

Looking For Value In Garbage: Intervention In Domestic Solid Waste Management

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Abstract: The objective was to determine the effects of the intervention in the management of domestic solid waste for reuse, with the aim of reducing the environmental impact in the district of Los Olivos. The approach was quantitative, descriptive, quasi-experimental design. The population consisted of 40 families from a condominium in the north of Lima who were trained with 12 educational sessions on solid waste management. The participatory mechanism used was the intervention of a program that managed the reuse of domestic solid waste, which involved citizen participation in the municipal waste management process in order to reduce environmental impact and improve citizen awareness. The instrument used was an 11 question questionnaire on the level of knowledge about solid waste that it categorizes as adequate, moderately adequate and inadequate. Likewise, for the collection indicators, information from the SIGERSOL 2017 system was used, based on current regulations (paper, plastics, glass, and organic waste). The data collection techniques were direct observation and survey, respecting ethical considerations. The results demonstrated the effects of educational intervention in the management of domestic solid waste, and serves as a sustainable cooperation strategy within municipal environmental policies. It is concluded that the educational intervention plays a predominant role in the creation of responsibility, conscience and commitment of the citizens, thus developing a culture of care of the environment in the community. Hence the importance of educating and promoting good practices in the management of domestic solid waste to preserve the environment and improve the quality of life of the community.

Index Terms: waste, domestic, recycling, waste, reuse, solids, value.

1. INTRODUCTION

Domestic solid waste management is a challenge to preserve the quality of life of the human species and the environment; according to World Bank estimates, solid waste generation at the municipal level is expected to double by 2025[1]. The main causes of urban pollution from solid waste generation are population growth, economic growth, rapid urbanization and improved quality of life in communities [2][3]. Triggering factors are rising per capita income and high urbanization, which accelerates the accumulation of solid waste. In the early 1990s, some 2.9 billion people lived in cities, generating 0.64 kg. of municipal solid waste per person per day (680 million tons per year). In 2012, 1.2 kg. of waste per person was generated (equivalent to 1.3 billion tons per year) and these quantities are expected to double by 2025, as the number of urban residents is expected to be 4.3 billion, producing an average of 1.42 billion tons of waste per capita per day, equivalent to 2.2 billion tons per year [4]. In the specific context of Peru, per capita generation is 0.75 kg of urban solid waste per day. At the national level, the coverage of waste collection services reached 71.9% in 2010 (PAHO, 2010). The collected waste has a final disposal of 43.5% in sanitary landfills, 10.6% in controlled landfills, 45.3% in open-air landfills, 0.6% are incinerated in the open air, and a percentage close to 0% has another disposal (bodies of water, feed, etc.)[5]. Solid waste management is a challenge for urban managers in developing countries due to increased waste generation. The burden associated with waste management in the municipal budget is a reflection of high management costs, but above all the misunderstanding of the diversity of factors affecting the different stages of waste management and the interaction between them, which is necessary for the proper management of the functioning of the entire system [6]. On the other hand, the very conception of solid urban waste management mechanisms applied in Peru is deficient and reduced because it does not include all the actors involved in this process. If we take into account that the generation of a healthy environment is a common good, it is not possible to delegate its production to a single actor in the process, as is the case in most cases where the State, through the municipal governments where they manage the

collection, treatment and disposal of solid waste [7]. Faced with this situation, the intervention proposed the application of selective collection and reuse of domestic solid waste. This mechanism presents as one of the main advantages: the high degree of recycling of domestic solid waste, the high degree of involvement of citizens by their role in the selection of their own waste and the possibility of reusing them for themselves. The recovery of recycled waste allows the generation of sustainable economic activities and the financing of the collection, treatment and disposal services of domestic solid waste managed by the Municipality, reducing the tax burden for citizens participating in this program. To this end, cooperative strategies are considered within the economies of countries that demonstrate effective and sustainable management with a participatory character [8]. It is important to share and understand the experiences of other developing countries that have similar difficulties in the management of domestic solid waste recycling and that propose programs to reduce, reuse and recycle, as detailed below. At the international level, as in Thailand's capital, Bangkok, a programme of segregation at source is being implemented for the management of domestic solid waste. As in most developing countries, there is a lack of infrastructure and technology for household waste management within each municipality. They also reported from their experience that out of a total of 27 m. of solid waste, garbage generation per capita is 1.14 kg. a very high amount compared to other middle-income countries (0.79 kg. per capita). Landfills and open-air landfills are the most common methods of disposing of solid waste, but they have a large environmental impact in terms of air, water and soil pollution, as well as contributing to climate change. Due to the lack of political will to invest in infrastructure for recycling, most of the mechanisms operating in Thailand do so in the informal sector (segregators, collectors, waste shops for recycling), so the recycling rate remains low at around 21%. The programme included various mechanisms, such as the implementation of the 3Rs, recycling, reducing and reusing improved waste collection system and participatory solid waste management. However, low levels of citizen participation in waste sorting at source and a lower willingness to pay for municipal waste

management services were found, resulting in a Pearson correlation of 0.103 [8]. The experience developed in the Czech Republic, solid waste management is based on the selection of household waste, in which each family deposits its waste in containers assigned to each type of segregation within the municipality. The collection involves the application of established schedules and citizens are trained in the selection of waste and in the use of containers. Depending on the municipal budget, some cities use disposable bags for the collection of each family's waste, instead of containers, as this system requires less investment for both operation and maintenance. Information on waste volumes is managed by CENIA (Czech Environmental Information Agency). Mechanisms to encourage the selection of household waste include the application of reverse PAYT and standard PAYT and the differentiation of taxes according to the degree of recycling. The application of incentives increases the selection at source by 9.3% with respect to municipalities that do not apply incentives [9]. In this context, in Ghana, the willingness of households to participate in economic incentives for solid waste sorting is proportional to income level ($p=0.9280$). Empirical results from the Owusu study (2013) indicate that willingness to participate in such mechanisms is influenced by gender (female) and about 80% of households were willing to participate in exchange for economic incentives (US\$ 1,6347 per h-h per month). With respect to the solid waste management system present in this country, we found a prevalence of open-air landfills in which waste is not treated for final disposal, as in most sub-Saharan African countries. Accra, the capital of Ghana, and Kumasi, the second city with a combined population of 4 million, generate a total of 3,000 tonnes of solid waste per day. Kumasi has one of the best solid waste management systems, as 70% of the waste is transported to a recycling centre on the outskirts of the city. This study also points out the advantages of promoting the selection of solid waste at source, which facilitates recycling and the valuation of it's by products in the market [10]. At the national level, Rentería and Zeballos proposed an improvement proposal for the strategic management of the Segregation Programme at the source and selective collection of solid residential waste in the district of Los Olivos. In this research, they emphasize that the management of domestic solid waste lies in the reduction of solid waste that is taken to sanitary landfills so that, instead, it can be reused for environmental, social, and economic purposes. The program comprised two of the proposed four stages, i.e. generation and source segregation [11].

2 METHODOLOGY

The study was of applied type, [12], non-experimental transectional design and descriptive [13, 14]. According to the 2014 census, the population of the Los Olivos district was 365,900 (INEI) [15]. The sample consisted of 40 families who received training in door-to-door selective collection. The families participated in the training program on a voluntary basis. The training took place in the home on the management of domestic solid waste, so the criteria for selecting the participants was their permanent residence in the district of Los Olivos, within a condominium and that the members be minimum 4, maximum 6, during the period 2018. The data collection techniques were direct observation and the survey on a weekly basis, for which 12 results were obtained. Direct observation for the quantification of some indicators related to

technical feasibility, i.e. if this intervention works from department to department or if it should be a mandatory program issued by the municipality or a government regulation to minimize the generation of solid waste, and the economic viability within the family environment, accompanied by a bibliographic analysis of the theoretical and practical background, in order to know the state of the art. The instrument used was an inventory of collection indicators used by the Peruvian Ministry of Environment (MINAM) to measure the reduction and reuse of volumes of paper, cardboard, glass, metal, plastics, and organic waste. And these indicators are those required in the Intervention Program proposed by the researchers. They also meet the requirements of the Peruvian system's solid waste information system. This instrument responds to the needs of SIGERSOL 2017, based on current regulations. The Integral Solid Waste Management Law (Legislative Decree No. 1278) and its Regulations (approved by Supreme Decree No. 014 - 2017 - MINAM) require provincial and district municipalities to provide information on solid waste management and management at the Los Olivos municipal level [16] For the application of the instrument, each family received informed consent to participate in the research. The application of the survey was carried out house by house following the principles of Álvarez and the application of the instrument lasted approximately 30 minutes per family [17]. The data were entered into a database designed in Excel, the results were analyzed in the statistical program SPSS version 26, to describe the amount of domestic solid waste

3 RESULTS

This section details the 12 sessions as part of the intervention program, which took place over a period of three months, with one weekly visit, generating 4 visits in one month. The level of knowledge was measured through a family survey. This survey consisted of 11 questions, on the knowledge of domestic solid waste, taken from the thesis of Matthew (2016) [18], some indicated that are things that pollute the environment others, which are materials that are useless for nothing and others that are domestic garbage. Likewise, the importance of being informed about waste, they stated that it was to protect the environment, others to avoid diseases, others to have presentable and pleasant environments, others that all the options are correct, a third question was about whether they should be classified before eliminating them, some mentioned that others that they should not, but to the specific question that type of waste we commonly generate, the answers varied from simple to complex, dangerous, simple, costly, organic and inorganic. Then when asked specifically about what organic waste is, they mentioned that it is food waste, fruit waste, plastic waste, glass, wood, paper, any kind of waste, wire waste and or iron in any case. Some considered that the steps to be taken to improve household waste was to select and eliminate everything, others to collect, classify and eliminate, although there is the possibility of reducing, reusing and recycling. Considering recycling as a dangerous activity, an activity that consists of collecting garbage, or an activity that allows the reuse of solid waste after its transformation into another product. To do this, it must be collected in any container, disposed of in different containers according to its origin, and to the final question about what the remains of food or fruit are used for, the answers varied from feeding the animals that raise others to making organic compost and others for nothing. The results

were rated with 2 points each of which was established a rating between less or equal to 8 inadequate, 10 to 14, moderately adequate and 16 to 22 adequate, the results are detailed in three subsequent tables.

Table 1: Households' level of knowledge about domestic solid waste

Educational intervention	EDUCATIONAL SESSIONS							
	1era		2da		3era		4to	
Adequate	12	30%	14	35	16	40%	17	42.5%
Medianly adequate	12	30%	11	27.5	12	30%	11	27.5%
Inadequate	16	40%	15	37.5%	12	30%	12	30%
total	40	100%	40	100	40	100%	40	100

Table 1 shows that families after having received the 4 educational sessions reached adequate levels of knowledge from 30% to 42.5%. Likewise, those who started with 40% in the inadequate level lowered the percentage to 30%, which indicates that there are improvement changes after the first 4 sessions developed in the month. It highlights the position of the families that have the moderately adequate level, who are maintained as a percentage in this first stage.

Table 2: Households' level of knowledge about domestic solid waste

Educational intervention	EDUCATIONAL SESSIONS							
	5°		6°		7°		8°	
Adequate	20	50%	20	50%	20	50%	21	52.5%
Medianly adequate	10	25%	12	30%	14	35%	14	35%
Inadequate	10	25%	8	20%	6	15%	5	12.5%
total	40	100	40	100	40	100	40	100

Table 2 shows that families after having received the 4 educational sessions, in a second month (5°, 6°, 7°, 8°), reached adequate levels of knowledge from 50% to 52.5%. Likewise, those who started with 25% in the inadequate level lowered the percentage to 12.5%, which indicates that there are improvement changes after receiving 8 sessions developed in the second month. It stands out the position of the families that have the moderately adequate level, who increased from 25% to 35%.

Table 3: Households' level of knowledge about domestic solid waste

Educational intervention	EDUCATIONAL SESSIONS							
	9a		10a		11a		12°	
Adequate	21	53%	23	58%	25	63%	28	70%
Medianly adequate	15	38%	14	35%	14	35%	10	25%
Inadequate	4	10%	3	8%	1	3%	2	5%
total	40	100	40	100	40	100	40	100

Table 3 shows that families after having received the 12 educational sessions, in a third month (9th, 10th, and 11th, 12th), reached adequate levels of knowledge from 53% to 70%. Likewise, those who started with 10% in the inadequate level lowered the percentage to 5%, which indicates that there are improvement changes after receiving 12 sessions developed in the third month. It highlights the position of the families that have the moderately adequate level, who from 38% went down to 25%.

In the investigation, the families that received training selected papers, cartons, glass, plastics and organic waste, obtaining

the following results: The collection of papers and cartons 0.13 kg. /day, glass 0.125 kg. /day, plastics 0.09 kg. /day and organic waste 0.235 kg. /day on average, during the period of three months, which were reduced by 30%, 40, 38% and 15% respectively, as shown in Figure 1.

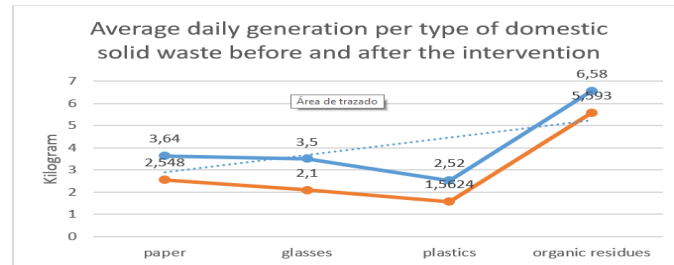


Figure 1 shows that the average generation of solid waste in the condominiums of the district of Los Olivos, there is some variation before and after the intervention. It is observed that the greatest variation is found between plastic from 1.5624% to 2.52% and glass from 2.1% to 3.5%. And the minimum variation is found in organic waste from 5.593% to 6.58%.

The participative mechanisms of domestic solid waste management are an improvement proposal to increase the participation of citizens in the process of collection, storage, control and reuse of waste management. It is necessary to work together with all actors in society, such as public and private institutions and the community to become aware of the reuse of waste, taking care of the environment and people's quality of life. Municipalities are responsible for directing community waste management to the greatest extent possible. According to the document "Environmental control in solid waste from provincial municipal management" report 2013-2014, it is reported that in Peru there is an inadequate disposal of municipal solid waste at the national level causing a serious environmental problem. The disposal of solid waste in the streets, the incineration of garbage, the lack of control of waste affects the quality of the environment putting at risk the health of citizens. It is important to point out that the authorities are not committed to waste management, and so far there have been no significant changes to improve the situation [19]. The objective of the study was to measure the effectiveness of educational intervention in the management of domestic solid waste to reduce environmental impact in the district of Los Olivos. According to studies by the Organization for Economic Cooperation and Development [20], the results show that there is effectiveness in educational intervention in solid waste management, which is considered a domestic cooperation strategy that ensures the sustainability of a municipal environmental policy. On the other hand, it says that training programs are a pending task and a challenge for solid waste management [21]. These expressions coincide with those of Edelman and Garrido, who consider that one learns and that this knowledge is transferable, which increases skills during the process [22]. Rodríguez and Montesillos also point out that the strengths and weaknesses of successful national and international urban solid waste management programs are intended to generate an applicable proposal that will prolong the useful life of sanitary landfills or controlled final disposal sites, reduce confinement costs and help reduce the environmental impact of the growing generation of such urban solid waste [23]. López also stressed the importance of presenting environmental education plans and programs as a

component of sustainable development, confirming that the implementation of programs with their respective training increases the capacity of good practices in solid waste management in the population [24]. These statements coincide with those of Reyes, Pellegrini and Reyes, who emphasize the need to propose recycling as a reuse program that includes the process of collecting and separating solid waste, the transportation system and the sale of waste [25]. In relation to the families after having received the first training, they reached 30% with adequate and moderately adequate knowledge. Subsequently, in the fourth intervention, 42.5% had adequate knowledge and 27.5% had moderately adequate knowledge. This conclusion coincides with that of Guzmán y Macías, who pointed out that environmental education generates changes in solid waste management and plays a decisive role in the final disposal of solid waste [26]. Similarly, Gonzaga states that the transformations achieved at the individual and group levels in the training showed a greater level of development of critical awareness and appropriation of a system of knowledge, skills, attitudes and values that reflect a formed environmental culture [27]. However, Niño, Trujillo and Niño (2017) evidenced that 88% of the Community expressed their willingness to participate and cooperate recognizing their fundamental role, and evidenced the need to improve current guidelines so that future projects or programs with their active participation are viable to a great extent [28]. In the Peruvian context, the instrument known as the inventory of collection indicators used by the Peruvian Ministry of Environment (MINAM) showed that the measurement of domestic solid waste management in families increases as the amount obtained per week and the economic costs of domestic recycling are reported [29][30]. On the other hand, in the Vassanadumrongdee & Kittipongvises study, the average generation of domestic solid waste per capita was 1.14 kg in the Thai capital, 55.6% more than in the Los Olivos district. On the other hand, solid waste management in the city of Bangkok does not emphasize source segregation for the implementation of an effective selective recycling program. Even the most common methods are landfills and open field landfills as final disposal, reaching a recycling rate of only 21%. Unlike Los Olivos district, the recycling rate is around 35% and is largely due to 100% coverage of the municipal solid waste collection and disposal service [8]. In the investigation, the families that received training selected papers, cartons, glass, plastics and organic waste, obtaining the following results: The collection of papers and cartons 0.13 kg./day, glass 0.125 kg./day, plastics 0.09 kg./day and organic waste 0.235 kg./day on average, during the measurement period, coinciding with Rojas, who established the favoring of the incorporation of waste separation actions. On the other hand, the experience of the Czech Republic [32] according to Struk's study, there is a mechanism that is applied at the national level [9]. For the reduction it was due to the reuse of the residues, this was observed in 30% in plastics and glasses that were used in house, as flowerpots and as troughs of parakeets since in the condominiums there are no spaces for gardens, for the paper, only the confection of block of notes was obtained and use of both faces for copies and/or notes, when there is the presence of minors, the older ones do not carry out the activity since it is easier to buy it. With regard to organic waste, the intervention has not been significantly successful, since they do not have the necessary implements and they are only thrown into the daily bin. This generates a

proposal to municipal institutions to create a directive for companies to take charge of specialized recycling. However, it is necessary a legal conformity of triangulated efforts between the organs of the public administration, the private initiative and the society, in the implantation of a solid waste management, capable of reducing the environmental degradation and the social inequalities. Despite some progress, there are still many socio-environmental challenges to be overcome, both by public managers and by contemporary society. [31][32].

4 CONCLUSIONS

1. The effectiveness of the educational intervention made it possible to increase the capacity for good practices in solid waste management, being applied as a domestic cooperative strategy that ensures the sustainability of a municipal environmental policy.
2. Therefore, it is essential to implement educational programs to strengthen the capacities of families to improve the management processes of domestic solid waste and their respective reuse.
3. The measurement of the volume of solid waste by type generates in the families attitudes of responsibility, conscience, commitment and behavior of good practices in the management of domestic solid waste for the benefit of the district. This is observed in the percentage decrease in 3 months of intervention.
4. It is necessary to have basic inputs and materials in the management process for the management of domestic solid waste.

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