Strategy to improve the solid waste management of Barangay Matictic, Norzagaray, Bulacan

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Strategy to improve the solid waste management of Barangay Matictic, Norzagaray, Bulacan

V de Paz¹, R Domingo¹ and F M Roxas¹

¹Asian Institute of Management, Manila 1229 Metro, Philippines

Corresponding author’s e-mail: vdepaz@aim.edu

Abstract. Solid Waste generation in the Philippine continues to be a national problem, and it is still increasing as the country’s population grows. This study aims to recommend improvements in the Solid Waste Management program at the national level by implementing behavioral change initiatives and alternative disposal plans for solid waste starting with Barangay (Brgy.) Matictic in Norzagaray, Bulacan as a pilot test. The research focus is reducing waste at the source and implementing changes in the manner of mobilizing resources to minimize waste generation. Research methodology includes Focus Group Discussion, interviews, and research with both internal and external stakeholders to facilitate gathering of data. This study shows that improvements in Solid Waste Management can be accomplished by allocating sufficient funds and efforts into changing the behaviour of households. It is recommended further that funding for the usual solid waste management interventions such as landfill and recycling must be implemented only if waste generation is avoided via proper resource planning and if waste segregation is strictly implemented through incentive programs or awareness initiatives. While technology plays a great role in managing solid waste, reframing the problem will improve outcomes. The global issue of waste must be perceived and resolved as an adaptive challenge, and not just a technical problem.

1. Introduction

In the waste management hierarchy, the most preferred method is waste reduction at the source [1]. Because of technology applied in solid waste management, however, initiatives to minimize waste at the source are ceded by application of various novel and innovative waste disposal and treatment methods. Investments in costly solid waste treatment processes or equipment are proven futile as waste volume continues to increase year after year. Uncontrolled waste generation, difficulty in waste collection, and zero waste segregation are pre-implementation problems in applying technology to manage solid waste effectively.

Solid waste problem becomes an adaptive challenge over time; implementing technical solution turns a simple problem into a future crisis. Lack of financial resources and technology cause many rural areas to dispose solid waste improperly and, at times, illegally. Poor communities, however, should not rely on waste disposal and treatment to minimize the increase in volume of garbage generation. People must learn that solid waste management starts by changing behavior, especially in consumption and production of materials. This study aims to recommend improvements in implementation of solid waste management plan at the national level by showcasing behavioral change initiatives and alternative disposal plans for solid waste starting at the barangay level, with Barangay Matictic in Norzagaray, Bulacan as a pilot test.
2. Literature review

1.3 billion tons per year of solid waste materials are estimated to be produced globally. World Bank data shows that majority of waste generation is from Asia (East and Central), Pacific, and Europe, which constitutes 40% of the world’s waste by magnitude [2]. As the population in the lower-income level countries continue to increase, so does their rate of waste generation. In addition, highly urbanized countries also affect the rate of waste generation such that those with high urbanization rate has higher waste generation per capita per day as compared to lesser urbanized countries [2]. World’s waste generation is projected to increase by 2030 from 2.01 Billion in 2016 to 2.59 Billion tons in 2030. In 2050, this is projected to increase by 3.40 billion tons. At this time, East Asia and the Pacific will generate a total of 714 million tons per year [3].

Most of the world’s generated solid waste is coming from food and green sources at 44%. 38% remaining is dry waste materials. Countries with high-income level have an increasing percentage of organic waste generation [3]. Lower-income countries have generated 56% of food and green waste materials. This means that more organic waste is generated in lower-income countries compared to higher-income ones. Managerial and technical limitations, consumer behavior, and government policies and regulations are identified challenges in managing food loss waste globally [3].

Waste collection in low-income countries is managed by households. Open dumpsites, burning to a lesser extent, and composting are the waste management methods practiced in these countries. As a result, problems such as pollution, human health problems, and traffic congestion are experienced by citizens from these countries. Waste disposal is dominantly done through open dumping in most low-income countries, especially where landfills are not available. Most of waste in low-income countries (estimated at 93%) is either burned or dumped in roads, open land, or waterways [3]. In the Philippines, population continues to rise. As of 2017, there are already 106.5 Million Filipinos in the country. It is comprised of 44.4% urban population; the remainder, rural. With the increase of population, generation of waste materials from domestic and industrial use also surges. In a study conducted by the National Solid Waste Management Council, total waste generated in Metric tons per day rose by 6.7% from 2012 to 2016. Urban and rural areas both account for an average waste generation per capita estimated at 0.40 kgs per day [3]. Figure 1 shows contribution of solid waste in the Philippines. Currently, majority (56.7%) of solid waste in the Philippines is generated by residential sources. Household-generated wastes form part of Municipal Solid Wastes.

![Figure 1. Percentage contribution of municipal solid waste in the Philippines [4].](image-url)

The Commercial wastes, both for market and non-market use, accounts for 28% of total waste in the Philippines. Institutional wastes, such as those for government offices, schools, and hospitals, make up 12%. Remaining 4% is from the industrial and manufacturing sectors [4,5]. Figure 2 shows the Percentage by Weight of Municipal Solid Waste fractions in the Philippines. Typical waste is made up of biodegradables (52.32%), recyclables (27.78%), and residual wastes (17.98%). Paper and cardboard (8.70%), plastics (10.55%), metals (4.22%), glass (2.34%), textile (1.61%), leather and rubber (0.37%) comprise recyclable materials. These data show that not all waste materials need to be treated or disposed of via landfill or other alternative methods. Biodegradables can be used as compost for farmers. Recyclable materials can turn into other useful materials to augment poor family’s livelihood.
income. Composting and recycling are two alternative methods that can help to reduce solid waste [4,5].

![Percentage by weight (%) of MSW fractions in the Philippines](image)

**Figure 2.** Percentage by weight of municipal solid waste fractions in the Philippines [4].

### 3. Solid waste management in Norzagaray, Bulacan

The Municipal Environment and Natural Resources Officer (MENRO) has been effectively implementing environmental programs and continuously monitors natural conditions focused on Solid Waste Management. The 10-year Solid Waste Management Plan of Norzagaray, Bulacan provides the over-all plan in managing solid waste over a ten-year timeline. Sections of the plan include waste characterization, collection and transfer, and processing of information collected in each barangay.

Methods to reduce, dispose or treat waste materials are also based on the study. Key issues for the community involving solid waste include the increase in population due to migration of people from Metro Manila to Norzagaray, Bulacan; increase in the development of existing products with different packaging; limited awareness of the community about proper waste disposal; perception that solid waste management is a free service and that the government has the sole responsibility; and excessive purchase of basic necessities such as food and clothing that lead to wastage.

Since the approval of the 10-year Solid Waste Management Plan for Norzagaray, Bulacan has been allocated a total of PhP 5 to 7 Million budget for its implementation. Total expenditures for solid waste management has been estimated at around PhP 8 Million. 80% of the funding comes from Internal Recovery Allotment (IRA) General fund, while 20% emanated from the development fund. This is the amount that is invested in managing solid waste for Norzagaray, Bulacan. However, the investment’s positive impacts have been minimal.

A “No segregation, no collection” policy was not implemented based on the municipal mandate. Educating Norzagaray’s residents, particularly the youth was the key to this policy. This was enforced through MENRO’s Information, Education, and Communication (IEC) program.

Following Norzagaray’s 10-year Solid Waste Management Plan, MENRO advised each barangay to conduct their own waste source reduction. Ensuring proper segregation, composting of bio-wastes using simple and workable technology, recycling, and building their own MRF were encouraged. Unfortunately, this was not strictly followed by each barangay based on interviews with barangay representatives.

In 2005, solid waste activities were centered on construction of an open dumpsite. However, a local ordinance [6] regarding solid waste management had mandated that the open dumpsite be closed and to replace it with a controlled dumpsite. A Category I Sanitary Landfill (SLF) was then developed in compliance with Ecological Solid Waste Management Act, or Republic Act (RA) 9003, for the disposal of residual waste. Within the landfill area, they also constructed a municipal or Central Materials Recovery Facility. This served as the holding area for the segregation of waste materials. A total of 20 families live in the
landfill at present whose primary source of livelihood is selling segregated waste materials to nearby junkshops.

4. Findings and discussion

Focus Group Discussion, interviews, and site inspection were conducted to gather relevant data needed for the study. Focus Group Discussion involves LafargeHolcim Philippines representative, Barangay Council of Brgy. Matictic, Norzagaray Bulacan, and selected households in Brgy. Matictic. During the Focus Group Discussion, the Barangay Captain answered questions about waste collection and segregation activities in the barangay and found out if these are consistent with LGU’s environmental management plan. Selected households in Brgy. Matictic were asked to determine the types of waste materials that they currently generate and estimate its volume, level of environmental awareness especially on the aspect of solid waste management among the household participants and the dynamics about waste segregation and management in the community.

From our Focus Group Discussion and interviews, it was found out that Barangay Matictic follows the Solid Waste Management Plan created by MENRO, with some limitations. Currently, the barangay does not have a budget to construct a Materials Recovery Facility (MRF). Although MRF is mandatory by law for each barangay, there are other budget allocation priorities the council is considering. MENRO’s push for every barangay to build their own MRF has not complied in Brgy. Matictic.

In 2018, Barangay Matictic had a total of 1,473.10 Kgs or 1.47 MT of waste materials collected and disposed to the sanitary landfill. This is 123 Kgs per day on average. In a recent data gathering conducted by MENRO for their Waste Analysis and Characterization Study (WACS), they recorded a total of 166 kgs of waste materials in their one-month survey for Barangay Matictic. Since waste segregation scheme is not implemented in Brgy. Matictic, in addition to the lack of proper MRF in the barangay, waste materials collected are disposed directly to the landfill. Data shows, however, that not all waste materials are for disposal, 90 kgs of food wastes from Brgy. Matictic dumped directly to landfill per month would have been used in vermi-composting that can be sold to farmers in Norzagaray, Bulacan.

The lack of waste segregation was observed to cause the landfill to reach its full capacity. Unsegregated waste materials piled-up, and these were already visible along the road. Over capacity of the landfill was brought about by factors such as poor landfill design, absence of expansion in the Solid Waste Management plan, absence of an alternative method for waste treatment or disposal, absence of any maintenance plan for landfills, and limited availability of a garbage collector. Norzagaray barangays generate an estimated 1.1 MT per month of solid waste based on their Waste Analysis and Characterization Study. 51% biodegradable waste generated in the municipality translates to 0.6 MT of biodegradable waste. This can produce compost through vermicomposting, which is a method of producing organic fertilizer using vermi-worms [7–9]. Vermi-compost can be used to yield better quality of farm products [7–9]. According to Department of Trade and Industry (DTI), 150 kgs of biodegradable waste plus 2 kgs of vermi-worms can produce 90 kgs of compost [9]. Thus, 0.36 MT of vermicompost can be generated from 0.57 MT biodegradable waste per month. Selling price per one kg of vermicompost is at PhP 7 per kg, which means that there is an opportunity for Norzagaray community to generate an estimated PhP 2,450 per month or PhP 29,400 per year worth of vermicompost from biodegradable waste if it is properly segregated and collected. However, this amount is not fully realized due to lack of effective segregation at the source. Although Norzagaray already had a composting operation beside its sanitary landfill, its yield is underestimated since waste segregation is not properly implemented.

Treatment of residual waste accumulated by Brgy. Matictic was considered for co-processing in a cement plant. LafargeHolcim Philippines, a cement manufacturing plant located right beside Brgy. Matictic, co-processes waste materials by feeding them in the kiln. It is a proven safer technology [10]. Brgy. Matictic should consider further discussions with LafargeHolcim. The company is willing to provide support to the community through its Social Development Plan (SDP) for projects addressing environmental or social issues. LafargeHolcim’s acceptance of barangay’s waste materials for co-processing depends on how they view their landfill condition. Norzagaray landfill’s over-
capacity continues to be a health risk in Norzagaray, Bulacan. Hence, strategic implementation to ensure “Zero Waste” is urgent. This will prevent government penalties from being imposed due to non-compliance, leaching risks, degradation of forests, and inconvenience to the community due to foul odors.

Another issue to consider for co-processing as alternative to landfill is its social impact. 20 families are currently relying on selling waste materials to junk shops as livelihood. Choosing co-processing is a good option for Brgy. Matictic if an alternative livelihood for these families is provided.

5. Strategic improvements

Behavioral change is key to maximize the impact of Solid Waste Management at the national level. Educating households to segregate their waste would work if there are incentive programs offered to the community in exchange for doing segregation properly. Since “No Segregation, No collection” is mandated by law, appropriately segregated waste materials mean compliance with RA 9003.

Going beyond the usual government “mandate”, the Eco-Saver’s Awareness and Incentives campaign is a suggested strategic initiative for Brgy. Matictic. Strengthening waste segregation at the national level is achievable based on the effectiveness of EcoSaver’s incentives program at the municipal level. Since food waste comprises the highest percentage of waste materials, segregating these wastes from other household wastes can reduce landfill disposal. Food waste processed into organic fertilizers can help several farmers in Norzagaray, Bulacan. Farmers’ product yields can also increase since cheap, organic fertilizer has higher nutrients [11]. This should result in an increase in farmer’s income and would entice more farmers to implement sustainable farming initiatives. It should also encourage other municipalities currently converting food waste to organic fertilizers to take part in actively segregating their waste materials at home.

Instead of a community recycling program, Polyethylene terephthalate (PET) plastic wastes can be shredded into Plastic and HDPE flakes used as raw materials for Polyester clothing and plastic materials. Agreement between a nearby PET recycling facility and the Municipal Environment and Natural Resources Office (MENRO) must be established. Once a Memorandum of Agreement has been implemented, PET bottles segregated and collected are to be transported to the PET recycling facility. Logistical costs should be recovered by the local government as part of their funding for Solid Waste Management.

Segregated waste materials with high calorific value are good substitute for coal in cement manufacturing companies. Waste materials as fuel-substitute minimize the use of coal in cement process. Less coal means less generation of carbon dioxide, which is the primary Greenhouse gas that causes climate change. More materials “co-processed” means less waste disposed to landfill. In effect, there will be less utilization of landfill and more opportunities to use land for agricultural or industrial purposes. Figure 3 presents actions and new ideas in improvement of solid waste management in Brgy. Matictic, Norzagaray, Bulacan.
5.1. **Strategy**

The usage of sanitary landfill can be minimized through behavioral Change strategy such as incentive programs, enhanced vermi-composting for segregated and collected food waste, improved plastics recycling through a long-term agreement with PET recycling company, and co-processing of residual waste such as plastics, paper, and textile materials as coal substitute for cement plants.

5.2. **Style**

The overall management of the project should be under the Municipal Solid Waste Management Board, which is indicated in RA 9003, or the Ecological Solid Waste Management Act. The Management team’s style must be authoritative such that the compliance to “No segregation, No collection” Policy is properly accomplished.

5.3. **Skills**

Brgy. Matictic lacks awareness about solid waste segregation. In addition, they do not have information about the benefits of vermicomposting, co-processing, and recycling. To manage these gaps, technical skills, and awareness campaigns about solid waste segregation, reduction, recycling, and disposal must be utilized.

5.4. **Shared values**

The Municipal Solid Waste Management team in Norzagaray, Bulacan does not have a strong commitment culture. Technical and financial support is not well-provided in the community. The Municipal Environment and Natural Resources Officer (MENRO) is often left with all the management tasks on top of other duties and responsibilities. Shared value appropriate for the MSWM team is teamwork and co-ownership such that the team would be made more accountable in enabling stakeholders to comply with the regulations, commit in the mission of minimizing the use of landfills for the future generation, and instill the mindset of sustainability.

5.5. **System**

Improvement in the system will be based on the solid waste generation process:
5.5.1. Waste generation

Solid Waste Awareness Orientation should be conducted. Brgy. Matictic will be trained on how to prepare weekly food budgets to avoid over-spending and over-consumption. They will also be trained about other alternatives they can use in cooking their meals in order to minimize buying ingredients placed in sachets and single use plastics. Using the Eco-Saver’s Incentives program, their commitment to apply what they learned during the orientation will be monitored.

Eco-Saver’s Incentives Program starts with a team discussion about the incentives with MENRO, including roll-out and preparation of materials and funding. MENRO coordinates with the Barangay Captain of Brgy. Matictic for the orientation schedule. Venue and time of orientation to be finalized and announced. Barangay Captain invites household representatives to join. MENRO also coordinates with LafargeHolcim’s CSR Manager and CEO for the additional funding needs and participation during the activities. Printing of Eco Saver’s incentives card is to be arranged by MENRO and LafargeHolcim.

During the orientation, MENRO distributes the Eco-Saver’s Incentive card. The mechanics are simple. Households only need to follow the waste segregation guidelines in the card, take evidence of their efforts, such as photos or actual segregation measures. Evidence must be presented to the Barangay Captain for verification. Barangay Captain then will go to their house and inspect how the household is doing their waste segregation. Once this has been verified, the Barangay Captain will mark his card as his first approved activity. Three approved activity will make the household eligible for a cash incentive. This would be PhP 500 per three verified and approved activities. Households who have completed three approved activities can still join the program by sustaining its segregation activities or completing the other tasks found in the incentives card. If all tasks were completed, the household can request for another Eco-Saver’s incentives card from MENRO.

The program will be evaluated based on the increase of household’s awareness about waste segregation. In addition, increase in waste segregated and transported to the MRF and vermicomposting area will also be monitored.

5.5.2. Waste segregation

Three different colors of waste bins and plastic bags are required for each household in Brgy. Matictic: green for food waste, black for plastic and paper wastes, and blue for residual wastes. No other colors will be allowed. The plastic bags should be properly tied to prevent spillage during collection. Since food waste generation is the highest, its waste bin should be the biggest among the three. In the incentives program, the practical application and frequency of waste segregation are given the priority in terms of rewards. To prevent any leakage or gaming in the implementation of Eco-Saver’s Program, MENRO needs to collaborate with LafargeHolcim and other barangays for secondary evaluators that can complement Brgy. Matictic Captain’s evaluation. The final decision in awarding incentives is through the consensus of MENRO, LafargeHolcim, and other barangay representatives in addition to the Brgy. Captain’s choice. In addition, before awarding the incentives to the household winner, MENRO will conduct surprise visits to check if the waste segregation task/activity of a household is consistently done.

5.5.3. Waste collection

Food waste will be collected the most frequently. Schedule of collection is every Monday, Wednesday, and Friday. No more than one day delay is allowed in waste collection to eliminate foul smell if uncollected waste accumulates. Previously, waste collector picks up the waste in each household without any acknowledgment. However, with the incentives program, waste collectors will be tasked to ask household representatives to acknowledge collection using a form. Waste collector will also be assigned to record all those who are not complying with segregation mandates and have the right to refuse waste collection if segregation is not done according to the guidance provided. Plastics, papers and residual waste will only be collected every Friday. Often, collecting waste has not always been completely efficient. A significant volume of uncollected waste materials may result to landfill overcapacity.
To address potential issues regarding waste collection, especially when optimum collection efficiency is not met, changes in the manner that waste is segregated and collected must be implemented. Usual practice in collecting waste is for waste collectors to grab segregated solid waste from homeowners then dump it in the waste trucks. A proposed improvement in collecting waste to ensure that materials collected are 80% to 90% accurate is by conducting door-to-door collection. This is a deviation from the previous method, in which the waste collectors will go to each household in Brgy. Matictic and check the materials to ensure that they are collected and sorted with minimal to zero addition of unsegregated waste. For instance, the waste collector goes to a house to collect waste. Before depositing the waste at the dump truck, the waste collector needs to inspect the waste materials and check for unsegregated waste included in the pile. Once this has been cleared, he/she can collect the materials and place them in a container before transferring to the dump truck. If unsegregated waste materials are considerably voluminous, then the waste collector must be given right to refuse inclusion of the waste for disposal until it is segregated properly. The waste collector will be held liable for any non-compliance in terms of waste segregation. Accuracy and acceptability of segregation are one of the primary responsibilities of the waste collector. However, their salary upgrade must be considered because of his/her added responsibility. This has been proven effective in India, wherein the method was known to be the “most beneficial” according to a study from The Asia Foundation (TAF) [13].

5.5.4. Waste disposal
Weight of solid waste and the households that properly segregated their waste will be properly recorded and accounted for. For residual wastes, they will be delivered to the Materials Recovery Facility, sorted and disposed to landfill.

5.5.5. Waste diversion and recovery
Food waste collected will be transferred to the vermi-composting area for processing. Not all food waste is pure, and not all waste can be converted into vermicompost. Hence, an acceptable food waste purity requirement must be established. According to FoodPrint, a non-profit organization that conducts research, practices, and studies on food production practices, there is a 70:30 recommended ratio between brown and green waste that must be considered in Vermicompost, respectively [7–9]. Brown waste is composed of paper, wood, dried, and dead plants, while green waste is mostly food scraps, young plants, and wet leaves. Any materials in excess of the 70:30 ratio will make the material “contaminated” and could affect the quality of vermicompost and vermiworms. This means that there is an allowable percentage of weight for food waste.

Plastic wastes will be delivered to Valenzuela City in a PET recycling facility. Pre-processing of PET waste materials involves cleaning of segregated materials and additional sorting to ensure presence of metals or harmful products are removed from the waste pile prior to its processing.

5.6. Structure
Team structure is linear. Department of Environment and Natural Resources (DENR) and National Solid Waste Management Commission (NSWMC) will take active lead roles. Mandates by national government will be complied with by the Norzagaray Local Government Unit. However, coordination among the cement companies, Barangay Captain, and team at Brgy. Matictic and other barangays in Norzagaray will be spearheaded by MENRO in line with the implementation of the project.

5.7. Staff
Vermi-composting facility in Norzagaray already has laborers employed. Additional drivers and vehicles (elf trucks) are needed for the transport of vermicompost and collected plastics in the recycling facility. Additional laborers are also required for the removal of plastic labels and cleaning of bottles delivered to Toplun in Valenzuela City. Toplun Plastic Corporation is a waste plastic importer and plastic flakes exporter from Valenzuela City that provides plastic packaging recycling services in their facilities.
6. Conclusion
Improvement of Solid Waste Management at the barangay level requires focus on waste source reduction. This necessitates adequate government fund allocation and behavioral change efforts at the household level. Behavioral change approach via Eco-Saver’s Incentives Program translates to proper waste segregation and resource planning. These complement landfill and recycling operations in addressing concerns about the uncontrollable increase of generated solid waste volume. Establishment of behavioral change scheme enables segregated food waste to be diverted to vermicomposting. Long-term agreement with plastic recycling companies becomes more viable because of efficient waste collection and segregation. Co-processing is also recommended as a waste treatment measure. However, other municipalities and cities within Bulacan and Metro Manila must help achieve waste volume generation in order to reduce coal usage by 10% in LafargeHolcim. Otherwise, co-processing of waste materials is not a suitable activity in the long-run. Following this study, a three-phase replication of solid waste management best practices in Barangay Matictic drives a nationwide strategic improvement. Phase I starts at the Barangay level, wherein Barangay Matictic conducts Information, Education and Communication (IEC) activities to all barangays in Norzagaray, Bulacan. Phase II is at the provincial level, wherein the Bulacan Provincial government takes the lead in educating other provinces in managing solid waste issues. Phase III is at the national level, in which best practices and solutions are consolidated to form a more robust National Solid Waste Management policy.

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