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# The Role of Informal Waste Management in Urban Metabolism: A Review of Eight Latin American Countries

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Solid Waste Management

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Review

# The Role of Informal Waste Management in Urban Metabolism: A Review of Eight Latin American Countries

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**Abstract:** Social and spatial segregation structures in Latin America are perceived as processes for the selective concentration of social or demographic groups in geographic sectors of the city. This voluntary or forced segregation creates poor, wealthy, and marginal areas, leading to the territory's marginalization and fragmentation, destroying the symbolic and territorial urban continuity. To understand the behavior of waste pickers in a Mexican city, we sought to know the conditions of the informal collection activity in eight Latin American countries with similar conditions. Therefore, the goal was to carry out a bibliographic evaluation that included the environmental contribution of waste pickers, their organizations, and their link with urban metabolism. The tasks performed by informal waste pickers in the cities of the eight selected Latin American countries, their organizations, and their way of working were studied. Their role in reducing environmental impact and improving the quality of life of city dwellers was evaluated. Web sites, web searches, and face-to-face meetings created electronic communication channels with this community were analyzed. In some cases, they are well organized and become microentrepreneurs with salary, social security, and economical insurance by starting an ecological business. In contrast, marginal groups seeking economic support collect, separate, sort, and group recoverable waste daily and sell it at waste distribution points. This link in the urban metabolism reintroduces valuable solid waste into the production chain. In addition, materials with commercial value, such as metals, plastics, paper, cardboard, and wood, can re-enter the production chain as secondary materials for industry. Thus, a collective of well-organized waste pickers contributes to the city's sustainability and provides better living conditions for the waste pickers. In Mexico, there is a lack of official information regarding the number of waste pickers, organizations, activities, and their environmental contribution. Therefore, a directory with that information is highly relevant to designing public policies to recognize the essential contributions of this sector.

**Keywords:** waste pickers; Latin America; urban metabolism; environmental impact; recycling; eco-business



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## 1. Introduction

The social–urban problem in Latin America occurs with the illegal occupation of low-value municipal areas such as riverbanks, hillsides, land near garbage dumps, and open dumps. Because of these conditions, they forgo public health and endanger their physical safety. Economic vulnerability refers to the lack of resources that limit acquiring means for daily sustenance and finding self-employment in recycling [1,2]. Environmental risks due to mass consumption and disposal of waste continue to be largely unconsidered by society, and the recoverable waste incorporated within waste is neither recognized nor separated. In Latin America, Asia, and Africa, the informal sector collects, separates, and sells valuable materials [3]. This activity shows the ingenuity of those involved in collecting, sorting,

separating, and commercializing valuable materials that society disposes of in “garbage cans” and plastic bags on street corners. Waste pickers represent one of the most excluded and impoverished segments of society [4].

Consequently, an inclusive new model of waste management must be established. A radical approach capable of addressing poverty and contributing to the inclusion of informal waste pickers in the city’s municipal management system. Sustainable participatory waste management as a practice of recovery, reuse, recycling, and introduction of valuable materials into the productive chain of a region is enhanced by forming cooperatives, organizations, or recycling groups that are organized and empowered, supported by public policies, integrated into the solidarity economy, and oriented toward social equity and environmental sustainability [5]. This concept intertwines social, environmental, and economic arguments. It generates employment and self-employment for informal collectors, increases income, and improves occupational health. It produces a flow of materials with the entry of valuable products into the production chain. It reduces the use of raw materials extracted from nature by using recycled waste as resources and increases the generation and promotion of human development opportunities. To achieve inclusive and participatory management, there must be governance and democracy, offering new forms of public and private collaboration in waste management’s political and social context. This literature review recognizes informal recyclers as environmental service providers, empowering them through capacity building, information, and participation, allowing for social inclusion [6]. The dignification of these people through the recovery of valuable materials that enter as resources in the productive chain is a necessity that cannot be postponed. Through electronic communication with representatives of waste pickers organizations and research of electronic information, the countries with the most significant representation in the organization, conditions of inclusion or ways of inclusion of waste pickers, and evidence of work in advance of 15 to 20 years were identified. This way, Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, and Peru were selected.

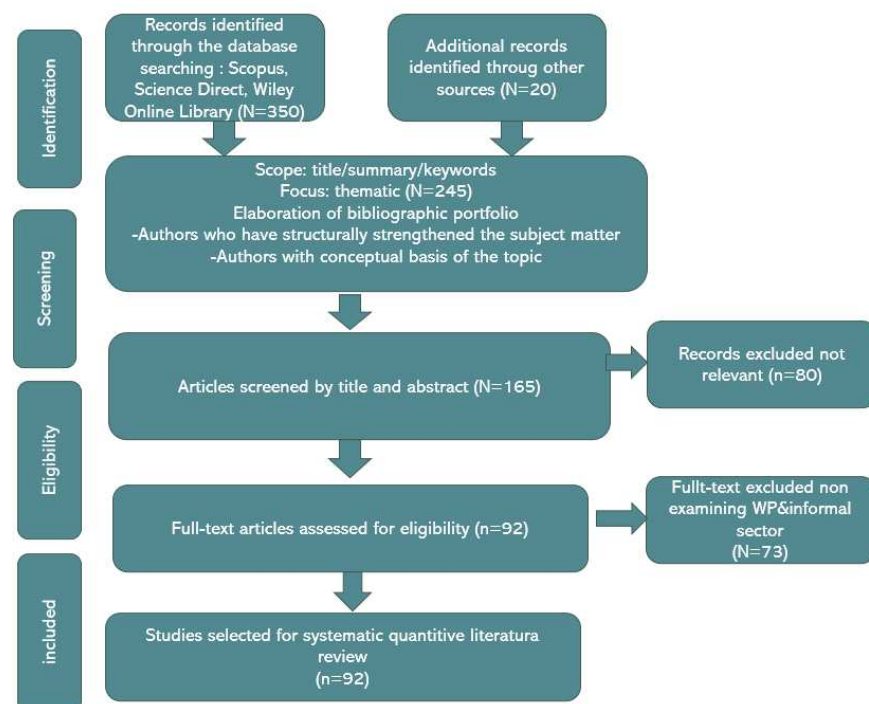
Urban metabolism is a model to facilitate the description and analysis of the flows of materials and energy within cities, such as undertaken in a material flow analysis of a city. It provides researchers with a metaphorical framework to study the interactions of natural and human systems in a specific region. The study of urban metabolism becomes a technical, political, and economic endeavor that facilitates our understanding of their materials and energy supply networks, seeking the efficiency and effectiveness of transformation processes as well as reducing the environmental impact of their waste, enabling policymakers to anticipate unwanted events based on present signals. “Urban metabolism is a concept that evolved from the μεταβολικός (metabolikós) biological concept [7], which was coined in the nineteenth century by Theodor Schwann, and which has its historical origins in the economic theory of Karl Marx [8,9]. Urban metabolism refers to “the total of the technical and socioeconomic processes that occur in cities, resulting in growth, production of energy, and elimination of waste” [10], that is, the operation of cities as metabolic bodies [11].

## 2. Methodology

The information was obtained by searching and consulting bibliographic references of electronic resources in catalogs, libraries, and thesis repositories about urban solid waste (USW). References were entered into Science Direct, Wiley Online Library, and Scopus and stored in Mendeley, using keywords such as urban metabolism, informal collection, sustainable cities, recycling, informal collectors, eco-business, “Scrap dealers,” and scavengers. Using metadata for advanced research, information on informal or grassroots waste picker networks in the different countries was the most researched for the area of influence in this case.

The information was obtained by searching and consulting bibliographic references from electronic resources in catalogs, library repositories, and theses about informal urban solid waste collection in cities. The keywords were urban metabolism, informal collection, sustainable cities, recycling, informal collectors, eco-businesses, ‘scrap dealers,’ ‘scavengers,’ ‘scavengers,’ and valorization of urban solid waste (VUSW). In addition to using the Boolean

operators AND/OR/NOT and their combinations and inverted commas. Using metadata for advanced searches, information on informal or grassroots waste picker networks was in the different countries where they are established. Eight low-income countries were selected for this research since they offer electronic information and have a more significant presence of informal recycling organizations with or without waste pickers. In the search for an important topic are organizations of informal waste pickers or waste pickers, thus focusing on informal waste picking as an invisible, unrecognized, unimportant, undervalued, and clandestine activity in the absence of social, governmental, and economic inclusion. The initial search was carried out for the 20 most prominent Latin American countries, and the results were narrowed down to the countries with the highest representation in terms of organization, conditions of inclusion or inclusion pathways, and evidence of work in the last 15 to 20 years (so far in the 21st century). Detailed information on Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Mexico, and Peru is presented. Of these approximately 370 articles, the literature was refined and analyzed to meet the objectives of this systematic review [12–15]. The model is used in the SRL method, which is divided into four sections: planning (purpose of the literature review and protocol and training), selection (searching for literature and practical screening), extraction (data extraction and quality appraisal), and execution (synthesis of studies and writing the review). In addition, the data search and selection diagram based on the PRISMA Statement steps was elaborated (Scheme 1).



**Scheme 1.** Diagram of search and data selection based on SLR and PRISMA Statement steps. Own elaboration.

### 3. Results

#### *Organizations and USW Generation*

In Latin American countries, due to their economic condition, municipal, state, or national governments, to date, do not have records or databases on the generation, income, and daily disposal of MSW generated by their inhabitants.

Many organizations, groups, or individuals who carry out informal collection activities daily do not publish them, either because they carry out the activity individually or because they do not belong to a group or organization. Therefore, their work is unknown or remains anonymous.

In 2018, the U.N. Environment report published in Buenos Aires, Argentina, in the framework of the XXI Forum of Ministers of Environment of the Latin American region [16], in the section on Sustainable Development Goals (SDGs), stated that one-third of all waste generated in Latin American and Caribbean (LAC) countries to date ends up in open dumps. This practice affects health, contaminates soil, water, and air, and has little capacity for recycling and fractional separation at the origin. The U.N. News published: “each Latin American generates one kilogram of garbage per day, and the region produces about 541,000 tons per day, which represents about 10% of the world’s garbage” [16] (see Table 1). According to population and development standards, Brazil and Mexico are the countries with the highest waste production in the region, and Haiti is the country that produces the least waste.

**Table 1.** Countries’ highest volumes of waste generated per capita [16].

Country	Quantity/Person/Day
Chile	9.9 kg/inhabitant
Uruguay	9.5 kg/inhabitant
Suriname	8.5 kg/inhabitant
Panamá	8.2 kg/inhabitant

Latin America stands out for its diversity in different aspects. One of the biggest problems is the generation of organic waste which accounts for 30–60% [17]. In each of these countries, the production is diverse, and the generation is abundant, so the production and generation of organic waste are high. The main problem is open-air landfills. In these countries, a common problem is the incorrect management of urban solid waste. In the face of a complex social, economic, and political panorama, the rulers allocate their financial resources to other interests, leaving aside the environmental problem. Unfortunately, each country acts alone and seeks to solve its environmental problems in isolation. There is no Latin American standard or average to serve as a base, reference, or limit for waste treatment, such as the European Community has under Directive 2004/35/E.C. on environmental liability concerning waste prevention and treatment [18].

The Economic Commission for Latin America and the Caribbean indicates that inadequate solid waste management negatively impacts people’s health and the environment. On the one hand, inadequate waste management, mainly when disposed of in open-air “dumps,” can result in severe impacts on the health of the population, primarily due to enteric diseases such as typhus, cholera, hepatitis, cysticercosis, trichinosis, leptospirosis, toxoplasmosis, scabies, mycosis, rabies, salmonellosis, and others, depending on local conditions [19]. Among the environmental effects is the loss of surface water quality due to leachate runoff [20]. Considering that waste pickers live in slums close to their working place implies daily exposure to MSW at an open dump or landfill site where they scavenge, separate, and bale valuable waste for sale, causing health and social problems. In addition, they face numerous risks, including infections and respiratory complications from fumes, bioaerosols, and sharps injuries [21].

Organizations of informal gatherers are distributed around the world. Each of these organizations is a free choice for each group of waste pickers, who, when organized and legally constituted, are eligible for institutional support once the organization is formalized. In Latin America, it is suggested that each group or organization be open to the public and make an internal manual of procedures, inputs, and outputs of materials, as well as rules for its activities and a list of its representatives (see Table 2).

**Table 2.** The actions carried out by recyclers and distributors of recoverable materials (own elaboration).

Visible Networks of Waste Pickers (in Electronic Media)		Country
1	<a href="https://renarec.com/">https://renarec.com/</a>	Ecuador
2	<a href="https://globalrec.org/es/rem/">https://globalrec.org/es/rem/</a>	The Global Alliance of Waste Pickers is a networking process supported by WIEGO among thousands of waste picker organizations with groups in more than 28 countries, mainly in Latin America, Asia, and Africa.
3	<a href="https://www.wiego.org/es">https://www.wiego.org/es</a>	International
4	<a href="http://www.redrecicladores.net/">http://www.redrecicladores.net/</a>	Latin America
5	<a href="http://movimientorecicladoreschile.blogspot.com/">http://movimientorecicladoreschile.blogspot.com/</a>	Chile
6	<a href="http://www.fenarep.org.pe/">http://www.fenarep.org.pe/</a>	Perú
7	<a href="https://www.blogger.com/profile/17278186539006176243">https://www.blogger.com/profile/17278186539006176243</a>	Asociación Nacional de Recicladores de Venezuela
8	<a href="https://asociacionrecicladoresbogota.org/">https://asociacionrecicladoresbogota.org/</a>	Colombia
9	<a href="http://www.wpau.org/">http://www.wpau.org/</a>	
10	<a href="https://www.mnrc.org.br/">https://www.mnrc.org.br/</a>	Brasil
11	<a href="https://distintaslatitudes.net/historias/serie/reciclaje/recifavela-brasil">https://distintaslatitudes.net/historias/serie/reciclaje/recifavela-brasil</a>	Brasil
12	<a href="http://www.wastepickerscollective.org/">http://www.wastepickerscollective.org/</a>	India
13	<a href="https://streemuktisanghatana.org/">https://streemuktisanghatana.org/</a>	India
14	<a href="http://www.safaisena.net/">http://www.safaisena.net/</a>	África
15	<a href="https://www.chintan-india.org/">https://www.chintan-india.org/</a>	India
16	<a href="http://www.surewecan.org/">http://www.surewecan.org/</a>	Brooklyn, New York, United States
17	<a href="http://amelior.canalblog.com/">http://amelior.canalblog.com/</a>	Francia
18	<a href="http://facyr.org.ar/">http://facyr.org.ar/</a>	Argentina
19	<a href="https://www.revistaperfil.com/vida/cultura/reciclaje-en-costa-rica-la-mision-de-convertir-la-basura-en-la-salvacion-del-planeta/OAIBI6YVFNFMXE7CNCIS6WU7A4/story/">https://www.revistaperfil.com/vida/cultura/reciclaje-en-costa-rica-la-mision-de-convertir-la-basura-en-la-salvacion-del-planeta/OAIBI6YVFNFMXE7CNCIS6WU7A4/story/</a>	Costa Rica
20	<a href="https://www.pe.undp.org/content/peru/es/home/ourwork/environmentandenergy/successstories/ResiduosArequipa.html">https://www.pe.undp.org/content/peru/es/home/ourwork/environmentandenergy/successstories/ResiduosArequipa.html</a>	Perú

List of waste pickers' networks consulted on the web pages of social networks, NGOs, and waste pickers' organizations. (Own elaboration) accessed on 10 December 2021.

The information gathered for this literature review was synthesized by the author in Table ???. The activities carried out by waste pickers and collection centers after the daily collection are summarized in this Table.

**Table 3.** The actions carried out by recyclers and distributors of recoverable materials (Own elaboration).

Activity	Description	Displacement/Actions
Collection	Searching, tracing, identification, collection, transport, preparation, sale.	Type and capacity of the material transport vehicle, type of waste requested, regularity, i.e., schedule of delivery of materials, delivery of the requested quantity.
Hoarding/Storage	Receipt materials, sorting, weighing, stockpiling, labeling, and storage for sale.	Purchase of recoverable materials delivered on-site with the requested delivery conditions.
Recycling	Purchase of materials by the waste dealer, transfer of recoverable materials to industry for entry into the production chain.	Entry into the production chain of recoverable materials. Delivery by type of material, equipment, reception of materials, weighing, identification, approval, entry of materials, and payment for materials received. Invoice of sales amount and delivery of materials.
Marketing	The waste dealer recovers, packages, and transports the sale or recoverable materials to the industries at a price established by the industry.	Receives the selected materials, pays or bank deposits to the seller, and invoices the operation.

The generation of MSW is a multifactorial and environmental problem that needs to be solved through various solutions and the adoption of several methodologies. The aim is to reduce the environmental impact by employing actions such as reusing, recycling, and separating recoverable materials to enter the production chain and minimize the amount of MSW going to landfills. The characteristic of these developing countries and their MSW management programs is a non-fractionated or source-separated collection. Cities in developing countries share the common characteristic of the municipal MSW collection service that a maximum of 70% of MSW is collected, and the remaining 30% is disposed of inadequately, with MSW lying in streets, gullies, and vacant lots [22].

This behavior occurs in economically deprived and low-income areas, which comprise a high proportion of the population. Therefore, people seeking economic livelihoods are inclined to rely on recycling waste materials.



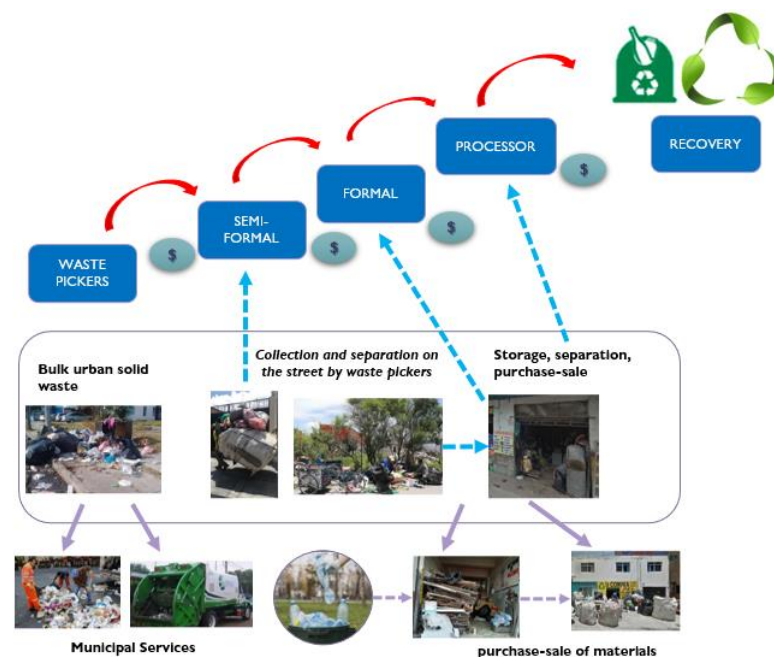
Informal waste pickers' activity is associated with low economic status groups, poverty, and even delinquency. They are the first link in the waste recovery chain and end up in companies that use the waste as second-use material to manufacture new products.

The casual collection of valuable waste products offers flexible hours and a daily income depending on collection volume [23] and wherever they are best paid. A productive chain of recoverable materials generates economic benefits and efficient informal recycling. However, the casual collection brings health and social problems to the waste pickers. Low-tech manufacturing or service providers are mainly unregulated, labor-intensive, and have unregistered work hours. Optimistic estimates suggest that only 30% of this 70% of the total waste collection is generated in cities in developing countries [24]. The other 30% are willing to in open dumps, streets, or water bodies, leading to environmental degradation and public health risks [25,26].

"Recycling has become an industry made up of more than two million informal waste pickers around the world," says Rachel Kyte, vice president and director of the World Bank's Sustainable Development Network [27]. It is now a global business with international markets, extensive supply and transport networks, and partnerships. At the local level, uncollected MSW contributes to flooding, air pollution, and impacts on public health.

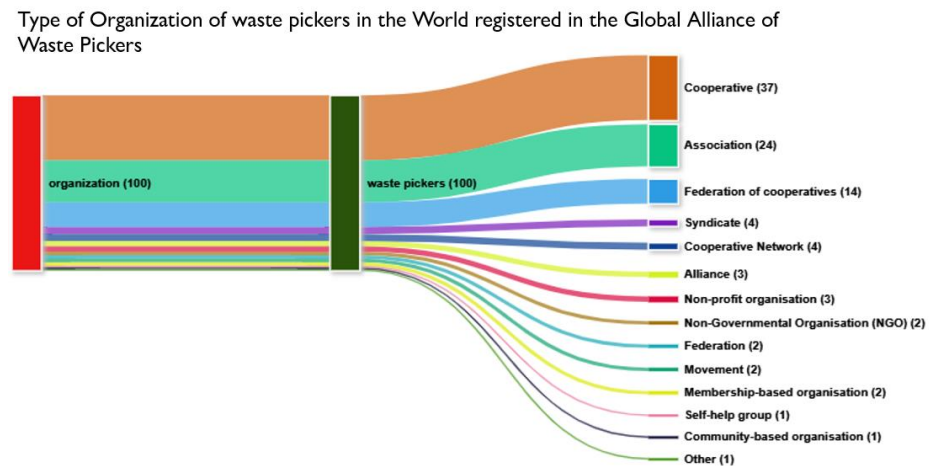
The characteristics of waste picker activities and the form of organization in Latin American countries are presented as follows:

The following tables and Sankey diagrams have been prepared for graphic representation of the organization of waste pickers in Latin America (see Figure 1).



**Figure 1.** The production chain of recoverable materials from municipal solid waste. Own elaboration.

It shows the value chain of materials that are useful for another process and considered raw materials. The waste pickers reassemble the higher quality materials, package, transport, and sell them. In addition, the waste dealer collects a quantity of recoverable waste to sell to industries. These actions generate economic resources, give another use, and prevent these materials from reaching the landfill (Figure 2).



**Figure 2.** Grouping by affinity and common needs. Source: <https://globalrec.org/es/rem/> (accessed on 10 December 2021). Waste pickers Around the World (WAW), is the first global database on waste pickers. (n) means the number of each type of association.

Waste pickers worldwide are registered and organized voluntarily, according to affinity and convenience, depending on the country and the benefits they obtain (Figure 3).



**Figure 3.** Waste Pickers organizations in the Americas. (n) means the number of each type of association.

### Argentina

In Buenos Aires, Argentina, 6760 tons/day of waste are generated by 3 million porteños. There are 676 waste collection trucks from the conurbations transporting waste to CEAMSE, an acronym for the landfill plant that manages the waste of 36 municipalities. In general, 20% of the landfill can reach total capacity in 5 years [28].

The recycling sector is one of the critical sectors for the development of the Argentine Republic. The “Argentina Recicla” program, launched on 9 November 2020, by the Ministry of Social Development, estimates 150,000 cartoneros, careers, and recyclers working in the country who recover up to 10,000 tons/day of waste. This sector is considered a key one in the country, so the corresponding ministry will provide work clothes, personal protection elements, and tools and will articulate the recycling system with the participation of waste pickers and a municipal recycling system (Figure S4). It will also implement marketing networks, logistics, equipment for regional nodes, and technical assistance. In addition, it will activate remarkable recycling for organics and recycling of electrical and electronic equipment (WEEE), high-density polyethylene (HDPE), low-density polyethylene (LDPE), and tires. This entity is known as the Federación Argentina de Cartoneros, Carreros y Recicladores (FACCYR) [29,30].



### Brazil

The work of Porto et al. [31] (2004) in Rio de Janeiro, Brazil, points out the living, working, and health conditions of waste pickers (“catadores”) in the landfill (uncontrolled dump) and the conditions they are exposed to daily when working at their source of survival. It points out the importance of establishing public policies that integrate different dimensions of the problem, mainly social inclusion, environmental preservation, public health, and the dignity of these workers. In 2010, Brazil established regulations and responsibilities to manage MSW from raw materials to the final disposal. From there emanates Law No. 12.305/2010 [32], which institutes the Brazilian Solid Waste Policy (BSWP), defining basic economic and environmental sustainability guidelines, including reduction, reuse, recycling, and proper disposal. As such, this law includes the requirements and inclusion of informal recyclers and the participation of associations and cooperatives of informal recyclers [33].

The evolution of the municipal solid waste management system in João Pessoa (Brazil), a pioneer city in Brazil with door-to-door selective collection programs, was studied by Ibáñez-Forés, Bovea, Coutinho-Nóbrega, de Medeiros-García y Barreto-Lins [34–36]. These authors conducted the 2005–2015 analysis of the system implemented in different sorting units and selective collection programs using a Life Cycle Assessment (LCA) with the actors of the Municipal Solid Waste Management (MSWM) system. The implementation of the door-to-door program is managed by associations of informal waste collectors and the incorporation of new methodologies, such as the biomethanization of organic waste. This analysis showed the temporal evolution of the environmental indicators that measure the environmental performance of the Municipal Solid Waste Management (MSWM) system, implemented in João Pessoa, Brazil, by the system called the classification unit by stages of the waste life cycle. The stages considered were collection, sorting, intermediate transport, recycling, and final destination (landfill) [37–39].

In Porto Alegre (Brazil), women’s participation in waste pickers’ activities is increasing as an opportunity to contribute resources to the family and not stay at home, as they cannot find domestic work in middle-class homes. However, the openness to other social problems, such as collaborating with drug traffickers, and decreasing this illicit activity through the opening of the Eulalia Arts Centre (CEA), aims to counteract the existing dynamics in the local community and criminal activities by providing social benefits for the members. The association “Nuevo Ciudadano” employs people known as ‘sin techo’ (homeless or street people) who receive a salary and health services, including social security. The informal recycling sector (IRS) brings additional social, environmental, and economic benefits, such as reduced operational costs and environmental impacts at the landfill. A global example is Brazil’s best practice of including “catadores” who cease to be informal by forming a cooperative as reported by Rutkowski and Rutkowski [40] (2015) by studying 25 cases of cities benefiting from a door-to-door collection of recyclables, improving municipal recycling indicators, and the economies of the partners. The organization and support of “catadores de lixo” (Portuguese for rubbish collectors) have led to cooperatives in Rio de Janeiro, Belo Horizonte, Recife, Niteroi, and Salvador, where there are 14 cooperatives with 2500 members. One of these cooperatives, COOPAMARE, collects 100 tons of recyclables monthly. COOPAMARE members earn USD 300 per month (Figure S2) [41,42].

In Porto Alegre, “catadores” joined the city’s curbside recycling program, reducing overall costs and serving 79% of the city’s 1.1 million inhabitants. “CEMPRE” (Compromiso Empresarial para Reciclagem), an industry association, issues a monthly newsletter and manages a database on solid waste management (Figure S5). When considering the “catadores” results, the direct line industries that participate in and benefit from recycling are Coca-Cola, Mercedes Benz, Nestlé, Pepsi-Cola, and Procter & Gamble. This dynamic has encouraged similar programs in Argentina, Costa Rica, Mexico, and Uruguay [43].

### Chile

In 1995, all household waste was disposed of in landfills and dumped, promoting social inequality [44]. Today, 77% of the 7 million tons generated by households are

disposed of in 38 landfills across the country (“SEREMI” of the Environmental of the Metropolitan Region, Santiago, Chile) [45].

In 2016, the Recycling Law was enacted, making Chile the first Latin American country with a national regulatory instrument for the sustainable management of its waste based on extended producer responsibility (Figure S6). Law 20.920 [46] for waste management, extended producer responsibility, and promotion of recycling, known as the REP Law, aims to reduce waste generation and promote its reuse, recycling, and other types of recovery. Law 20.920 requires the manufacturer and importer of six priority products (batteries, packaging, electrical and electronic goods, lubricating oils, and tires) to encourage recycling [45].

The Ministry of the Environment (MMA) (Figure S7) established environmental management instruments for manufacturers and importers to recover waste generated by their products at the end of their useful life [45]. The task of recycling by publishing the “Grassroots Waste Pickers Inclusion Policy” (2016–2020) seeks to boost the social, economic, and environmental inclusion of 60,000 grassroots waste pickers and incorporate them into collection chains [47].

### Colombia

In 2017, a study on the characterization of waste picker organizations by the National University of Colombia established that a waste picker could collect, on average, 2.4–2.7 tons per month of separated material to be recycled and transport the material by human traction on carts or tricycles. In total, 78% of Colombian households do not recycle. Colombia generates around 12 million tons of waste annually, of which 17% is recycled.

Colombia consumes 24 kg/year of plastic per person, 56% of which is single-use waste. Recycling is low, and in 4 years, 321 landfills will end their useful lives. In 2019, waste pickers were listed in 319 organizations, and more than 30,000 waste pickers were listed in the Single Information System (SUI) of the Superintendencia de Servicios Públicos Domiciliarios (Figures S5 and S6). Table 4 lists the affiliates distributed across the departments, and in 2018, they collected 767,137 tons of waste in 25 departments by 232 waste picker organizations.

**Table 4.** Distribution of the waste pickers affiliated with organizations in Colombia (<https://www.semana.com/sostenible/> accessed on 10 December 2021).

Department	Number of Groups Affiliated with the Organizations	Number the Waste Pickers Members
Bogotá	118	17,286
Antioquia	29	2337
Valle de Cauca	19	1590
Cundinamarca	20	860
Santander	17	736
Meta	12	1603
Boyacá	12	548
Atlántico	13	1063
Bolívar	8	303
Casar	8	227

As of May 2019, the results were: 55% for paper and cardboard, 30% for metals, 8.8% for plastics, and 8.8% for waste recycling. In 2018, 767,137 tons were recovered in 25 departments by 232 waste picker organizations. As of May 2019, the results were: 55% for paper and cardboard, 30% for metals, 8.8% for plastics, and 8.8% for waste recycling waste [28] (Anonymous, 2020b). See Figure S5. Waste pickers in Colombia are organized into 319 organizations in 27 departments. See File photo [48]. See Figure S6. The work activities of waste pickers in Colombia, see Stock photo [48] and Table 2, and the distribution of waste pickers affiliated with organizations in Colombia (Figure S8) are also provided.

The actions undertaken by Colombia in 2020 with the call for recycling included the invitation to more than 200 companies producing packaging, the issuing of environmental licenses by the National Association (ANLA), and the initiation of 21 pilot projects for the use of the waste generated, among others. This initiative, presented in line with the Extended Producer Responsibility, related to the Circular Economy Strategy, aims to eliminate landfills and close material cycles (Figure S9). Waste pickers in Bogotá are fighting for justice. Once marginalized and excluded from the collection of recyclables from the city's streets, they are now constitutionally protected and are a model for other waste pickers worldwide [48].

#### **Costa Rica**

The Costa Rican Ministry of Health reported that the Recycling in Costa Rica program [49] "... in 2015, it registered 17,200 tons of recycling, in 2016 it was 40,000 tons". Data for 2018 are not yet available," but it was a dramatic increase [49]. Recycling in this self-proclaimed green country was only 1%. Of the waste generated, 14 municipalities do not have a waste management plan. In 2012, the Solid Waste Management Act was passed. In 2012, the collection center "San Rafael de Heredia," with 12 employees, collected 25 to 30 tons per month. In 2014, Law 8839 [50] indicated that 81 municipalities had to include a waste management action plan. In 2015, it initiated the collection of organics from 200 households to be trained in separating waste, shells, food leftovers, tea bags, and white napkins [51]. Historical data are available on recycling quantities and their annual increase [51]. The State of the Nation report in the chapter on Human and Sustainable Development in 2019 states that in Costa Rica, 3982 tons/day of solid waste is generated. A total of 3132 tons/day are sent to landfills or semi-controlled dumps, representing 78.7% of the total, and the whereabouts of the rest of the materials are unknown (Figure S10). The goal for 2021 was to collect 600 tons/day by waste pickers [51]. There are no regulations or associations that regulate the work of waste pickers in the country that legislate the activity of informal recycling [52]. However, the work of an Environmental Engineering student, Walter Sanabria-Berrocal [53] (2020), from the Tecnológico de Costa Rica, investigated the social and economic aspects of the lives of informal waste pickers and their role within the recycling value chain. Sanabria-Berrocal highlights: "The role and contribution of informal recyclers is the basis of the separation chain and its importance" [54]. The collection of recoverable solid waste: an alternative management model by Luis Eladio Rodríguez González published in October 2020, notes that: "In Costa Rica, Law 8339 for the Integral Management of Solid Waste [50] establishes that the municipality is the entity responsible for providing waste collection throughout the territory where it has jurisdiction (Figure S11). However, most local governments have not demonstrated the capacity to fully address the needs of all the districts within their canton. In many cases, this task has ended up being delegated to a few groups, many of them informal, which do not offer the best service and do not have a formal collection process that takes full advantage of the added value of the waste generated daily." It was published in a journal of the Instituto Tecnológico de Costa Rica [52].

Recycling efficiency is affected by low source separation in Costa Rican households and businesses due to a lack of civic culture. The study entitled "Invisible Markets: The Informal Sector of Waste Management" is a proposal that identifies social and economic aspects of the lives of informal recyclers, their role in the recycling value chain, and the reduction of greenhouse gas emissions [54].

#### **Ecuador**

The citizens' initiative "ReciVeci" began formal activities in 2005, promoting inclusive recycling in Ecuador and working to improve the living and working conditions of grassroots waste pickers, who ceased to be informal by joining the Regional Initiative for Inclusive Recycling [55]. A "grassroots waste picker" refers to formal or informal workers in the recycling value chain. More than 20,000 Ecuadorians work as grassroots recyclers, collecting anything that can be recycled and generating income from its sale. These materials are cardboard, paper, plastic (bags or bottles), glass, bricks, and metal

(aluminum or scrap metal). The collection is done door-to-door by the grassroots recycler, who sets a day and time when he or she will go to the household and deliver the separated materials, committing the citizens to the route scheduled by the grassroots recycler [55]. The house that collects and separates the waste keeps a record and an approximate mass. By adding up the lists of all the neighbors, an exemplary recycling neighborhood is sought. Monthly recycling progress and best separation practices are communicated to encourage and motivate recycling in the neighborhood to implement improvements. In the neighborhood, they designate strategic places to link with grassroots waste pickers, such as schools, universities, shops, and churches [56].

In 2008, the National Network of Waste Pickers of Ecuador (RENAREC) was designated as the voice of grassroots waste pickers in Ecuador. The network is made up of more than 50 waste picker associations organized at the national level, bringing together more than 1500 waste pickers and their families. The aims of RENAREC are for grassroots waste pickers to be recognized as associates and to belong to RENAREC, to receive payment for the service they provide, to have social security, to implement fair commercialization processes without intermediaries, to have protective equipment, and to generate environmental awareness among the population. This organization is governed by four axes (Figures S12 and S13) as identified in a legal organization in Ecuador: Axes of the National Network of Waste Pickers of Ecuador [57]. Figure S11 shows the Second International Congress Smart City Ecuador “Quito to recycle” [58].

The Empresa Pública Metropolitana de Gestión Integral de Residuos Sólidos (EMGIRS), in coordination with the Metropolitan Secretariat of Environment, was part of the Second International Congress Smart City of Ecuador held at the Swissotel Hotel on 26–27 June 2018, Quito reports, 2018 [58].

### México

Like other Latin American countries, Mexico has diverse conditions in each region and the 32 states that make up the territory. As a developing country, the characteristics of its cities and municipalities are marked by a rapid expansion and polarized resources, from the richest to the extremely poor, with rulers who do not provide the necessary urban infrastructure. Urban solid waste management is poor, which, in turn, results in the insufficient collection of the waste generated by the population. One consequence is inadequate disposal [59]. Piles of waste on street corners, vacant lots, and uncontrolled municipal or clandestine dumps cause severe problems at first sight, such as harmful fauna and damage to health and the environment. This situation is an opportunity for the informal collection of valuable materials and waste pickers to sell them. This daily survival activity of the waste pickers involves roaming the streets of the city daily and, after a long walk, selling the materials they scavenge from containers or street corners as a source of economic resources within the commercialization chain.

Mexico’s three levels of government (municipal, state, and federal) spend, at least on paper, between 30 and 50% of their operating budgets on waste management and collection which accounts for between 50 and 80% of the waste generated [60,61]. This country does not require the separation of waste, so the recovered materials are mixed with those that are not, diminishing their commercial value. As stated by [62–64], the conditions of high environmental pollution or damage to health in Mexico City are related to the working conditions of waste pickers. They point out that waste collectors have a life expectancy of 39 years, while the life expectancy of the general population is 67 to 79 years. On the other hand, [65] mentions that MSW generation in the Federal District, now Mexico City (Mexico City), is estimated at 12,500 tons per day (2009 data) and is increasing by 5% per year. In 2012, MSW generation was 16,250 tons per day, with more than 50 million tons per month, which are transported for disposal in an area of 420 hectares in the Bordo Poniente landfill, where unplanned settlements have been set up by waste pickers who manually separate the waste that is unloaded daily by government collection trucks, without any protection. The government of Mexico City has tried to implement waste management programs that did not work and is now looking for other options.

In the case of Mexico City, until a few years ago, no structured organizations, cooperatives, or waste pickers had been identified that would work together for a common goal, allowing them better livelihood conditions. It was “vox populi” that for more than 50 years, there were and probably still are “mafias” controlling the thrash and supported by political parties. The “pater familia” controlling the rubbish in Mexico City was even called the King of Garbage [66].

In Mexico City, the chain of recoverable materials, collected, sorted, and collected by waste pickers on the street or at the landfill, is delivered in exchange for an economic benefit to a self-appointed leader. The waste leader, in turn, sells to an industry with a profit margin of up to 300% of the value paid to the waste picker [67]. These daily actions at the Bordo Poniente landfill are carried out outside the law, arbitrarily, without guarantees or social recognition, as there is no guarantee of an organization as a group or cooperative. The government authorities, colluding with these “mafias,” tolerate and cover up these abuses, maliciously hiding what happens with urban solid waste in this megalopolis.

In México, the Sociedad Cooperativa de Seleccionadores de Materiales (SOCOSEMA), operating in Ciudad Juárez-Chihuahua, recovers 150 tons per day of paper, cardboard, glass, rubber, plastics, animal bones, organic matter, and metals; approximately 5% of the waste is received by the landfill, which has been in operation since 1975 [68]. Primary collection, therefore, can generate significant social and economic benefits. The National Association of Plastics Industries (ANIPAC) held the 2019 Plastics Industry Outlook Forum on 26 February 2019, in Mexico City [69]. Plastics account for more than 3% of the gross domestic product [69], and Mexico is ranked 21st as a plastic recycler [70].

On 6 November 2019, the First National Forum on Inclusive Recycling was held in the halls of the Senate of the Mexican Republic. At this meeting, groups of metal, plastic, and electronic recyclers made presentations, and people from Ecuador were invited to socialize the actions they carry out with informal recyclers [71]. For Mexico, it would be a big step forward if a law were made to recognize waste pickers so that they could be part of society and get credit for what they do for the environment (Figure S14).

Figure S15 shows photographs from the National Forum on Inclusive Recycling, FNRI, hosted by the Senate of the Republic in Mexico City [71].

In Mexico, more and more social groups are using trash as a valuable resource, which helps cut down on the problem of too much trash (Figure S16).

In Mexico, 102,895 tons/day (about 53.1 million tons per year) of trash are generated daily, of which only 84% are collected, and 16% are found in streets, parks, beaches, rivers, and vacant lots, causing air, soil, and water pollution. Each inhabitant generates 1.2 kg per day. The recycling rate in the country is only between 20 and 25% nationally, where practically half of the waste can be recovered and reused.

The foundation #WithoutWaste brings together partners in Latin America and the Caribbean who are interested in innovation, better policies, and the ability to make use of food waste (<http://sindesperdicio.net/es/> accessed on 10 December 2021).

Annually, on 24 October the “Pepenafest” takes place in Mexico City. Pepenafest is a meeting point for different artistic, social, and educational disciplines. The theme addressed is environmental culture, specifically in managing urban solid waste, whose slogan is “rubbish does not exist. We generate it” [72]. At this festival, several works of art and handicrafts made from solid waste are exhibited in the exhibition “Nothing is Rubbish.” This artistic response brings together artists, environmental groups, entrepreneurs, and social organizations seeking to promote Mexico’s recycling culture. The goal is to teach and encourage people to recycle so that they can save money (Figure S17).

Figure S18 shows photographs alluding to the festivals initiated in 2008 in Mexico with the 1st International Recreational Recycling Festival, Cholula, Puebla, Mexico, which is a collage of elaboration from the different events in Mexico City and Cholula, Puebla [73].

Despite the aforementioned “mafia,” there are already three organizations of waste pickers in Mexico City: Asociación de Selectores de la Metrópoli, A.C.; Frente Único



de Pepenadores, A.C.; and Unión de Pepenadores del Distrito Federal Rafael Gutiérrez Moreno, A.C. [74].

The website <https://ecolana.com.mx/> (accessed on 10 December 2021) has created a register of waste reception centers that allows consumers in the states of the republic to locate the collection center from a list that identifies the waste they want to recycle by selecting the registered collection center of their choice where they can take their waste. The e-page rates the collection center and recommends it. The user can download the application (APP), register his or her movements, and benefit from it. This application asks the user to upload images to share with other users.

The disadvantage of the application is that it is aimed more at collection centers registered in Mexico City than other centers in the country. So, people who do not live in this megalopolis cannot afford to go to collection centers that are far away.

#### Perú

In Peru, in 2019, Municipal Ordinance No. 053-219-MDMM approved the regulation of the formalization of waste pickers in the district of Magdalena del Mar. Its objective is to support and regulate the activity of the selective collection of solid waste. This collection contributes to the process of environmental sanitation, favoring the use of materials for the preservation and rational use of natural resources. Likewise, the regulation of this activity contributes to the formalization of these actions, which will impact the generation of better-quality sources of employment [75]. The Municipality of Villa El Salvador, the commission of administration, planning, and budget, in this Ordinance incorporates the administrative procedure of municipal registration of organizations of authorized recyclers for the selective collection and commercialization of solid waste [76].

In 2010, the initiative, supported by the United Nations Development Programme (UNDP), organized waste pickers into formal associations to regulate and expand their work. Initially, only 5 percent was collected. The percentage of solid waste collected has increased to 25% in the Arequipa district. The waste pickers' association "Nuevo Mundo" currently collects 300 kg of solid waste daily (Figures S19 and S20). The project has stimulated the formal organization of waste pickers into an association called "Recicla Vida" (PNUD, 2010). The waste picker associations in Peru are described in [77–80].

#### 4. Discussion

In some Latin American countries, waste picker activities are supported and monitored by foundations in European countries [81–83].

According to the World Bank, population growth projections for Latin America are 17% from 2005 to 2025 [27]. High population growth is the leading cause of waste production, which is rapidly increasing as new container materials become available. The importance of exercising measures to decrease waste production and the high population growth are responsibilities that governments must assume [84]. In Colombia, the local municipal government promotes affiliation with environmental eco-organizations through institutions such as Corporaciones Autónomas Regionales para el Desarrollo Sostenible [85]. In Bogotá, waste pickers' livelihoods or MSW management policies include landfill dwellers. La Chureca in Managua, Nicaragua [86] has plans for mechanization and formalization of MSW management from 2009 onwards in government development projects to stick to this stage to work on MSW separation at the landfill. Up to 2000, informal waste pickers earn income for their families by working at the landfill. Nicaragua and other low-income countries use the term for the value-added activity of "separating materials" and recovering capital for the livelihoods of these families [61].

In 1972 in Managua, Nicaragua, the "La Chureca" (uncontrolled rubbish dump, human settlement with social problems, child labor, overcrowding in substandard housing, unhealthy conditions, domestic and gender violence, high rates of child illiteracy and school absenteeism, malnutrition, and extreme poverty) was established. In August 2007, AECID (Spanish Agency for International Development Cooperation) and the Mayor's Office of Managua, Nicaragua, initiated a project to solve the social, environmental,

and housing problems that existed in La Chureca, transforming the lives of more than 1500 people known as “churequeros.”

AECID and the Nicaraguan Mayor’s Office donated 263 houses next to the landfill, sealed the landfill to avoid further hydrological, soil, and atmospheric contamination, and installed an MSW treatment plant managed by the AECID construction company TRAGSA with more than 10,000 m<sup>2</sup>. A complex (auxiliary and administrative buildings such as offices, workshops, kitchens, changing rooms, a nursery, and houses) provides employment. This recycling plant is a modern MSW sorting plant that recovers plastic, glass, paper, cardboard, bricks, metals, and organic matter to produce 70 ton/h of compost, four material separation lines, and 224 jobs in three shifts [86,87].

In primary collection, the recovery of materials from house to house, on city street corners, in open-air dumps in ditches, and at landfills is a source of work that does not require a particular educational or socioeconomic level. Instead, the waste pickers say, “It’s just scavenging for things that have value so I can trade them for money and buy things I need to eat every day” [88].

This bibliographic review shows that the lack of governance increases the generation of unemployment, and the lack of incorporation of workers into social security systems makes them more vulnerable, leading these people to generate their own jobs in the search for a livelihood and contribute to the economy of the place where they carry out their activity. The strengthening of the primary collection activity that contributes to the value chain of the materials collected in the street, in warehouses, from house to house, or in other strategic places that they form and organize makes this activity their livelihood.

Therefore, the informal collection is a green alternative for separation and recovery chains and follows guidelines in line with the axes of sustainability (environmental, social, and economic factors) that lead to eco-development, eco-efficiency, and the generation of eco-businesses [89,90], including informal ones.

The effect of economic insertion in waste recovery, reuse, and recycling from cooperatives and other forms of organizations supported by public policies, including waste pickers within the Solidarity Economy, will allow them to be directed towards social equity and environmental sustainability.

For this reason, primary recyclers are a factor in the urban waste management formula, contributing positively to environmental conditions. Therefore, the adaptation of models must consider the different contexts of reuse and recycling behavior in each location, including geographical, social, economic, legal, and political factors [5].

## 5. Conclusions

This review found that organized groups of informal waste pickers have more economic benefits and make everyone in the group better off than if they worked as individuals.

As Latin American regulations on the valorization of waste as a resource are implemented, and guidelines for the preparation of recoverable materials and reasonable prices are standardized in the country where the activity is carried out, under established conditions and laws, there will be order in this type of green job or eco-business [37,90–92].

Therefore, criteria based on the circular economy should be adopted and established. This can be a strategy aimed at reducing the generation of products from virgin materials as much as possible. In other words, materials used more than once can be encouraged by stopping the flow of economic and ecological resources so that fewer raw materials are taken from natural resources.

There is a big gap between primary collectors, society, and the government. Each person needs to be recognized for his or her dignity and worth in order to end social instability.

In Mexico, there is a lack of official information regarding the number of waste pickers, organizations, activities, and their environmental contribution. Therefore, a directory with that information is highly relevant to designing public policies that recognize the essential contributions of this sector.

**Supplementary Materials:** The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su15031826/s1>, Figure S1. Argentine waste pickers. Source: Photo by the Argentine Federation of waste pickers (accessed online in 2018 <https://distintaslatitudes.net/historias/serie/reciclaje/recicladores-pandemia-guatemala-argentina>). Figure S2. ‘Catadores’ (waste pickers) in Brazil. Own source from images published on international networks. (<https://distintaslatitudes.net/historias/serie/reciclaje/recifavela-brasil>, <https://globalrec.org/>, <https://www.google.com.mx/url?sa=i&url=https%3A%2F%2Fglobalrec.org%2Fpt-br%2F2020%2F10%2F20%2Fcampanhas-de-solidariedade-para-coletar-dinheiro-para-pessoas-catadoras-em-tempo-de-coronavirus-doe%2F&psig=AOvVaw0iL1cYU-bh8Jx2Cv2HGEI7&ust=1619809588562000&source=images&cd=vfe&ved=2ahUKEwj63KeKk6TwAhVCRawKHT3FDxsQr4kDegQIARBi> y en Latitud R, <https://latitudr.org/> accessed on 10 December 2021). Figure S3. Waste pickers in Chile [images from Chilean organizations] (Anonymous, 2020, 2021 [44]). Figure S4. Argentine waste pickers. Source: Photo by the Argentine Federation of waste pickers [accessed online in 2018 <https://distintaslatitudes.net/historias/serie/reciclaje/recicladores-pandemia-guatemala-argentina>]; Figure S5. ‘Catadores’ (waste pickers) in Brazil. Own source from images published on international networks. [<https://distintaslatitudes.net/historias/serie/reciclaje/recifavela-brasil>, <https://globalrec.org/>, <https://www.google.com.mx/url?sa=i&url=https%3A%2F%2Fglobalrec.org%2Fpt-br%2F2020%2F10%2F20%2Fcampanhas-de-solidariedade-para-coletar-dinheiro-para-pessoas-catadoras-em-tempo-de-coronavirus-doe%2F&psig=AOvVaw0iL1cYU-bh8Jx2Cv2HGEI7&ust=1619809588562000&source=images&cd=vfe&ved=2ahUKEwj63KeKk6TwAhVCRawKHT3FDxsQr4kDegQIARBi> y en Latitud R, <https://latitudr.org/> accessed on 10 December 2021]; Figure S6. Waste pickers in Chile [images from Chilean organizations] [Anonymous, 2020, 2021 [44]]; Figure S7. The proposed organizational structure for the management of so-called inclusive recycling [taken from the working document entitled Modelo de gestión de reciclaje inclusivo Región Metropolitana, 2016] [45]; Figure S8. Waste pickers in Colombia in 319 organizations in 27 departments. Archive photo [48]; Figure S9. Work activities of waste pickers in Colombia. Archive photo [48]; Figure S10. An initiative to improve the quality of life of grassroots waste pickers in Costa Rica <https://www.revistaperfil.com/vida/cultura/reciclaje-en-costa-rica-la-mision-de-convertir-la-basura-en-la-salvacion-del-planeta/OAIBI6YVFNFMXE7CNCIS6WU7A4/story/> accessed on 10 December 2021; Figure S11. San Rafael Heredia, Costa Rica: Grassroots Waste Pickers’ Collection Centre [51]; Figure S12. Citizens’ initiative in Ecuador: [56]; Figure S13. Legal Organization in Ecuador: Axes of the National Network of Waste Pickers of Ecuador (<https://renarec.com/quienes-somos/> accessed on 10 December 2021); Figure S14. Second International Smart City Ecuador Congress “Quito to recycle” [58]; Figure S15. Photographs of the Foro Nacional de Reciclado Inclusivo, FNRI, hosted by the Senate of the Republic in México City; Figure S16. A photograph was taken from a report [93]: “A waste picker without waste is a farmer without a field, a doctor without patients, a fish without water ... a bird without a sky”; Figure S17. Meeting of waste pickers from across the country in Mexico City [74]; Figure S18. Photos alluding to the festivals initiated in 2008 in Mexico with the 1st International Recreational Recycling Festival, Cholula, Puebla, México [73]; Figure S19. Waste Pickers’ Associations in Perú “Asociación de recicladores Jesús María”, Asociación Lima Norte “Juan Pablo II” <https://www.cocacoladep Peru.com.pe/historias/medio-ambiente-basilio-gomez--de-reciclador-informal-a-referente-del-reciclaje->, <https://trome.pe/familia/lima-sur-recicladores-orgullosos-chamba-63684/>, <https://compuempresa.com/info/asociacion-de-recicladores-juan-pablo-ii-los-olivos-20544969740> (accessed on 10 December 2021); Figure S20. Group of waste pickers from the association in the Peruvian district of Arequipa, where a UNDP-supported program has helped to organize workers, regulate them, and expand their work (Photo UNDP, Perú) <https://www.pe.undp.org/content/peru/es/home/ourwork/environmentandenergy/successstories/ResiduosArequipa.html> (accessed on 10 December 2021).

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