Collective Action in Waste Management: A Comparative Study of Recycling and Recovery Initiatives from Brazil, Indonesia, and Nigeria Using the Institutional Analysis and Development Framework

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Abstract: Recycling and recovery provide not only a sustainable option to decrease the volume of waste that needs final disposal, but also a blueprint to a circular economy. However, rates of recycling/recovery still remain very low on a global scale. While it is important to look for technology-based solutions to improve recycling/recovery activities, such solutions might not be necessarily affordable in many countries. A solution that involves the active participation of the population, on the other hand, has the potential to succeed in any country. The challenge is to attract and unite people to achieve such common goals. The theory of collective action and the Institutional Analysis and Development (IAD) framework, that have been originally used in resource management, are two concepts that can be adapted to organize recycling/recovery initiatives. This manuscript discusses what recycling/recovery programs can learn from the theory of collective action and the IAD framework, through a qualitative comparative study of such initiatives from three different cities. They are; Curitiba in Brazil, Padang in Indonesia, and Akure in Nigeria. The cases show the potential benefits of both concepts, not only in formulating and implementing recycling/recovery programs but also in making corrective measures for continuous improvements. All cases also showed the importance of increasing awareness-raising to change public perception towards waste from being a nuisance to a valuable resource.

Keywords: collective action; institutional analysis and development framework; waste policy; waste governance; waste management; recycling and recovery; circular economy

1. Background

Global waste generation reached 2 billion tons/year in 2016, and it is estimated to grow to 3.4 billion tons/year by 2050 [1]. Population growth is not the only reason for this expected increase in waste generation; changing consumption habits resulting from increased purchasing power is also a significant factor. For example, the growth of the middle class in the two largest populations in the world—China and India—will make a substantial impact on future waste generation rates [2,3]. On the other hand, we will also face resource scarcity issues thanks to the same two reasons: population growth and increasing consumption habits. It is interesting to note the same waste, that we see as a problem, is also offering a valuable partial solution to the resource scarcity issue through recycling and recovery, together with a blueprint towards a circular economy [4]. However, the current amounts we recycle/recover stand at a very low level on a global scale. In fact, the circularity of the global economy has decreased from 9% in 2018 to 8.6% in 2020 as per the last two Circularity Gap Reports [5,6].

The above situation warrants a discussion on what strategies we should employ to enhance recycling/recovery activities. While developed or high-income countries can look for high-end technological solutions, developing and low-income countries may not have the ability to afford such solutions [7]. On the other hand, solutions that involve active participation of people (city residents and/or communities) have the potential to be sustainable in all countries irrespective of their economic development, although the return it may bring will be more substantial in the developing countries for several reasons. First, the economic benefits and employment prospects brought by selling recyclables (such as paper, plastics, glass, etc.) or other recoverables (e.g., nutrients through composting, energy through incineration of biogas production) can be significant to developing countries. In addition, active participation of people in such recovery activities also gives another avenue to raise much needed awareness in sustainable waste management.

It is convenient to assume that the logic of economic gains through recycling can attract public attention for such activities. The reality is often a lot more complicated, making it a chicken or the egg type of a dilemma. Public participation supports recycling/recovery activities to prosper, but a prosperous, already-running program is also often needed to convince the hesitant public. Where should we begin? This made us think about cross-disciplinary pollination of ideas and bring two relatively established concepts in the economics and socials sciences through this paper into the realm of waste management, particularly to the recycling/recovery part of it. One is the economic theory of collective action [8]. Collective action is an action performed by a group of people with the goal of enhancing their status while achieving a common objective, which may fit very well with the context of recycling/recovery. The second concept is the Institutional Analysis and Design (IAD) framework that has helped many different disciplines to look at how people collaborate and organize themselves across organizational and state boundaries to manage a common resource [9]. Collaborating and organizing people across organizational and state boundaries is indeed the need of the hour to improve recycling/recovery activities, and hence IAD framework also has something valuable to offer to waste management.

Both of these concepts have been originally proposed to deal with resources. Then the next question is whether we can consider waste a resource or not? Although waste has not been considered a resource traditionally, this thinking is now changing thanks to a combination of reasons, including resource scarcity and gradually increasing awareness in sustainability [3]. Another example for this realization is slow, but gradual transition of our economy into a circular one. As mentioned before, the backbone of a circular economy is the resource recycling/recovery process which involves collection and sorting material and finally converting them to new material or energy or in some cases extracting the nutrients such as in composting. The objective of the research covered in this manuscript is to see how recycling/recovery programs may learn/benefit from the above two concepts. To further this background, we will first discuss the potential applicability of collective action theory in waste management in the next section, and the IAD framework is then introduced as our method of analysis in the section after. IAD framework is then applied to three case studies from three cities, where policy-backed new recycling initiatives took place. A discussion on how these initiatives were able to form collective action, together with our observations, is presented at the end.

2. Collective Action in Waste Management

The collective action theory states that people participate in a process to achieve a goal if their common interests are matched and justified from the economic point of view [8]. It also acknowledges the value of individuals forming groups to make rational choices and self-interest, which can lead to decision-making. Depending on their choices, the outcome can vary, and the group achieves the best results when the members choose to cooperate [10]. This, however, is based on the trust and rational choice of the members paying it off together [11]. Especially, lack of trust between members can lead to the free-rider problem explained by individuals having incentives to "free-ride" on the efforts of others in certain groups [12].

A few previous studies have discussed collective action within the scope of resource use [9,13–17]. Since collective action theory focuses on managing beneficial but finite resources, it has been applied to managing common-pool resources. Common-pool resources are the natural or human-made resource-systems that generate limited quantities of extractable units [9,18]. For example, a fishing ground is a natural common pool resource, and the extractible units comprise of fish, while an irrigation system is a human-made common pool resource, where irrigation water is the extractible unit. Waste that has been treated as a nuisance for a long time is now receiving the recognition of a resource mainly thanks to recycling/recovery. As mentioned before, the attitude towards waste is changing mainly due to resource scarcity and realization of the locked-in material value [4]. Therefore, in our view, waste is also qualified to be a human-made common pool resource as it offers extractable units such as recyclables, energy, or nutrients. Thus, one of the arguments we are making in this research is that waste should also be well qualified to benefit from collective action theory.

Although collective action has not been applied directly to managing waste, existing literature points out at a couple of examples that may enrich our thinking on its potential. Yau [19] presented an empirical analysis of the rational choice of people's behavior in waste recycling and found out that the economic rewards could positively influence the outcome and promote recycling in Hong Kong. In addition, Duit [20] concluded that the institutional arrangement and membership are vital determinants for the environmental collective action on a large scale. Some previous research also implied the importance of human behavior in collective action to reach effective waste management [20,21]. Especially, Nilson and Harring [21] emphasized on making decisions based on the trust between actors, after their research on recycling behavior between individual households and cooperate-level institutions.

Activities involving a mixture of multi-level institutions such as governments, communities, households, corporates, and other civil organizations are also essential parts of waste management and its governance [3]. Collective action, even on a smaller scale of public participation, has the potential to make a significant impact in a larger population [22]. Previous studies involving human activities influencing the ecological systems, that have emphasized on the importance of the stakeholder collaboration, also shed some light on how they may be important to waste management as well [14,23,24]. Fostering any form of collaborative governance in waste management is often challenging due to the top-down hierarchy practiced in many developing countries [25]. This not only adds more challenges for municipality-level waste management but also hinders stakeholder participation in the process [26].

3. Method of Analysis: Institutional Analysis and Development (IAD) Framework

As discussed in Section 2, previous studies have looked at collective action within the scope of resource use. The Institutional Analysis and Development (IAD) framework is another concept that goes in line with collective action and resources management [9]. This framework captures the collective efforts needed in an action situation to overcome the challenges and foster social development [27]. As shown in Figure 1, the variables of baseline identified in the IAD framework are the attributes of the physical world and the community and then the rules in use. These variables provide the flexibility needed when a policy process differs from one society to another. The framework shows how the baseline variables influence the action arena, where individuals and stakeholders make collective choices to produce an outcome [28]. Thus, the framework explains how collective action could be affected by multiple factors derived from physical/cultural attributes and the rules in use during a policy initiative [9,16]. Consideration of how social aspects may affect the collective action of a group or a community, allows us to scale up the same collective action into a different stakeholder collaboration. With these strengths, the IAD framework can show us how multi-level institutional arrangements are interacting to make action choices between groups of actors to achieve a policy goal.
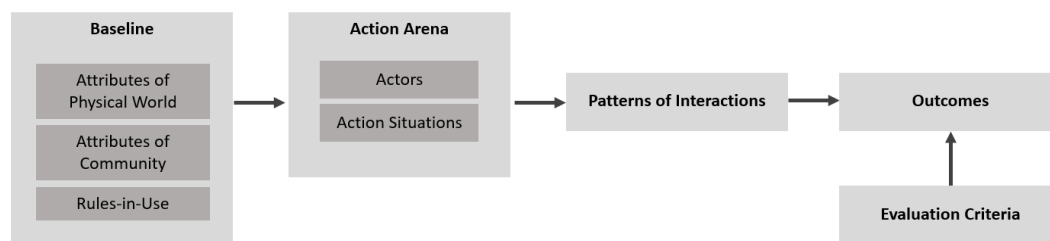
Figure 1. Institutional Analysis and Development (IAD) framework [9].

While previous literature has mainly looked at the IAD framework as a tool to analyze institutional aspects in resource management, some studies have also suggested its value in understanding the collaborations between stakeholders [29–34]. The framework also considers how the actors can make decisions during the process to make the policy outcome available, which can then be applied to examine the challenges in social aspects such as in the case of waste management. In this context, we make our second argument to state that the IAD framework is qualified to analyze recycling/recovery policy initiatives. Hence, it was used as the method analysis for this research. The IAD framework that we customized for the above purpose is presented in Figure 2.
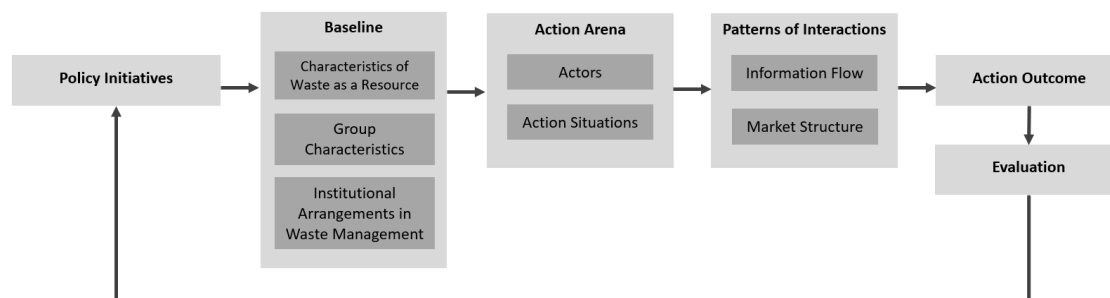

Figure 2. Customized IAD framework for waste management.

The IAD framework shown in Figure 2 comprises five stages, including one pre-step of "Policy Initiatives" to recognize the new waste management policy initiative being considered. There is also a feedback loop returning to the policy initiation (originating from the outcome/evaluation stage), to instill the flexibility for continuous improvement. Although the original IAD framework (Figure 1) did not have such a feedback loop, subsequent versions incorporated it [16,28,35]. We believe any alterations based on such feedback can be useful for recycling/recovery programs, alike.

The second stage is the "Baseline" of variables that influence policy implementation. As per the literature, the three categories of factors we identified based on the IAD framework in the baseline are: characteristics of waste as a resource, group characteristics, and institutional arrangements [36]. The resource characteristics are the physical aspects of resource which need collective action for its improved use. Group characteristics affect the level of collective action with social characters such as social capital and socioeconomic status. The third category, institutional arrangements represents the requirements of governance and rules in both formal and informal ways [16]. In a nutshell, the baseline provides all aspects of the physical and social environment.

The core part of the framework, where actors make decisions is the third stage—"Action Arena," which includes all actors who may have different, sometimes conflicting, interests, and action situations. Actors can be individuals forming groups, and the action situations are their interactions that generate an outcome. This stage can also involve groups of actors with unified interests. Followed by the action arena, the "Patterns of Interaction" stage influences more on the participation to take actions by the market structures and information flows, which can finally form the level of participation in the stage of "Action Outcome" [37]. These outcomes can be evaluated by patterns of interaction to measure efficiency [16]. The process may continue after "Evaluation" in case the feedback is taken

into consideration for possible modification to the policy. The framework may be applied to waste management in different contexts, with varying social structures.

4. The Cases: Curitiba in Brazil, Padang in Indonesia, and Akure in Nigeria

Brazil, Indonesia, and Nigeria are among the seven most populated countries in the world [38]. They are also characterized as emerging economies with rapidly growing urban populations [39]. For this study, we selected one city from each country: Curitiba in Brazil, Padang in Indonesia, and Akure in Nigeria. It must be mentioned that these three cities are neither the capital nor the most populated cities in their respective countries. The main reason for selecting these three cities is that they all went through some forms of waste management policy changes, followed by the initiation of recycling/recovery programs in the past. In the cases of Akure and Padang, these programs were implemented about 10–15 years ago; in the case of Curitiba, it was about 20–30 years ago. This context and data availability in the published literature provided us with a fair basis for making comparisons and observations that may be important to many other cities in the world.

The socio-economic data and waste-relevant information for Brazil, Indonesia, and Nigeria are presented in Table 1. While we will use data from the relevant periods in the subsequent discussions and analysis, data in Table 1 are mostly current (socio-economic part) or the latest complete set available (waste-related part) and presented for the sole purpose of giving a better contemporary perspective. As per this information, Brazil is an upper-middle-income country with a GDP per capita of USD 8920 and a total population of 209 million [40]. Brazil is also the fifth largest waste-producing country in the world, and with the growing consumption, the population has a high per capita waste generation rate [41]. Noticeably, the waste collection rate is at an impressive 90%, but the recycling rate remains low [42]. The second country in this analysis—Indonesia is a lower-middle-income country with GDP per capita USD 3894 and a total population of 268 million [43]. Nigeria, which is the most populous country in Africa, is also another lower-middle-income country like Indonesia, but its per capita GDP is about half of Indonesia to remain at USD 2028 [44]. The population of Nigeria is 196 million and has a high 2.61% population growth rate [44].

Table 1. Country/Waste Overview for Brazil, Indonesia, and Nigeria.

	Indicators	Brazil	Indonesia	Nigeria
Country Overview (2018)	GDP (Billion US$) [45]	1868.6	1042.2	397.3
	GDP per capita (US$)	8920.8	3893.6	2028.2
	GNI per capita (US$) [40,43,44]	9140	3840	1960
	Population, total (millions)	209	268	196
	Population growth (annual %) [45]	0.8	1.1	2.6
	Land area (sq. km) [45]	8,358,140	1,811,570	910,770
Waste (2009–2012) [41]	Municipal Solid Waste generation (t/yr)	62,730,096	59,100,000	25,000,000
	Generation per capita (kg/yr)	383.2	255	153.9
	Recycling Rate (%)	1	6.5	-
	Collection Coverage (%)	89.7	69	60
	Unsound Disposal (%)	42.02	25	100
	Waste Intensive Consumption (kg/$)	0.04	0.12	-

The waste management policy changes and the recycling/recovery programs initiated by each city are briefly introduced in the next few subsections.

4.1. Curitiba, Brazil

Curitiba is the capital city of the state of Paraná (Figure 3). Although the initial urban planning dates to the 1960s, incorporation of sustainable development into their planning model was not recognized until recently [46]. Curitiba initiated more steps in improving waste management in the 1990s when it grew in population as a result of a massive influx of migrants [47]. In 1991 the population

was recorded as 1,315,000 [48]. One major issue was littering, especially by the informal settlers who dumped waste into the rivers and other bodies of water [49]. The city launched three recycling/recovery initiatives that included elements of collective action: First, "Waste that is not waste" and "Waste Purchase Program" in 1989 and then later in 1991, the "Green Exchange Program," especially focused on the low-income neighborhoods [49].
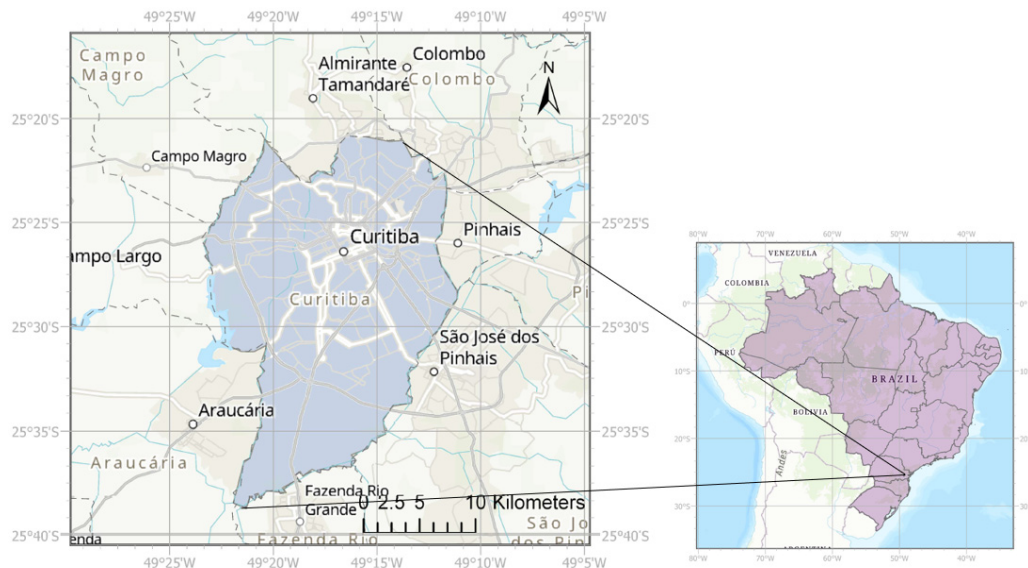

Figure 3. Relative location of Curitiba in Brazil (Geospatial data from GADM version 2.8; ArcGIS).

The objective of the "Waste that is Not Waste," which covered the whole municipality region, was to collect the recyclables from households and to hold residents responsible for separating the types of recycling [50]. "Waste Purchase Program," on the other hand, aimed at increasing the waste collection in the areas where socially marginalized people live (in the informal settlements) by compensating for the waste they collected [49]. Lastly, the "Green Exchange Program" was launched targeting the people in low-income groups. This program offered a bag of vegetables and fruits for every four kilograms of recyclables the participants brought in, as an incentive to promote waste reduction and increase recycling in the low-income neighborhoods [51].

It is also important to note the role of the informal sector in the waste collection and recycling in Curitiba. In 1999, a group of informal Catadores, i.e., the waste pickers, formed Movimento Nacional dos Catadores de Materiais Recicláveis (MNCR) to initiate collective action recycling networks [52]. The municipal government supported MNCR, especially with equipment, to carry out their waste management actions. Nowadays, Catadores have modernized their collection activities by adopting a real-time mobile-based application to locate recyclables in their neighborhoods [53].

4.2. Padang, Indonesia

With the introduction of regulation UU No. 18/2008, in 2008, the Indonesian government initiated many recycling/recovery programs to reduce waste in the nation [54]. One of the programs which received public attention was an attempt to instill collective action through a Solid Waste Bank (SWB)—a place where people gather their waste to sort organic for composting, non-organic for recycling, and the un-recyclables for landfilling [55]. Padang city (Figure 4), with a population of 833,600 (in 2010), implemented a total of 29 SWBs since 2010 [54,56]. SWB program was a good example of putting collective action theory into practice to improve waste collection and recycling [55]. However, the volume processed by the 29 SWBs stayed at a very low amount (319 kg/day) which was only 0.05% of the total MSW produced by the city [54,56]. Early efforts in Indonesia to make Reduce-Reuse-Recycle (3R) popular failed due to low public participation [54]. Although the volumes

recycled were not impressive, the SWB approach was able to change these dynamics and increase awareness within communities [55]. SWBs earned revenue by selling the recyclable to the industries. The state government-mandated industries to contribute to this effort through Extended Producer Responsibility (EPR) schemes introduced for some products [57].
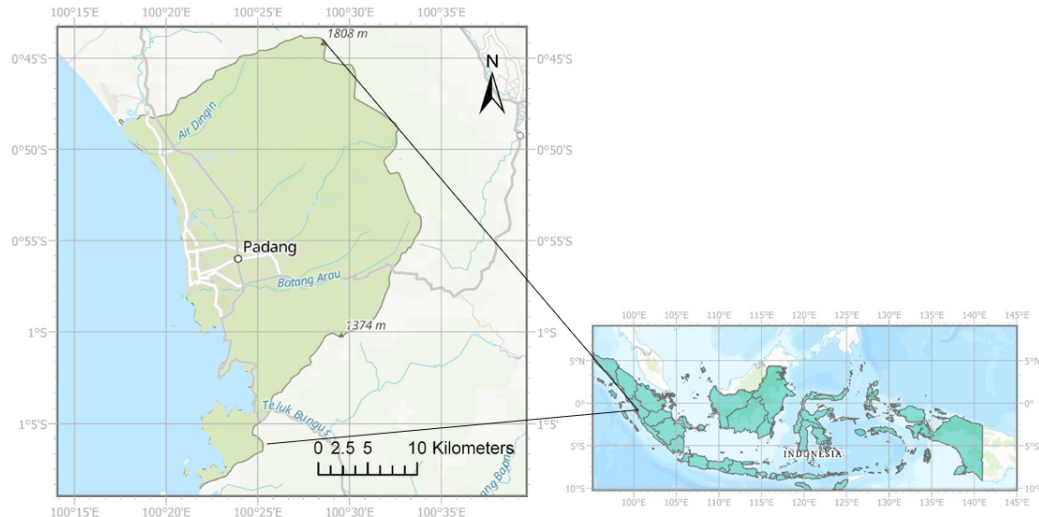

Figure 4. Relative location of Padang city in Indonesia (Geospatial data from GADM version 2.8; ArcGIS).

4.3. Akure, Nigeria

Akure is the capital city of Ondo State in Nigeria (Figure 5). The population of Akure has been growing steadily due to mass migration from nearby rural areas [58]. Traditionally, the public used to perceive waste management as a service they should receive from the government [59]. However, due to limited government involvement in waste management, uncontrolled and unregulated dumping of waste in public places, such as roads, drainage channels, rivers, and vacant lands, had been commonplace throughout the country, including Akure [60]. If there was any recycling, it was mainly conducted by the informal sector (i.e., waste pickers) which has been marginalized within the Nigerian society [26]. As a reaction to the recognition of environmental issues caused by the growing illegal waste dumps, Ondo State implemented a program called Ondo State Integrated Waste Recycling and Treatment Project (OSIWRTP) in 2006 with the capital city, Akure as the center-focus [61]. At that time, the city recorded a total population of 369,700 [62]. Ondo State Waste Management Board, which is considered as one of the few innovative government-led programs in Nigeria, was established to run the project and to deal with waste management issues [61]. In addition to the main objective of giving a collective action premise to encourage people to participate in the recycling process, the program also included fostering recycling markets, and government bodies collaborating with the private sector to handle solid waste [61]. The project started with 84 trained staff members to sort the solid waste into organics, plastic and metals and involved other "waste to wealth" awareness activities [63]. The government facilitated the recyclable materials collected from OSIWRTP sites to be sold to private enterprises dealing with scraps and recycled materials [61].
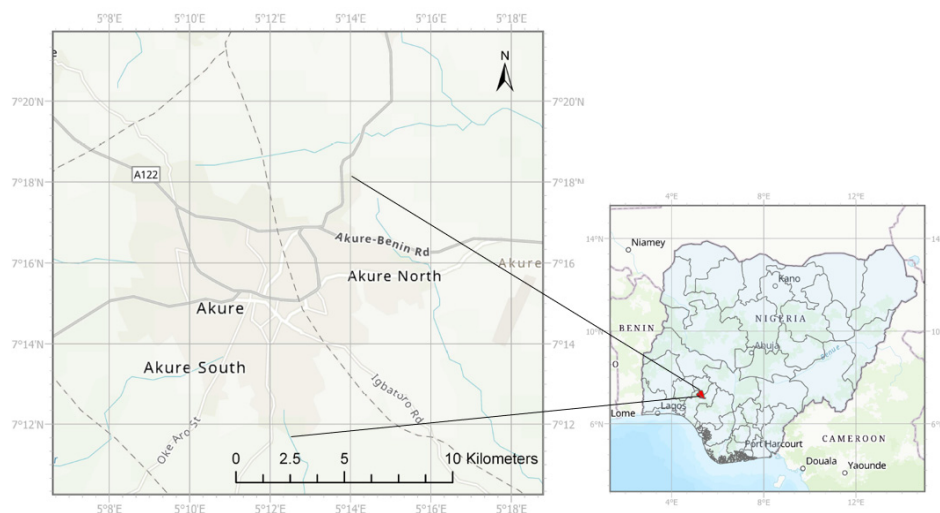
Figure 5. Relative location of Akure in Nigeria (Geospatial data from GADM version 2.8; ArcGIS).

5. Application of the IAD Framework to the Case Studies

Waste management-related information from Curitiba in Brazil, Padang in Indonesia, and Akure in Nigeria were streamlined using the customized IAD framework presented in Figure 2. For the ease of comparison, this information is summarized in Table 2. Column 1 of Table 2 indicates all stages of the framework in 5 (major) rows, along with the information pertaining to each city listed in the next three columns.

Ideally, the application of the IAD framework to a policy initiative should happen prior to or during its implementation, in order to allow actors to organize the information flow in the best possible way and give the opportunity to make any necessary corrections. However, since the cases we discuss here took place years ago, the application of the IAD framework only allows for a comparative study. A re-creation of a situation years after it happened, obviously faces the challenge of not having access to all necessary information. Therefore, it must be noted that the study we present below is only approximate and qualitative, but it still leads to some useful observations. A short discussion on how information was streamlined in each stage of the customized IAD framework is provided below.

5.1. Policy Initiatives

Policy initiatives and reforms made in all three cities as already discussed in Section 4 when we introduced the three cases. Hence, it is not repeated here.

5.2. Baseline

Although the three cities were different from each other, based on the social and institutional contexts, as a baseline, they also share similar characteristics. High organic content in municipal solid waste (MSW) was one of the characteristics they shared. While the 1990s organic fraction specifically for Curitiba is not available, the country average in 1990 was 52% [64]. Waste from Padang reported over 65% organic waste between 2005–2009 [65]. Although organic fraction for Akure has not been published in the literature, a feasibility study conducted in 2004 revealed that the average value for the country could have been as high as 80% [61]. The recyclable percentages for Brazil (country average), Padang City (based on domestic waste), and Nigeria (country average) for the same periods were about 31%, 20%, and 16% respectively [61,64,65]. These relatively lower percentage of recyclables are often seen in the developing economies because the material output (waste including recyclables) is much lower compared to the input into the economy while a country is in the development phase [66]. All three cities presented broadly unique character in terms of culture, history, and heritage. In Curitiba, Brazil, social inequality caused waste management in marginalized neighborhoods to be neglected [67].

Moreover, the individualistic culture in society was known to slow down efforts to form collective actions. Nonetheless, the socioeconomic standard for citizens in Brazil is relatively higher than in the other two countries. In Padang, Indonesia, their culture is more open to collective actions and supports participatory action through community-based programs [68,69]. Social culture in Nigeria shows some religious and ethnic heterogeneity in general. Previous research has also highlighted the negative influence that the colonial history of Akure has made on their society towards the attitude on collaboration [70,71]. The public perception in Nigeria, in general, was uniquely different from the other two countries, where residents expected waste management to be a public service that should be provided to them by the government [72,73].

The institutional arrangements within waste management governance were slightly different between the three cities. Notably, the cities in Brazil have more flexibility in policy execution due to decentralized city-led governance compared to the top-down governance structure in Indonesia and Nigeria. The decentralized urban planning in Brazil gave some flexibility for the city of Curitiba to set an effective strategy to introduce new policy programs. As the central government in Indonesia already plays a substantial role in waste management, Padang city introduced new policies to take the collaborations to a higher level to initiate interactions between communities and local governments. On the other hand, in the Ondo State of Nigeria, the state government took the matters into their own hand and introduced new policy programs covering the whole state, including our case in Akure. Followed by the polycentric structure in the governance, the approach employed in policy implementation was also different. In Curitiba, Brazil, the policy implementation was conducted at the municipality-level, while in Padang, Indonesia, it was handled by the highly motivated central government, but with a focus on community-level participation. The case from Nigeria shows that the central level of initiative in Akure city to improve waste management was controlled entirely by the state government.

5.3. Action Arena and Patterns of Flow

Action arena is where actors are involved in the action situation to make choices regarding their actions. The Patterns of Flow decides how the policy information flows in society to make actions and how it enables them to recover/recycle by the market structure. Role of the governance structure (centralized versus decentralized) in the institutional arrangements we discussed above also played an influential role in the Action Arena and Patterns of Flow in all three cases: Curitiba, Brazil to be decentralized, Padang, Indonesia and Akure, Nigeria to be relatively centralized. Particularly in the Curitiba case from Brazil, initiatives to bring more participation from different stakeholders were entirely started by the city [49]. Padang and Akure, on the other hand, had constraints limiting stakeholders' cooperation, mainly owing to the involvement of the central and local governments in decisions and finances.

The common finding in the action arena was the prominent role of the informal sector in recycling/recovery, which is usually the case in most developing countries [3]. This is a crucial part to consider in forming collaborations between actors. Recognizing this importance, the Brazilian government supported the waste pickers associations to take part in the process of filling the gaps in their waste management system. Moreover, recent technological advances such as smartphone apps have given a new space for the informal sector to improve participation through effective communication and develop better business models.

Followed by the action situation between stakeholders, it was also observed in all three cases, that the economic incentives by the market structure were being employed to promote the participation of low-income households. Indonesia's EPR agreement with industry participation was especially seen as an innovative approach.

5.4. Outcome and Evaluation

In Curitiba, the programs helped the city to increase public participation in recycling, especially in marginalized neighborhoods [49]. Participation reached about 70% in waste separation, collection, and recycling [74]. The same programs also fostered collaboration between the city and community-level associations. Curitiba received numerous recognitions for these initiatives, including the Global Sustainable City Award in 2010 and the Global Green City Award in 2012 by the United Nations Environment Programme [46].

In the case of Padang, the central government continued to maintain the responsibility for technical assistance, EPR, and monitoring and evaluating of SWB operation while the contribution from the local government to SWBs was not fully integrated [54,75]. Although the national target of recycling/recovery was set at 20%, Padang city SWBs have only achieved 5.5% (as of 2014), possibly due to this lack of integration of roles between the central and state governments [54].

In the case of Akure, we were not able to find any statistics in the literature to make comments on how public participation in waste management changed with the introduction of the new programs. However, the role of government in forming a system to draw collective action in waste recycling through both public-private participation, in this case, was admirable. The Akure case created space not only for job opportunities but also for the recognition of the informal sector [61].

For all cases, we were also not able to find if there were any periodic evaluations of the policies or if any amendments were made to the policies based on any such monitoring/evaluation results.

Table 2. Summary of the information streamlined using the customized IAD Framework.

Stages in the Customized IAD Framework		Cases Analyzed		
		Curitiba (Brazil)	Padang (Indonesia)	Akure (Nigeria)
1. Policy Initiatives	*Waste Management Policy Program*	· Waste that is not waste program (1989) · Waste purchase program (1989) · Green exchange program (1991)	· Solid Waste Bank (SWB) Program (2008)	· Ondo State Integrated Waste Recycling and Treatment Project (OSIWRTP) (2006)
2. Baseline	*Characteristics of Waste as a Resource*	· Organic fraction 52% · Recyclables 31%	· Organic fraction 65% · Recyclables 20%	· Organic fraction 80% · Recyclables 16%
	Group Characteristics	· Waste not seen as a resource · Individualism culture · Low public awareness · Upper-Middle Income [76]	· Waste not seen as a resource · Collectivism culture · Low public awareness · Lower-Middle Income [76]	· Waste not seen as a resource · Merged heterogeneous society · Low public awareness · Lower-Middle Income [76]
	Institutional Arrangements	· Decentralized governance · The city oversees/controls waste management with support from local communities · Focus went beyond recycling to on environmental risk awareness [49]	· Top-down governance · The central government controls waste management with support from local communities and local government · Focus on recycling [54]	· Top-down governance · The state government leads to waste management with private sector involvement · Focus on waste-to-wealth awareness [61]
3. Action Arena	*Actors*	· National Municipal Secretary of Environment (local branch of the national government to follow-up on the policy) [49]	· National Ministry of Environment (policy execution, technical assistance, arranging EPR) [54]	· Central and State Governments (technical and financial assistance) [61]

Table 2. *Cont.*

Stages in the Customized IAD Framework		Cases Analyzed		
		Curitiba (Brazil)	Padang (Indonesia)	Akure (Nigeria)
3. Action Arena	Actors	· Curitiba Municipality (overseeing waste management) · Curitiba Public Cleansing Department (coordinates daily waste management operation) [50]	· Padang City Government (technical assistance, training, monitoring, and evaluation) [54]	· Akure City Government (limited involvement in waste management, but plays an important role in planning) [61]
		· Industry (limited involvement)	· Industry (collaborates with the government on EPR) [54]	· Industry (limited involvement)
		· Waste pickers association (formed and supported by the governments) [1]	· Community cooperatives (formed together with SWBs and operates daily)	· Waste pickers not formally organized as an association
		· Informal actors (Catadores takes a role in collecting recyclables)	· Informal actors (Significant role by scavengers, waste pickers, itinerant buyers)	· Informal actors (Significant role by scavengers, waste pickers, itinerant buyers)
		· City residents	· City residents	· City residents
	Action Situation	· City residents participate in the programs initiated by the municipality. · Catadores actively participate in waste management. · Grassroots group MNCR formed recycling networks of Catadore at the state. [49]	· The community contributes to public awareness and recycling activities, resulted from the government initiative. · SWBs enabled communities to participate and get compensated for recycling.	· Public participation in waste management is limited; public views waste management to be a service given to them by the governments. · Failure of local management forced the state level to implement waste management. [77]
4. Patterns of Flow	Market Structure	· Economic value for waste in recycling. [49]	· Economic value for waste in recycling and private sector involvement with EPR. [54]	· Economic value for waste in recycling enhanced by private sector participation. [61]
	Information Flow	· Local government and decentralized approach. · Community-based information flow. · Technology adapted to access information.	· Central led top-down approach. · Community-based information flow.	· Central led top-down program and support with private sector involvement.
5. Action Outcome	Outcome in Waste Management	· The participation of the marginalized social groups in waste management increased. · Participation in waste separation, collection, and recycling reached about 70%. · Collaboration between local governments and the communities increased and became efficient.	· Public participation in waste recycling increased but did not reach the target (Padang city SWBs have only achieved 5.5% while the national target for recycling/recovery was 20%). · Central government operation has limitations in managing local community-level waste management, possibly due to the lack of integration of roles between the central and state governments.	· Data are not available to make comments on how public participation in waste management changed with the introduction of the new programs. · The government's role in forming a system to improve collective action, the inclusion of the informal sector, and job creation in waste recycling through public-private participation was admirable.

6. Discussion

During our analysis of the three cases from Brazil, Indonesia, and Nigeria, we were able to make some observations and conclusions on the applicability of collective action in recycling/recovery as

well as the suitability of the IAD framework to analyze such action. The basic logic in collective action theory of people's motivation to "participate in a process to achieve a goal, if their common interests are matched and justified from an economic point of view," is proven to be applicable to recycling/recovery as well. Although many of us wish to support sustainable waste management for environmental reasons, perhaps it is not the most substantial reason to unite people for achieving a common goal: people often expect a reason that goes beyond the goodwill. A goal, which offers a tangible economic benefit upon reaching it, certainly sounds attractive to many. This obviously has worked in low-income neighborhoods or unplanned settlements with little to no waste infrastructure, such as the ones explained in the case from Curitiba [49]. Aligning recycling/recovery with economic gain also helps to look for the correct business model for waste management activities. This is particularly important in the backdrop of literature pointing at many failed composting projects due to the lack of a sound business model [7].

IAD framework facilitated the function of a concept map to streamline information towards action outcomes in each policy involving stakeholders. Since we looked at more than one case, the framework also gave us an opportunity to compare the cases and arrive at some conclusions logically. The increased public participation and improved recycling were observed, in general, and these initiatives are still valued as it is rarely seen in many developing countries. In the case of Akure, it went above and beyond by creating new jobs as well. The comparison of outcomes also offers some conclusions about the efficiency of the government structures they employed. While the decentralized structure made the implementation more efficient in Curitiba, Padang and Akure suffered some setbacks due to the lack of it. As pointed out before, this exercise was only an attempt to conduct a comparative study based on limited information. However, the observations were still clear enough to suggest that the IAD framework can be a beneficial tool not only to arrange/screen information, but also to understand the social process of policy implementation. IAD framework also showed the extent of the actors' involvement based on the trust and rational choice to form collective action, during the implementation stage of those recycling/recovery initiatives.

A feedback loop in the IAD framework in Figure 2 is an essential element that supports the initiative to make continuous improvements through policy reformation allowing society to develop through a repeated process. However, our analysis did not benefit from it due to the limited information. The literature on all three cases did not report any information, even years after, on making further changes based on any outcome they received. This made us conclude that, perhaps, such improvements were not made at all. If true, disregarding the opportunity to allow for any future enhancements indeed shows a weakness in the planning of the policy initiatives in all three cases. Such discontinuity has been often found in development programs due to many reasons such as the changes in the political leadership or availability of financial resources. On a positive note, this should become a valuable lesson for future recycling/recovery initiatives in other cities in order to promote further development into societies participating in collective action.

All three cases shared a common public sentiment/perception towards waste: in general, in all three cities, waste was not viewed as a potential resource. The majority saw waste only as a nuisance, mainly due to the visible environmental damage created by the mismanagement of waste. This attitude was perhaps the main reason for low recycling/recovery rates reported in all three cities. It is not easy to attract the public's attention to something that has only a negative connotation and has no apparent value. The only exception is in the informal sector that has already made their livelihood out of the recyclables in waste. Interestingly, the best model to prove the economic justification needed to form collective action is already provided by the informal sector, in a rudimentary way. In fact, this also shows how important it is to involve the informal sector in any new recycling/recovery initiatives.

To gain public attention, collective action in recycling/recovery needs to happen on a more organized scale and should be supplemented by local education and awareness-raising campaigns. These activities should also extend beyond the typical norms of waste-pickers' recycling to include other things such as the recovery of nutrients (compost) and energy (through biogas or incineration).

In this sense, all three cities did accommodate some elements of awareness-raising into the programs they initiated [49,54,61]. In the case of Padang and Akure, there was awareness-raising for their recycling programs (or waste-to-wealth), and in Curitiba, it also included environmental risks.

7. Conclusions

This research focused on how recycling/recovery programs may benefit from two relatively established concepts in the economic and social sciences that were originally used for managing natural resources: one is the theory of collective action, and the other is the Institutional Analysis and Development (IAD) framework. The following conclusions and observations were made after a qualitative comparative study of the three cases from Curitiba, Brazil, Padang, Indonesia, and Akure, Nigeria, using the above concepts.

The theory of collective action can be applied to recycling/recovery initiatives. The precondition of having an economic justification for forming collective action is not a barrier to applying it towards recycling/recovery efforts as it brings local economic benefits. These benefits serve as a strong reason that unites communities in achieving a common goal. As seen in the case study from Curitiba, Brazil, the economic outcome has worked well in promoting recycling/recovery in low-income neighborhoods or unplanned settlements that have limited waste infrastructure. The study also revealed that the IAD framework works as an efficient tool to streamline information and arrive at a logical action-outcome for recycling/recovery policy initiatives. The cases also revealed that monitoring/evaluation could have been an opportunity to collect feedback to take corrective measures to improve the recycling/recovery initiatives through the years. Decentralized governance offers more flexibility to succeed in a recycle/recovery initiative, as seen in the Curitiba, Brazil case. It was also evident that the role of an intermediary as a platform, such as the ones observed in Padang, Indonesia and Akure, Nigeria, could play an essential role in improving the communication needed to sustain collective action. In line with stakeholder partnerships, resource limitations could overcome through public-private partnerships.

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