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Integrated Urban Solid Waste Management: Knowledge, Practices, and Implementation

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Abstract:

The current study sets out to ascertain the residents of Kabankalan City's degree of solid waste management knowledge, practices, and implementation. This further established the relationship between their knowledge, practices, and degree of solid waste management program implementation. The researcher-made questionnaire was used to assess solid waste management practices and program implementation, while a modified version of the questionnaire from the study by Trondillo, *et al.* (2018) was utilized to assess knowledge levels. For the study, 365 residents of Kabankalan City were chosen at random. The primary analysis employed in this inquiry was the Pearson r correlation. According to the findings, locals have a fundamental grasp of and a modest level of practice with solid waste management. The city's solid waste management program was only partially implemented. Last but not least, the amount of knowledge and implementation was substantially correlated with the residents' solid waste management practices.

Keywords: urban solid waste management; knowledge; practices; implementation.

JEL Classification: Q53; Q56; Q01; R11.

Introduction

For the majority of developing countries, improper waste disposal of solid waste is a major concern that encourages behavior that helps people acquire the knowledge, attitudes, values, commitments, and skills necessary for problem-solving (Eshete, *et al.* 2023; Yusuf and Fajri 2022).

Globally, an astounding 2.2 BT/year will be produced in solid waste by 2030, up from an estimated 1.3 BT/year today. In addition to increasing the manufacturing and consumption of disposable masks and other household wastes such as packed food, fresh food, and meal delivery, COVID-19 has created a new environmental challenge (Das *et al.* 2021; Mallick *et al.* 2021; Parashar and Hait 2021; Filho *et al.* 2021). Urbanization, economic development, changing lifestyles, and rapid population growth all played a role in the rise in resource use and waste production (Al-Dailami, Ahmad, Kamyab, *et al.* 2022).

Many developing and growing countries have had to contend with rapid population and economic expansion. Along with such rapid expansion, solid waste generation has greatly increased (Ahangar *et al.* 2021; Browning *et al.* 2021; Patwa *et al.* 2021). Many developing and growing countries have had to contend with rapid population and economic expansion. Along with such rapid expansion, solid waste generation has greatly increased (Ahangar *et al.* 2021; Browning *et al.* 2021; Patwa *et al.* 2021). This is further supported by Khan, et.al (2022) who posit that due to the increase in global population, urbanization, and industrialization, solid waste generation has risen quickly. Likewise, a lack of awareness of solid waste management may contribute to the implications of poor solid waste disposal (Singh *et al.* 2022).

According to Chati (2021), the majority of developing countries now face a serious problem with solid waste management. Solid waste is seen to be a beneficial resource if well managed, but when left, it may become a source of environmental and human concerns if not adequately handled. Excellent solid waste management practices exist in many industrialized nations that recycle trash. Due to their high population density and unstable economies, developing nations confront various difficulties, including sorting and processing municipal solid waste (MSW). Mismanagement like this might hasten the development of negative socioeconomic

and environmental issues (Khan *et al.* 2022). The environmental condition in the Philippines has reached crucial ratios in terms of managing solid waste, requiring immediate and collaborative action at all levels of the executive. The ecological solid waste management program was created to provide proper solid waste segregation, collection, transport, storage, treatment, and disposal.

In order to fully implement the Republic Act, the Local Government Units (LGUs), which are the principal implementers, are responsible for the majority of the duties. Likewise, this also requires public involvement for the effective implementation of waste management plans (Republic Act 9003)

1. Research Background

Kabankalan City demonstrated exceptional initiatives in managing solid waste and even increased its efforts to maintain its 2nd Platinum Environmental Award (Daily Star, June 2019). Likewise, the city received the Award of Seal of Environmental Good Governance. E.O. No. 2005- 011 explicitly established a multi-sectoral Task Force called "Kalinisan" to take charge of enforcing the City Ecological Solid Waste Management Ordinance. However, implementation of the law is not an easy process. It faced a lot of challenges encountered, including a lack of community decision-making ability, information flow that frequently occurs through government structures that are influenced by political contexts, and inequity in the allocation of budget (Zikargae *et al.* 2021; Jabeen *et al.* 2022). Furthermore, the management of solid waste has not made much progress. Local governments often lack the expertise needed to evaluate technologies or solutions in order to identify the most appropriate ones for their situation (EPA, 2020).

The main challenges experienced by many countries on solid waste management partially result from the lack of stakeholder awareness, inclusion, and participation (Singh *et al.* 2022). This is also supported by Awino and Apitz (2023) who posit that the major waste and environmental management challenges that continue to pose in many countries are economic constraints, weak policies and governance, waste trading, non-inclusive stakeholder participation, data limitations, and limited public awareness**.** Additionally, Kihila *et al.* (2021) underscores that a lack of awareness, weak regulatory frameworks, and enforcement, a lack of economic incentives, and a low priority in planning were given low attention by the authorities were among the reasons why solid waste management implementation is affected.

For sustainability and environmental security, the participation of stakeholders is very important. The project's success depends on the involvement of all stakeholders (Zikargae *et al.* 2022). The community supposedly possessed extensive expertise in solid waste management, according to Muiruri, Wahome, and Karatu's (2020) hypothesis.

In order to lessen the detrimental effects of garbage on the environment, Local Government Units have committed to implementing safe and effective waste management practices in their community. Because they believe they have no other options for handling their solid waste, in particular, most communities in underdeveloped countries frequently use garbage disposal methods that have been shown to be harmful to human health, like open dumping and burning which are the most prevalent practice. The practice of these garbage disposal causes several environmental issues like deterioration of water quality due to leaching from open dumping of municipal solid waste (Jabeen, *et al.* 2022).

The findings of the Sampulna (2022) research served as a reminder to the community that solid waste management is still a major problem in the Philippines even after the passage of Ecological Solid Waste Management of 2000, which mandates segregation at the barangay level. In the study of Kihila, *et al.* (2021), he emphasized that the fundamental issue has been a lack of waste segregation both at the source and during the later phases of waste management. Waste and recycling collection thus becomes ineffective. Combining garbage makes handling more complex and makes it more challenging to separate recyclables. Lack of recycling makes it impossible to reduce the amount of garbage produced and forces a sizable percentage of it to be collected, transported, and disposed of.

Note that, recycling, waste reuse, and trash reduction are the greatest waste management strategies. The employment of these approaches can result in a variety of environmental advantages. It has the potential to minimize or avoid greenhouse gas emissions, pollutant discharge, resource conservation, energy conservation, and the requirement for waste treatment technologies and landfill space (cyen.org). As the foundation for effective waste management, municipalities, and local governing bodies must involve the public actively in decision-making and implementation processes (Brotosusilo *et al.* 2020).

Solid waste management is underdeveloped and ineffective in various other nations. A lack of coordination amongst stakeholders, institutional flaws, a lack of recycling laws, and uncoordinated initiatives were some of the major problems noted (EPA, 2020).

The researcher is motivated to conduct a study to determine the knowledge, practices, and implementation of the Solid Waste Management Program as a consequence of this understanding.

2. Research Methodology

In this study, the City of Kabankalan's solid waste management program's implementation, knowledge level, and practice were assessed. This descriptive study involved the 365 randomly selected residents of the nine barangays of Kabankalan City Población as the respondents. For the purpose of assessing solid waste management knowledge, the researcher modified a questionnaire from Trondillo's, et.al (2018) study; nevertheless, a researcher-made questionnaire was crafted to assess practices and the extent of implementation. The instrument was put through validity and reliability tests to make sure the data gathered was relevant, significant, and meaningful. The result of the validity testing was 3.50 which provided a good rating in terms of its constructiveness and alignment with the purpose of the study. Likewise, the questionnaire was pilot-tested on other residents outside the sample but had the same characteristics as the target respondents. A Cronbach's Alpha of .841 for knowledge, .946 for practices, and .912 for the reliability of indicators in solid waste management implementation were obtained. A survey instrument with three (3) parts was utilized to collect the primary type of data. Part I included 20 questions that were answered with "yes," "no," or "I don't know." Based on the percentage, solid waste management knowledge was assessed. The greater the percentage, the more knowledgeable the locals were about solid waste. The percentage was interpreted using the scale below:

Score Rating	Descriptive Rating
76-100	Very knowledgeable about
51-75	Knowledgeable about
26-50	Somewhat knowledgeable about
1-25	Not knowledgeable about

Part II had twenty (20) statements regarding solid waste management practices. On a scale of 1 to 5, with 5 being the strongest agreement, responses were scored. Finally, Part III included 20 statements on the level of implementation for solid waste management. Answers to each question were given on a 5-point scale ranging from "always" to "never."

The mean and standard deviation were used to assess the City of Kabankalan's solid waste management practices and level of implementation. The mean scores were calculated using a five-point rating scale.

Mean Score Rating	Descriptive Rating	
	Practices	Implementation
4.50-5.0	Very Highly Practiced	Very Highly Implemented
3.50-4.49	Highly Practiced	Highly Implemented
2.50-3.49	Moderately Practiced	Moderately Implemented
1.50-2.49	Slightly Practiced	Slightly Implemented
1.0-1.49	Very Slightly Practiced	Very Slightly Practiced

To determine if there was an association between residents' knowledge and the extent of their solid waste management practices and implementation, the researcher employed Pearson's r correlation analysis.

3. Research Results and Discussions

3.1 Residents' Knowledge about Solid Waste Management Program

Generally, residents were informed about solid waste management. This proved that the residents were familiar with the concepts of solid waste management.

Table 1. Residents' Knowledge about the Solid Waste Management Program

No	Statements	F	%	Interpretation
1	Do you know any awareness program conducted by a local authority/school regarding waste management?	115	36.5	Somewhat knowledgeable
2	Do you know the penalties for violation of solid waste management?	105	33.3	Somewhat knowledgeable
3	Do you know how to dispose of the e-waste?	106	33.7	Somewhat knowledgeable
4	Unbroken or broken glass waste is disposed into a cardboard box lined with a black bag and taped.	115	36.5	Somewhat knowledgeable
5	Do you know that waste papers, plastic bags, a piece of metal and wood, and clothes are not garbage?	107	34.0	Somewhat knowledgeable
6	Do you think that residents in your barangay have an important role to play in the implementation of solid waste management at school?	273	86.7	Very knowledgeable
7	Do you know about the segregation of waste?	268	85.1	Very knowledgeable
8	Do you think waste segregation is important in the barangay or household?	270	85.7	Very knowledgeable
9	Waste segregation is beneficial to my barangay and house.	286	90.8	Very knowledgeable
10	Do you have a role to minimize the barangay and house waste	265	84.1	Very knowledgeable
	Over-all Knowledge	**58.03**		**Knowledgeable**

(Only the top 5 statements with the highest and lowest percentage ratings were included in the table)

Statements 6, 7, 8, 9, and 10 in particular had significant percentage distributions and were interpreted as being very knowledgeable. The residents were able to understand the advantages and significance of garbage segregation by comprehending their pivotal responsibilities in the implementation of solid waste management. Just by doing this, they were able to show how crucial garbage separation was to them, both at home and in the community. The extremely informed conclusion implied that locals were properly informed about solid waste management concepts. According to Muiruri, Wahome, and Karatu's (2020) evaluation of attitudes and practices connected to solid waste management, the community has an excellent grasp of waste management.

However, five (5) of the statements—more specifically, 1, 2, 3, 4, and 5—demonstrated that residents were at least somewhat informed about solid waste management. This indicated that residents had limited knowledge about managing solid waste.

Observed that residents had limited knowledge of programs conducted by the local authority/ school on waste management. They had limited knowledge about e-waste and how to dispose of it and the unbroken or broken glass waste was disposed of in a cardboard box lined with a black bag and taped. They were even having limited knowledge that waste papers, plastic bags, a piece of metal and wood, and clothes were not garbage. The result implied that residents' knowledge of the solid waste management concept was not adequate.

The main reasons for the current decline in ecosystem quality and harm to human health, according to Hasan, Hanafiah, and Satchet (2019), were a lack of awareness, a lack of knowledge of pertinent laws and regulations pertaining to solid waste, and poor management of solid waste.

3.2 Residents' Solid Waste Management Practices

The residents' overall mean rating for their solid waste management practices was 2.95, which was considered to be a moderate level of practice.

The residents' solid waste management practices had an overall mean rating of 2.95, which is regarded as a moderate practice. Of the five (5) practices indicated, the waste campaign got the highest mean rating of 3.0 interpreted as a moderate practice.

This shows that the city made a moderate effort to manage solid trash by conducting educational projects, educating the public, and communicating with them. However, only a little quantity of signs, instructional bulletins, and other campaign materials were employed to increase public knowledge of solid waste management. The city also adopted solid waste management rules, ordinances, and regulations.

Table 2. Residents' Practices of the Solid Waste Management Program

Practices	Mean	SD	Interpretation
Waste Segregation & Volume Reduction	2.98	1.162	Moderately Practiced
Waste Disposal Methods (Composting, Burying, Open dumping, Land Filling)	2.97	0.881	Moderately Practiced
Waste Recycling	2.89	1.296	Moderately Practiced
Waste Campaign	3.00	1.266	Moderately Practiced
Overall Practices	**2.96**	**1.151**	**Moderately Practiced**

Waste segregation and volume reduction also received a high mean score of 2.98, indicating moderate practice. The quantity of garbage that the residents separated into biodegradable and non-biodegradable components was moderate. Waste containers in the designated areas were moderately provided with covers and properly marked. Likewise, respondents moderately collected organic waste for animal feed.

The finding of Sampulna (2022) also reminded the community that despite the passage of Republic Act (RA) 9003, which required segregation, and solid trash management remained a significant issue in the Philippines, primarily due to the improper management of waste segregation at the local level.

Waste disposal methods got also the highest mean rating interpreted as moderate practice. Respondents indicated that they practiced moderately disposing of their waste through open dumping. Residents typically dumped or disposed of their trash in this manner and placed it in a disposal location. Additionally, respondents directly expose their garbage to fire in order to burn it. They also used composting as a means of getting rid of their garbage.

Of the waste disposal methods, burying and landfilling have low ratings. These methods of waste disposal need larger space, designed, constructed, and maintained by engineers These techniques were not workable for the residents. Most communities in developing countries frequently use garbage disposal methods that have been shown to be unhealthy for people, like open dumping and burning (or unregulated landfills), because they believe they have no other options for handling their solid waste. The practice of these garbage disposal cause several environmental issues like deterioration of water quality due to leaching from open dumping of municipal solid waste (Jabeen, *et al.* 2022).

Finally, the respondents' use of waste recycling was moderate. They used containers as garbage cans, receptacles, and bags while emphasizing the 3 R's (reduce, reuse, and recycle). During community events, city personnel reused their old decor. The moderate practice of recycling waste may be due to the fact that the city had only one (1) Materials Recovery Facility (MRF) which was considered a depository facility for waste materials. According to www.cyen.org, the best solutions to waste management were trash reduction, waste reuse, and recycling.

3.3 Solid Waste Management Program Implementation

The total mean rating of 2.89, which is considered moderate, represented the solid waste management program implementation indicators.

The social aspect earned the highest mean rating out of all the dimensions. According to the residents, the government and community were only moderately involved in implementing the solid waste management program. It was evident that the city and community were cooperating to execute a solid waste management program to a reasonable level by employing practical applications or environmentally sound trash reduction tactics including resource conservation, segregation, and recycling.

Table 3. Extent of Solid Waste Management Program Implementation

Dimensions	Mean	SD	Descriptive Interpretation
Institutional/Governance Aspects	2.88	1.272	Moderate
Social Aspects	3.03	1.215	Moderate
Health and Environmental Aspects	2.83	1.296	Moderate
Economic Aspects	2.75	1.363	Moderate
Overall Implementation	**2.89**	**1.166**	**Moderate**

As the foundation for effective waste management, municipalities, and local governing bodies must involve the public actively in decision-making and implementation processes (Brotosusilo *et al.* 2020).

Institutional/governance aspects, on the other hand, displayed a high mean rating. Residents moderately noted that the city has specific sites and bins for collecting recyclable goods, sorting them, and then collecting them for collection by the responsible committee. To oversee and carry out a solid waste management program, the city designated staff or a committee to work with the authorized office. To successfully manage solid waste, one of the city's barangays had a Materials Recovery Facility (MRF) for the segregation, processing, and/or acquisition of recyclables. MRF was created as a result of the development of the city's solid waste management policies, rules, and laws.

Residents also noted that the city provided receptacles or bins to a moderate extent of implementation protecting the health and well-being of the town and its citizens. To further enhance public safety and the welfare of the neighborhood, the city collected solid waste in a reasonable manner that prevented damage to the container and leaks or being dispersed inside the collecting area. Agricultural trash and other items were only sparingly composted.

Finally, to reduce the amount of waste as observed by the citizens, the city moderately implemented the sale of bottles, plastics, cans, and other scraps to junkshops. The city moderately implemented the crafting of protocols, benchmarks, and marketing strategies for recyclable materials as well as new production facilities for products made from recovered and post-consumer materials. The city contacted potential customers and reviewed and modified how the commodities were processed to somewhat increase their marketability.

Solid waste management was not well established and inefficient in several other countries due to a number of serious issues like a lack of stakeholder participation, institutional structural flaws, a lack of mandated recycling, and uncoordinated approaches, according to EPA (2020).

3.4 Association between the Level of Solid Waste Management Implementation and Residents' Solid Waste Management Knowledge and Practices

Table 4. Association between respondents' knowledge and practices about solid waste management and the degree to which the solid waste program has been implemented

Variables	rho	p-Value	DECISION FOR H_0	CONCLUSION
Knowledge and Practices	.576	.000	Reject Ho	Highly Significant
Knowledge and Implementation	.612	.000	Reject Ho	Highly Significant
Practices and Implementation	.740	.000	Reject Ho	Highly Significant

***Correlation is significant at 0.05 level (2-tailed)*

At 5% level of significance, the results revealed a significant positive correlation between respondents' knowledge and their level of practice (rho =.576, p =.000), level of implementation (rho =.612, p =.000), and level of practice and implementation (rho =.740, p =.000).

The strong correlation implied that respondents' practice levels improve as their knowledge levels do, and vice versa. This implied that when respondents' knowledge level rises, their extent of practice increases, and vice versa. When respondents have a high degree of practice, solid waste management implementation also increases to a greater extent. Not to mention, as knowledge levels increase, implementation levels rise as well, and vice versa.

Conclusions and Further Research

There are still several residents that don't know much about solid waste management. The residents were able to fairly manage their garbage, nevertheless. The city's solid waste management program was fairly implemented, necessitating great social responsibility and commitment from the government and community to increase program effectiveness. Finally, the respondents' understanding of solid waste management concepts had an impact on their practices and how the city carried out its solid waste management program.

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Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that might influence the work reported in this paper.

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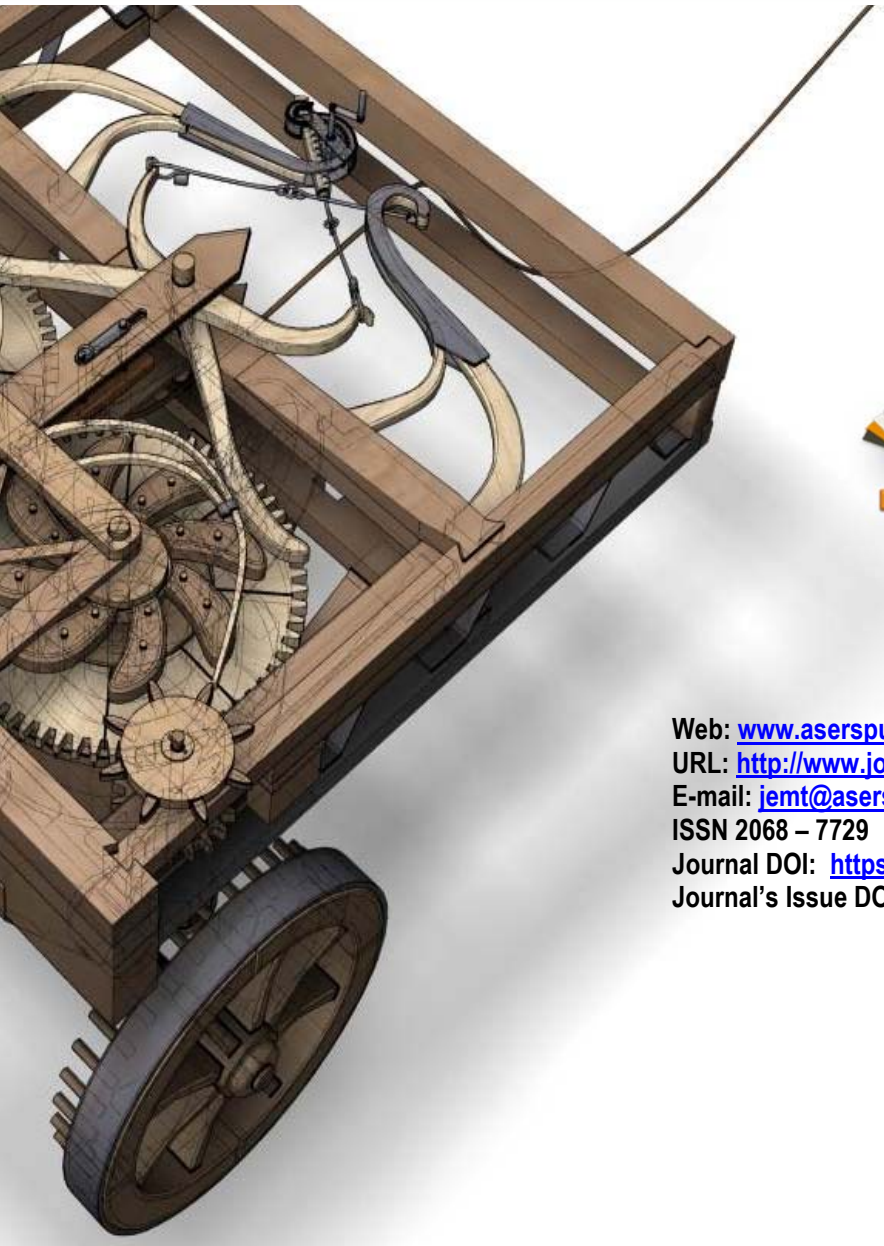

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