participate in an organized and coordinated manner in the provision of public service [33].

The formalization of recyclers has impacted their lives. Some have created or are linked to organized legal entities and are duly registered with the Superintendence of Public Services, to provide the activity of solid waste management. The corporate purpose of these legal entities must be the provision of the public cleaning service and the realization of recovery activities. These regulatory provisions have sought to progressively reduce the activity of informal recyclers, until they are formalized as providers of a public service. It has also tried to prohibit informal recyclers in the vicinity of landfills or dumps that should be closed. Other problematic measures for informal recyclers have been the prohibitions of the transport of garbage in unsuitable or inadequate vehicles and the prohibition to separate and classify garbage on public roads. Nonetheless, these situations are still common in the exercise of this task in the city of Bogotá [33,38]. Despite the legal prohibition, irregular or informal recyclers, and even formalized, recyclers carry out their work with technical difficulties. They are exposed to risks to their health and suffer from physical exhaustion. For reasons such as these, the ruling that regulates their work becomes ineffective, as has been stated in the survey results.

The regulation that rules the public service of cleaning, the collection and the use of the waste, contemplates general laws of the national order and local regulations that establish the duty of the local authorities to watch over the adequate provision of the public service. Although the objective of these standards has been to ensure the integral management of solid waste efficiently and without endangering human health, they are still ineffective regarding the effects suffered by recyclers in the streets and regarding their reality, which is accounted for in this study. In addition, although some of its provisions refer to recyclers to promote their participation in the management and use of solid waste, there are tacit prohibitions to exercise their work. In this sense the vast majority of recyclers have to work outside the legal parameters. In conclusion, this legal framework impacts them directly, without achieving an improvement in technical conditions in which they perform their work or grant social value to their job, so that they can overcome their conditions of poverty.

6. Conclusions

The survey found that very few users perform a good process of waste separation. This leads to the loss of many waste materials that could be recovered and reused. In this sense, separation at the source plays an important role in recycling processes.

From a cluster analysis it was observed that improvement in separation and classification are related, and these steps are the most important steps within the recycling process. This reality leads to the fact that for a material to be sold and/or marketed, it is fundamental that it is correctly separated at the source. Therefore, it was evident that the difficulties of the recyclers are associated with the lack of culture and education of people regarding the separation of waste at the source.

An interrelation between regulation, psychosocial context, and working conditions was found, demonstrating that the experience and the formalization process of the recyclers includes several aspects of its psychosocial context, of the conditions in which they exercise recycling in Bogotá and of the characteristics of the new regulations. Likewise, it was observed that the gender variable is related to greater difficulties in the work, because of differences in the work experience between men and women.

According to the Constitutional Court, recyclers are subject to special protection. This indicates that they must be protected by current regulations. From this study it is evident that the decree obliging them to associate was not clearly communicated to them and this has led to many of them still not belonging to an association, and many of them have even withdrawn from these associations. Furthermore, the current regulation does not protect them, and they continue to show problems of discrimination from the population, in addition to stigmatization. This means their work is not recognized by the population, public service companies, and least of all by the government.

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Appendix A

Table A1. Structure of the survey applied to each recycler.

General Questions	
1.	Name of the person interviewed
2.	Gender: Male _____ Female _____
3.	How many people are in charge?
4.	Where do you live?
5.	If female, ask her if she is the head of a family
6.	Ask him/her how long he/she has been a recycler and how long has he/she recycled in his/her neighborhood?
7.	Why did you become a recycler (history)?
8.	As a man, how does it feel to be a recycler?
9.	As a woman, how does it feel to be a recycler?
10.	How do you think society sees you as a recycler?
Activity Questions	
1.	How do you consider separation at the source in the area where you live?
2.	Do you think it has improved in recent years?
3.	What do you think of the social work of the recycler?
4.	How do you market recycling?
5.	Ask him/her what strategies they would use to improve source separation.
6.	What is the most difficult part of your job?
7.	How do you imagine the work of the recycler in 20 years?
8.	What is the best-selling material that is sold and what is the material that has no outlet in the market?
9.	How do you classify paper? (for example, in newspaper, white paper, cardboard, etc.)
10.	Do you know the new regulations regarding recycling that forces them to associate?
11.	Ask if he/she belongs to a recycler's association.
a.	If the answer is yes, ask him/her what benefits it has brought him/her to be associated/
b.	If the answer is negative, ask why he/she is not associated.

Table A2. Example of an interview applied to a recycler.

General Questions	
1.	Name of the person interviewed Juan Camacho
2.	Gender: Male <u> X </u> Female _____
3.	How many people are in charge? 6 persons, 5 sons and mother
4.	Where do you live? Las Cruces
5.	If female, ask her if she is the head of a family
6.	Ask him how long he/she is a recycler and how long does he recycle in his neighborhood? He is a recycler 25 years ago and in the neighborhood, he recycles 20 years ago
7.	Why did he/she become a recycler (history)? Since he was 11 years old, he lives on the street. 25 years ago, that his wife became pregnant and neither of them had an economic income to support his family, after this his wife died in his last birth and remained as a single father and his family situation was more complex
8.	You as a man, how does it feel to be a recycler? Being a recycler is a task that uses it to obtain the sustenance of your home, for basic aspects such as chocolate or rice
9.	As a woman, how does it feel to be a recycler?
10.	How do you think society sees you as a recycler? Society believes that I will steal them, you think that they are not working, but that they are looking for someone to steal, in addition to being regarded as people inferior to them

Table A2. Cont.

Activity Questions	
1.	How do you consider separation at the source in the area where you live? People mix everything, very few bags are separated in recyclable and non-recyclable things
2.	Do you think it has improved in recent years? Recycling has not improved because a relative of former Mayor Mockus has a cardboard shop in the south and they have a truck with which they recycle and take away the possibility for recyclers to get materials to receive money for the collection
3.	What do you think of the social work of the recycler? The recycler is a means to reduce the amount of garbage that is taken to the dumps and take advantage of what people throw away
4.	How do you market recycling? The recycler goes to stores where they buy bottles of different products and sells them, likewise, sells other materials such as paper and copper
5.	Ask what strategies they would use to improve source separation. Look in detail at the bag and see if there are more files (office sheets), see if there are beer cans and glass bottles.
6.	What is the most difficult part of your job? The hardest part is the role of the authorities in seeing a recycler looking for recyclable materials from the bags, because they believe they are doing improper things and take them out of the sector
7.	How do you imagine the work of the recycler in 20 years? In 20 years, the recycler disappears because companies are taking over the recycling industry, they only want their own benefit and they take away the poor people
8.	What is the best-selling material that is sold and what is the material that has no outlet in the market? The best-selling material is copper, more exactly yellow copper because there are three colors yellow, red and white; They buy the brass at U.S.\$5 per kilogram. And the worst selling material is plastic because it takes up a lot of space and does not have a significant weight, the kilo of plastic is bought at U.S.\$0.011
9.	How do you classify paper? (for example, in newspaper, white paper, cardboard, etc.) Take out the white paper only because the newspaper is bought at a very low price just like cardboard
10.	Do you know the new regulations regarding recycling that forces them to associate? He has heard that the government wants them to associate with different associations, but for him it is more profitable to sell materials to stores than to belong to an association
11.	Ask if he/she belongs to a recycler's association. He does not belong to any recycler's association c. If the answer is yes, ask him/her what benefits it has brought him/her to be associated. d. If the answer is negative, ask why it he/she is not associated. He does not belong to any association because in many of these associates they alter the weights in the balance, and decrease the weight and therefore the value that must be paid for said amount of recycled material

References

- Botello-Álvarez, J.E.; Rivas-García, P.; Fausto-Castro, L.; Estrada-Baltazar, A.; Gomez-Gonzalez, R. Informal collection, recycling and export of valuable waste as transcendent factor in the municipal solid waste management: A Latin-American reality. *J. Clean. Prod.* **2018**, *182*, 485–495. [\[CrossRef\]](#)
- Visvizi, A.; Lytras, M.D. *Smart Cities: Issues and Challenges*; Elsevier: Amsterdam, The Netherlands, 2019; ISBN 978-0-12-816639-0.
- Navarrete-Hernandez, P.; Navarrete-Hernandez, N. Unleashing Waste-Pickers' Potential: Supporting Recycling Cooperatives in Santiago de Chile. *World Dev.* **2018**, *101*, 293–310. [\[CrossRef\]](#)
- Gutberlet, J. Cooperative urban mining in Brazil: Collective practices in selective household waste collection and recycling. *Waste Manag.* **2015**, *45*, 22–31. [\[CrossRef\]](#) [\[PubMed\]](#)
- Yokoo, H.-F.; Kawai, K.; Higuchi, Y. Informal recycling and social preferences: Evidence from household survey data in Vietnam. *Resour. Energy Econ.* **2018**, *54*, 109–124. [\[CrossRef\]](#)

6. Hoornweg, D.; Bhada-Tata, P. *What a Waste: A Global Review of Solid Waste Management*; Urban Development Series; World Bank: Washington, DC, USA, 2012.
7. Wilson, D.C.; Velis, C.; Cheeseman, C. Role of informal sector recycling in waste management in developing countries. *Habitat Int.* **2006**, *30*, 797–808. [CrossRef]
8. Gutberlet, J.; Baeder, A.M. Informal recycling and occupational health in Santo André, Brazil. *Int. J. Environ. Health Res.* **2008**, *18*, 1–15. [CrossRef] [PubMed]
9. Gutberlet, J. Briefing: Social facets of solid waste: Insights from the global south. *Proc. Inst. Civ. Eng. Waste Resour. Manag.* **2013**, *166*, 110–113. [CrossRef]
10. Uddin, S.M.N.; Gutberlet, J. Livelihoods and health status of informal recyclers in Mongolia. *Resour. Conserv. Recycl.* **2018**, *134*, 1–9. [CrossRef]
11. Ostrom, E. Crossing the great divide: Coproduction, synergy, and development. *World Dev.* **1996**, *24*, 1073–1087. [CrossRef]
12. RNI Desplazamiento-Personas. Available online: <http://cifras.unidadvictimas.gov.co/Home/Desplazamientovvg=1> (accessed on 25 September 2019).
13. Binion, E.; Gutberlet, J. The effects of handling solid waste on the wellbeing of informal and organized recyclers: A review of the literature. *Int. J. Occup. Environ. Health* **2012**, *18*, 43–52. [CrossRef] [PubMed]
14. Gowan, T. American untouchables: Homeless scavengers in San Francisco's underground economy. *Int. J. Sociol. Soc. Policy* **1997**, *17*, 159–190. [CrossRef]
15. Wittmer, J.; Parizeau, K. Informal recyclers' geographies of surviving neoliberal urbanism in Vancouver, BC. *Appl. Geogr.* **2016**, *66*, 92–99. [CrossRef]
16. Jaffe, K.; Dong, H.; Godefroy, A.; Boutang, D.; Hayashi, K.; Milloy, M.-J.S.; Kerr, T.; Richardson, L. Informal recycling, income generation and risk: Health and social harms among people who use drugs. *Int. J. Drug Policy* **2018**, *60*, 40–46. [CrossRef] [PubMed]
17. Tremblay, C.; Gutberlet, J.; Peredo, A.M. United We Can: Resource recovery, place and social enterprise. *Resour. Conserv. Recycl.* **2010**, *54*, 422–428. [CrossRef]
18. Xue, Y.; Wen, Z.; Bressers, H.; Ai, N. Can intelligent collection integrate informal sector for urban resource recycling in China. *J. Clean. Prod.* **2019**, *208*, 307–315. [CrossRef]
19. Ardi, R.; Leisten, R. Assessing the role of informal sector in WEEE management systems: A System Dynamics approach. *Waste Manag.* **2016**, *57*, 3–16. [CrossRef] [PubMed]
20. Lange, U. Informal sector activities: Economic influences on waste management systems. *Waste Manag.* **2013**, *33*, 1321–1323. [CrossRef]
21. Wilson, D.C.; Araba, A.O.; Chinwah, K.; Cheeseman, C.R. Building recycling rates through the informal sector. *Waste Manag.* **2009**, *29*, 629–635. [CrossRef] [PubMed]
22. Ezeah, C.; Fazakerley, J.A.; Roberts, C.L. Emerging trends in informal sector recycling in developing and transition countries. *Waste Manag.* **2013**, *33*, 2509–2519. [CrossRef] [PubMed]
23. Hayami, Y.; Dikshit, A.K.; Mishra, S.N. Waste pickers and collectors in Delhi: Poverty and environment in an urban informal sector. *J. Dev. Stud.* **2006**, *42*, 41–69. [CrossRef]
24. Moreno-Sánchez, R.D.P.; Maldonado, J.H. Surviving from garbage: The role of informal waste-pickers in a dynamic model of solid-waste management in developing countries. *Environ. Dev. Econ.* **2006**, *11*, 371–391. [CrossRef]
25. Consejo de Estado República de Colombia. *Fallo 66203*; State Council: Bogotá, Colombia, 2013.
26. Corte Constitucional República de Colombia. *Sentencia C-048*; Constitutional Court: Bogotá, Colombia, 2018.
27. Corte Constitucional República de Colombia. *Sentencia C-259*; Constitutional Court: Bogotá, Colombia, 2016.
28. Corte Constitucional República de Colombia. *Sentencia T-622*; Constitutional Court: Bogotá, Colombia, 2016.
29. Corte Constitucional República de Colombia. *Sentencia T-299*; Constitutional Court: Bogotá, Colombia, 2008.
30. Corte Constitucional República de Colombia. *Sentencia C-431*; Constitutional Court: Bogotá, Colombia, 2000.
31. Corte Constitucional República de Colombia. *Sentencia T-724*; Constitutional Court: Bogotá, Colombia, 2003.
32. Republic Congress. *Servicios Públicos Domiciliarios*; Republic Congress: Bogotá, Colombia, 1994.
33. Minambiente. *Prestación Del Servicio Público De Aseo*; Minambiente: Bogotá, Colombia, 2013.
34. Minambiente. *Aprovechamiento Del Servicio Público*; Minambiente: Bogotá, Colombia, 2016.
35. Saldaña, J. *The Coding Manual for Qualitative Researchers*, 3rd ed.; SAGE Publications Ltd.: Thousand Oaks, CA, USA, 2015; ISBN 978-1-4739-0249-7.

36. Hernández, R.; Fernández, C.; Baptiste, M.P. *Metodología De La Investigación*, 6th ed.; McGraw-Hill: Ciudad de México, Mexico, 2014; ISBN 978-1-4562-2396-0.
37. Linzner, R.; Salhofer, S. Municipal solid waste recycling and the significance of informal sector in urban China. *Waste Manag. Res.* **2014**, *32*, 896–907. [[CrossRef](#)] [[PubMed](#)]
38. DNP. *Informe Nacional De Aprovechamiento*; Dirección Nacional de Planeación: Bogotá, Colombia, 2016.
39. Bhawal Mukherji, S.; Sekiyama, M.; Mino, T.; Chaturvedi, B. Resident Knowledge and Willingness to Engage in Waste Management in Delhi, India. *Sustainability* **2016**, *8*, 1065. [[CrossRef](#)]
40. Niño, J.J.C.; Hernández, L.P. El trabajo en la pepena informal en México: Nuevas realidades, nuevas desigualdades. *Estud. Demogr. Urbanos* **2012**, *27*, 95–117. [[CrossRef](#)]
41. DANE Censo Nacional de Población y Vivienda (CNPV). 2018. Available online: <https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/censo-nacional-de-poblacion-y-vivienda-2018> (accessed on 12 November 2019).
42. Torres, A.; Méndez-Fajardo, S.; López-Kleine, L.; Galarza-Molina, S.; Oviedo, N. Calidad de vida y ciudad: Análisis del nivel de desarrollo en Bogotá a través del método de necesidades básicas insatisfechas. *Estud. Gerenc.* **2013**, *29*, 231–238. [[CrossRef](#)]
43. Fereday, J.; Muir-Cochrane, E. Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. *Int. J. Qual. Methods* **2006**, *5*, 80–92. [[CrossRef](#)]
44. Minvivienda. *Decreto Único1077*; Minvivienda: Bogotá, Colombia, 2015.



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