

## SOLID WASTE MANAGEMENT PRACTICES AMONG THE COMMUNITIES OF OPOL, MISAMIS ORIENTAL, PHILIPPINES

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### Abstract

The assessment aims to evaluate compliance with RA 9003 provisions by assessing solid waste management (SWM) implementation in the three most inhabited Barangays of Opol: Barra, Igpit, and Poblacion. Increased solid waste collection rates in 2013 indicate a pressing need for waste reduction strategies, particularly from commercial and household sources. Findings will guide initiatives to reduce Barangay-level waste production, benefiting the Municipality and expanding SWM research. The research focuses on evaluating SWM practices in residential and commercial establishments of the selected barangays, emphasizing household segregation, collection services, composting, and plastics management. An Integrated SWM program, aligning with RA 9003, will be initiated between barangays and the LGU to address identified issues comprehensively. This initiative contributes to achieving Sustainable Development Goals related to climate change, quality of life, health, employment, industrialization, innovation, and sustainable consumption patterns, particularly in Opol, Misamis Oriental.

**Keywords:** Solid Waste, Management and Practices, Western Misamis Oriental.

### INTRODUCTION

Arazol and Idol (2016) argue that assessing the effectiveness of a solid waste management system is essential to gauge its efficiency, with methods like time and motion studies providing valuable insights into collection procedures. These studies aid solid waste managers in identifying areas for improvement, such as collection efficiency and transfer periods, while also considering factors like onsite storage to ensure public health and economic viability.

Opol, one of Misamis Oriental's twenty-four municipalities, has seen significant population and economic growth over the past decade, leading to the conversion of agricultural lands to urban use in anticipation of increased waste generation. Domingo and Manejar's research (2021) supports this correlation between urbanization, economic growth, and solid waste generation, highlighting it as a global issue affecting both developed and developing countries like the Philippines.

In response to these challenges, the Municipality of Opol has adopted a systematic solid waste management program aligned with Republic Act 9003, also known as the "Ecological Solid Waste Management Act of 2000," and RA 7160, the "Local Government Code of 1991." These laws empower Local Government Units (LGUs) to implement waste reduction initiatives, promote the 3Rs (reduce, reuse, recycle), and maintain ecological balance. The program encompasses various methods of Ecological Solid Waste Management (ESWM), including waste generation, collection, storage, processing, transportation, and disposal, with a focus on

waste diversion through recycling and composting. Statistics from the Philippine National Solid Waste Management Commission (NCWMC) from 2008 to 2018 reveal that a significant portion of municipal waste originates from residential and commercial sources, underscoring the need for effective waste management strategies. However, despite regulations governing the use of Sanitary Landfills and Dumpsites, studies by Galarpe and Parilla (2014) and Galarpe (2015) suggest shortcomings in the Philippine Solid Waste Management system, indicating a need for more advanced intermediary processing technologies and facilities.

Opol's Municipal Environment and Natural Resources Officer (MENRO) reports the presence of a Sanitary Landfill spanning 13.25 hectares in Maapo, Patag, Opol, Misamis Oriental. Household waste collection has been ongoing since 2001, covering six coastal barangays. Despite increased collection frequency in 2013, waste reduction at the source remains a challenge for both commercial and household sectors.

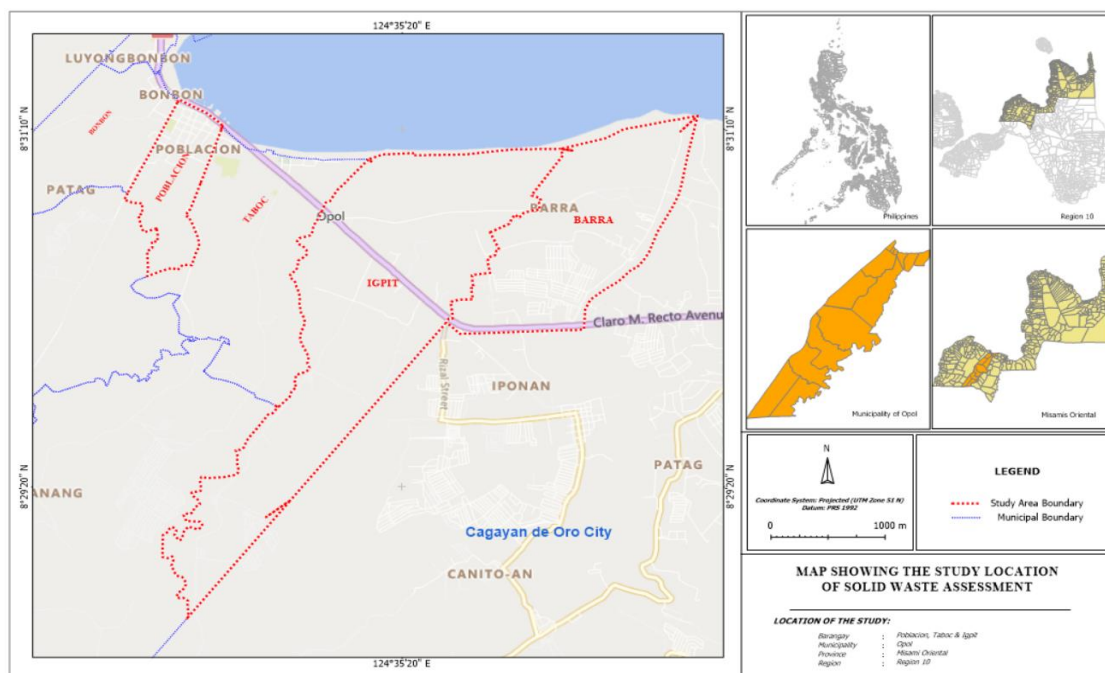
To address these issues, an assessment will be conducted to evaluate compliance with RA 9003 provisions in the three most inhabited Barangays of Barra, Igpit, and Poblacion. Findings will inform the development of initiatives aimed at reducing waste production at the Barangay level, benefiting the Municipality and contributing to the broader body of research on solid waste management. Additionally, these findings will guide the formulation of policies and initiatives by the LGU to address solid waste challenges effectively.

## **MATERIALS AND METHODS**

### **Study Area**

Opol, Misamis Oriental, situated within the Cagayan–Iligan Industrial Corridor, serves as the westernmost municipality adjacent to Cagayan De Oro City (Figure 1). It is positioned between 8o20' north latitude and 124o25' and 124o35' east longitude. Geographically, it is bordered by Macajalar Bay to the north, the City of Cagayan De Oro to the east, the City of El Salvador and the Municipality of Manticao to the west, and the Province of Lanao Del Norte to the south. Spanning a total land area of 17,513.43 hectares, it constitutes approximately 4.77% of the province's total area and encompasses 14 barangays. Opol is approximately 11 kilometers from Cagayan De Oro City, 9 kilometers from El Salvador, and 21 kilometers from Laguindingan Airport. This study aims to assess solid waste management in Opol, Misamis Oriental, specifically by conducting random interviews with various commercial and household respondents from the top three urbanized barangays within the municipality: Barra, Igpit, and Poblacion, as per the NSO 2010 CENSUS. Data collected through interviews are supplemented with information obtained from online scholarly articles and publications.

The topography of Opol was characterized by rugged terrain with approximately 25% flood plains starting from the coast of Macajalar Bay, extending inward to the southern direction towards the Province of Lanao Del Norte. Approximately 3 km of terrain rises, forming a mountain range that suddenly drops to a small-level area in the portions of Tingalan and Nangaon, then again rises higher southwards towards the boundary of Lanao Del Norte.



**Figure 1: Map Showing the Study Areas in 1) Barangay Barra 2) Barangay Igpit, and 3) Barangay Poblacion, Opol, Misamis Oriental, Respectively**

### Collection of Samples and Analysis

Convenience sampling, a form of non-probability sampling, was utilized due to time constraints in selecting respondents. However, the limitations of this method prevent the generalization of results to the entire population. The questionnaire employed closed-ended questions to ensure comparable responses, facilitating quicker and easier data analysis. These questions were adapted from previous studies on solid waste management in upland communities of Cebu by Prieto (2022). The questionnaire was structured to cover various aspects such as garbage production, disposal methods, satisfaction with solid waste management services, waste generation, recovery efforts, consequences of improper waste management, awareness of disposal sites, and respondents' willingness to engage in alternative initiatives. A total of fifteen commercial establishments were interviewed, including eateries, hardware stores, coffee shops, vulcanizing shops, convenience stores, barber shops, resorts, motor shops, and fruit stands, alongside forty-six households.

### RESULTS AND DISCUSSION

The surveys for both residential and commercial sectors had the same set of questions. Table 1 determined the ranking of the days of highest waste generation for the commercial sector. The interview result shows that Tuesday ranked number 1 with a score of 67, meaning that it has the highest waste generation among other days, followed by Wednesday (55 or rank 2), Thursday (47 or rank 3), Sunday (43 or rank 4), Monday (42 or rank 4), and Friday (30 or rank 5), while the day with the lowest waste generated is Saturday (29 or rank 6).

**Table 1: Rank of Days with Highest Waste Generation in Commercial Use**

Days	Score	Rank
Sunday	43	4
Monday	42	4
Tuesday	67	1
Wednesday	55	2
Thursday	47	3
Friday	30	5
Saturday	29	6

### Disposal Method

Respondents were not restricted in their responses and could select multiple choices based on the collection services they utilized. Therefore, the data collected does not represent the total number of respondents. Table 2 illustrates that the primary waste disposal method was Garbage Truck Collection, with a cumulative score of 30 from residential respondents and 14 from commercial respondents.

Communal Site Collection was another commonly used method, utilized by 16 households and 3 commercial establishments. None of the respondents reported disposing of garbage through burying, burning, or dumping in open spaces, and no private services were utilized by either commercial or residential respondents. This finding has conformed to the studies of Allesch and Brunner (2014) and Coracero et al. (2012).

**Table 2: Distribution of Respondents based on the Waste Disposal Method**

Method of Disposal	Residential	Commercial
Garbage Truck Collection	30	14
Communal Collection Site	16	3
Burying in Open Space	-	-
Burning in Open Space	-	-
Dumping in Open Space	-	-
Private Services	-	-

### Barangay Collection Services

The frequency of barangay collection was being asked, to get a glimpse of the barangay stepped in the role by RA 9003. Based on interviews, 27 residential and 5 commercial respondents stated that garbage collection frequently happens once a week, the other 20 residential and 12 commercials were 2-4 times a week. Only 1 from residential experienced the everyday collection and zero from the commercial (Table 3).

**Table 3: Collection Frequency Response of Resident and Commercial Sector**

Frequency of Collection	Residential	Commercial
Once a week	27	5
2 – 4 times week	20	12
Everyday	1	-

**Table 4: Segregation Practices of Resident and Commercial Respondents**

Segregation Practice	Residential	Commercial
<i>Yes</i>	40	15
<i>Biodegradable and non-biodegradable</i>	26	3
<i>Biodegradable, non-biodegradable, and hazardous waste</i>	10	8
<i>Biodegradable, non-biodegradable, hazardous waste, and recyclable waste</i>	3	4
<i>No</i>	6	-
<i>Lack of different containers</i>	5	-
<i>Time consuming</i>	5	-
<i>Waste collection is not strict</i>	6	-
<i>Not aware of policy/guidelines</i>	4	-
<i>Others</i>	3	-

**Segregation Practice**

As per the mandates in RA 9003, segregation must be before the collection (Irene and City, 2014; Jeremias and Fellizar, 2019). Based on the survey, 40 household respondents practiced segregation, 26 of which segregated their waste into biodegradable and non-biodegradable, 10 into biodegradable, non-biodegradable, and hazardous waste, 3 segregated into biodegradable, non-biodegradable, hazardous, and recyclable waste. However, 6 respondents have stated that they do not segregate their waste, due to the lack of different containers, time-consuming, and waste collection is not strict, the other 4 respondents were not aware of the policy/guidelines, and 3 stated their other reasons. On the other hand, all 15 commercial respondents practice segregation, with the majority segregating waste into biodegradable, non-biodegradable, and hazardous, followed by the 4 respondents who segregated their waste into biodegradable, non-biodegradable, hazardous, and recyclable, while 3 segregating their waste into biodegradable and non-biodegradable.

**Table 5: Satisfaction with Collection Services**

	Residential	Commercial
<i>Yes</i>	17	10
<i>No</i>	28	5

Respondents were interviewed on their satisfaction with the barangay collection services. Table 5 shows the 17 residential and 10 commercial respondents satisfied with the services. However, 28 residential and 5 commercial respondents, with a total of 33 were not satisfied with the services, which means a higher number of unsatisfied than satisfied respondents.

**Table 6: Waste Generation Ranking of Residential and Commercial Respondents**

Waste type	Score	Residential	Score	Commercial
<i>Paper products</i>	125	5	33	2
<i>Plastic products</i>	109	6	45	1
<i>Food waste</i>	161	1	15	5
<i>Cans</i>	152	3	21	4
<i>Glass</i>	156	2	26	3
<i>Hazardous waste</i>	152	3	33	2
<i>E-wastes</i>	128	4	7	6

The respondents are requested to rank their waste generation levels. There were seven identified types of waste. Each rank had corresponding scores, 1 being the highest frequency and 6 being the lowest, to assess the ranking of waste generated by residential and commercial establishments.

For the residential areas, the leading waste generated is (1) food waste with a total score of 161, followed by (2) glass with 156 points, (3) cans and hazardous waste with 152 points, (4) e-waste with 128 points, (5) paper products with 125 points, then the lowest (6) is the plastic products with only 109 points. For commercial areas, the leading waste generated was (1) plastic products, (2) paper products and hazardous waste, (3) glass, (4) cans, and (5) food waste, while the lowest (6) is e-waste. These wastes should be handled properly especially those that are considered hazardous (Moduye et al., 2020; Nguyen and Tan, 2020).

**Table 7: Material Set Aside by Residential and Commercial Respondents**

Waste set aside from disposal	Residential	Commercial
<i>Paper products</i>	2	0
<i>Plastics</i>	10	1
<i>Food waste</i>	1	0
<i>Plastic bags and containers</i>	17	1
<i>Glass bottles</i>	36	8
<i>Aluminum cans</i>	24	3
<i>Metals</i>	19	4
<i>Others</i>	1	1

By asking the respondents if they set aside certain materials and what they did to the materials, Table 7 indicates that glass bottle is the top material set aside, according to 36 and 8 respondents from residential and commercial, respectively, followed by aluminum cans, metals, plastic bags and containers, plastics, and paper products. The material least set aside is food waste by 1 commercial respondent, while the other 1 residential respondent set aside other waste type.

Set aside waste material mainly sold by the 41 residents and 7 commercial respondents, while 16 residential and 2 commercial reuse them, and only 1 residential respondent and 2 commercial respondents recycle their waste. None of the respondents practice composting and other recovery initiatives (Table 8).

**Table 8: Material Recovery by Residential and Commercial Respondents**

Material recovery	Residential	Commercial
<i>Reuse</i>	16	2
<i>Sell</i>	41	7
<i>Recycle</i>	1	2
<i>Composting</i>	-	-
<i>Others</i>	-	-

**Table 9: Perceived Effects of Improper Waste Management**

Effects of improper waste management	Residential	Commercial
<i>Health problems</i>	38	15
<i>Air pollution</i>	37	15
<i>Water pollution</i>	33	15
<i>Soil contamination</i>	35	15
<i>Increase in pest</i>	33	14
<i>Aesthetic nuisance</i>	36	15
<i>Fire hazard</i>	26	14

Table 9 concerns the significant effects of improper solid waste management. Respondents were able to identify more than 1 effect. They perceived health problems as the leading effect with 38 respondents, followed by air pollution with 37 points, aesthetic nuisance with 36, soil contamination with and water pollution with 35 points, and increase of pests with 33 points, while the lowest perceived was fire hazard with 26 points. Health problems, air pollution, soil contamination, and aesthetic nuisance have an equal score of 15, followed by the increase in pest and fire hazards with 14 points. Hence, must be handled properly (Prieto, 2022).

Table 10 explains that the majority (33) of residents are unaware of the final disposal site, while 12 are from the commercial, few (13) residents and 4 commercial respondents know the final destination of waste disposal (Table 10). On the other hand, 46 residential respondents have expressed their interest, with a majority leaning toward recycling with 44 responses, reusing and composting with 41 responses, 40 for the “zero waste” lifestyle, and 16 for learning about donating unused items.

Regarding the commercial respondents, all 15 respondents are also interested in learning all SWM practices indicated in the interview tool, with only 1 interested in donating unused items. Generally, all respondents from both residential and commercial are interested in learning SWM practices (Table 11).

**Table 10: Awareness of Final Destination of Waste Disposal**

Aware of final destination	Residential	Commercial
<i>Yes</i>	13	4
<i>No</i>	33	12

**Table 11: Respondent Willingness in Learning other SWM Management Practices**

Other SWM practices	Residential	Commercial
<i>Yes</i>	46	15
<i>Recycling</i>	44	15
<i>Composting</i>	41	15
<i>Reusing</i>	41	15
<i>“Zero waste” Lifestyle</i>	40	15
<i>Donation of unused items</i>	16	1
<i>No</i>		

## CONCLUSION AND RECOMMENDATION

The interviews provided insights into waste management practices within the most populous Barangays of Barra, Igpit, and Poblacion in Opol, Misamis Oriental. Overall, both residential and commercial sectors show a high level of segregation between biodegradable and non-biodegradable waste. However, some residential households do not practice segregation due to lax collection procedures, insufficient containers, and time constraints, with few being aware of the relevant policies and guidelines.

In the study area, the commercial sector generates the highest amount of waste on Tuesdays. The frequent garbage collection, occurring once a week for residential areas and 2–4 times a week for both residential and commercial sectors through garbage trucks and communal site collection, indicates the effectiveness of collection programs. Notably, none of the communities engage in open dumping, burning, or burying garbage in open areas. However, several residential respondents' express dissatisfaction with their Barangays' collection services.

Regarding environmental awareness, most commercial and residential respondents are unaware of the destination of waste after disposal. Both sectors predominantly segregate glass bottles, followed by aluminum cans and metals. Positive waste management practices, such as segregation, selling, and reusing, are common among households. They are also aware of the adverse effects of improper waste management, such as health issues, air and water pollution, soil contamination, pest infestation, aesthetic problems, and fire hazards. Residents and businesses are willing to participate in waste management initiatives, but some attitudes, like non-composting, hinder these practices.

Food waste is the primary waste generated by residential areas, while plastic products dominate in the commercial sector, particularly in establishments such as eateries, hardware stores, coffee shops, vulcanizing shops, barber shops, resorts, drug stores, and convenience stores. The survey within the three selected barangays of Opol, Misamis Oriental, highlights the need for various solid waste management services, particularly focusing on household segregation, barangay collection services, material recovery through composting, and plastic management.

To address these issues, the Municipality may consider developing ordinances and waste minimization measures, such as establishing composting facilities and investing in machinery equipment for managing biodegradable waste, in alignment with the waste reduction program mandated by RA 9003, or the "Ecological Solid Waste Management Act of 2000," and its implementing rules and regulations outlined in DAO 2001–34. Composting offers several benefits, including biofertilizers, groundwater protection, increased agricultural productivity, enhanced food security, and various environmental advantages.

Moreover, initiating an Integrated Solid Waste Management (ISWM) program between Barangays and the Local Government Unit (LGU) in accordance with the provisions of RA 9003 is recommended. This approach, informed by the survey findings within the selected Barangays, would involve a comprehensive process, encompassing discharge/storage, collection, intermediate treatment, and final disposal. It holds potential for achieving



Sustainable Development Goals (SDGs) related to enhancing life and health, promoting decent work, supporting industrialization and innovation, improving production and consumption patterns, addressing climate change, and fostering partnerships, particularly in Opol, Misamis Oriental.

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