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Household Solid Waste Generation among Urban and Urbanising Communities in Butuan City: A Comparative Analysis

Breix Michael G. Agua[a], Jan Niño G. Tinio[b], [a,b]Caraga State University, Butuan City, Philippines, Email: [a]bgagua@carsu.edu.ph, [b]jgtinio@carsu.edu.ph

The increasing volume of solid waste has been an issue in recent times, not only in the Philippines but also in other countries as well. For Butuan City, local ordinances are made to at least give remediation and intervention for this alarming scenario. In this study, a sample of 427 households using multi-level random sampling was obtained. Stratification of household respondents was carried out across types of a community (urban and urbanising) and income classifications (low, middle and high). The socio-economic profiles of the respondents, including the number of household members, monthly income, and monthly expenditure were obtained. Waste characterisations across waste classifications and waste types were measured weekly. An investigation was also made about which of the household socio-economic profiles are correlated with the amount of weekly generated solid wastes. Results showed that the total generated solid waste per household is 6.2955 kg per week, including biodegradable, recyclable, non-recyclable and special wastes. Kitchen/canteen waste and plastic film packaging are among the top generated wastes by the households. It was also found out that selling out, putting in trash, reusing and throwing to compost and open pits are the usual means of waste disposal. Across all types of wastes, it is the monthly expenditure that displayed significant relationships. Meanwhile, the monthly income unveiled a significant relationship with the amount of generated recyclable, non-recyclable, and special wastes. Households from urban barangays produce more biodegradable waste than those from urbanising barangays. Higher volumes of recyclable and special wastes can be produced by the households from the higher-income class, compared to those from the low- and middle-income classes.

Key words: *Household solid waste, Socio-economic correlates, Solid waste management policies.*

Introduction

Solid waste management has become a popular concern, not only in the Philippines, but also across the entire globe as well. Mismanaged wastes, especially when contaminated with hazardous materials, have resulted in experiencing pollution in the air, water, and soil. It has become one of the prime factors that could harm marine and wildlife. Undeniably, not only the animals are affected by this but also human beings as well. Ferronato and Torretta (2019) enumerated some of the environmental and health risks which can be attributed to improper waste management. For instance, it can lead to the pollution of groundwaters that are utilised for drinking and household purposes; contamination of the water bodies such as rivers, lakes, and the oceans caused by the uncontrolled waste disposal; and even the increasing risks of cancer and respiratory diseases due to burned household wastes.

In the study conducted by Jambeck, et al. (2015), the Philippines was among the top 20 countries in the world for 2010 to have produced mismanaged plastic waste. The country ranked third following China and Indonesia. Antonio (2010), said that waste plastics comprise a major part of the waste stream in the Philippines, which can be attributed to the difficulty in separating plastic waste from mixed wastes. Glass waste was also evident due to the low number of recyclers.

The relevant literature suggests some of the variables that are correlated with the quantity of wastes. Jaffar, et al. (2018), stated that family size is strongly correlated with waste generation. The same observation was found by Sivakumar and Sugirtharan (2012), wherein it was highlighted that families with larger family sizes tend to produce larger quantities of waste. In addition to the above-mentioned waste generation correlates, Hanaki, et al. (2010), included the level of concern about the environment and willingness to separate the wastes. Also, factors that significantly impact waste generation include the employment status, household size, annual income, and recycling and awareness about waste segregation policy (Singh, et al., 2016).

Butuan City, where this study was conducted, is a highly urbanised city which is located in the northeastern part of the archipelago of Mindanao, Philippines. Its population in the 2015 census was about 337,063 people. Over the years, the population of the city is increasing, together with its improving economy. This would then account for the increasing volumes of waste and hence the call for this study.

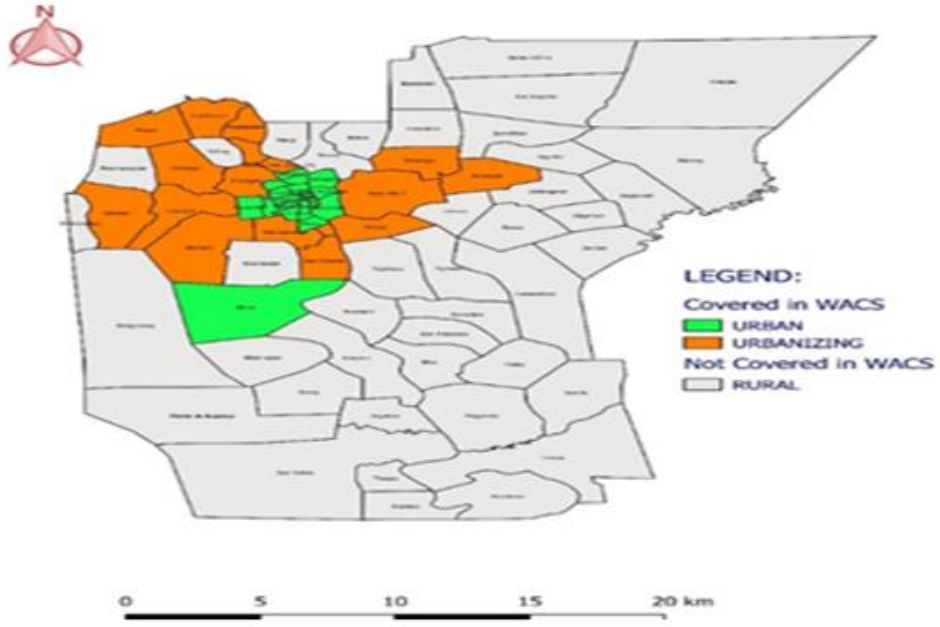
In the present study, socio-economic correlates to weekly generated wastes classified as biodegradable, non-recyclable, recyclable, special wastes and total wastes were determined. The said socio-economic variables include the family's household size, monthly income in Philippine Peso (Php), and monthly expenditure (in Php). The family's practices of solid waste management were identified. Comparisons in the volume of wastes accumulated weekly across types of community and income class classification were made.

Methodology

The study employed a two-stage stratified random sampling in the selection of the participants. The first-level stratification was carried out across urban and urbanising barangays, while the second-level was made across income classification. Moreover, 427 households were interviewed from the 44 participating barangays of Butuan City, Philippines, using a self-made questionnaire. Please see Figure 1 below for the research locale. The variables under study include the weekly generated wastes measured in kilograms, and the socio-economic variables which are the family's monthly income (in Php), monthly expenditure (in PhP), and the household size. The household's weekly generated waste has four classifications, which are biodegradable, non-recyclable, recyclable and special wastes, each of which has several waste types. The household's monthly income with ranges: less than Php9,520.00, between Php9,520.00 and Php66,640.00, and more than Php66,640.00 is classified as Low-, Middle-, or High-Income class, respectively (Alberto, Santos, & Vizmanos, 2018).

Frequency counts and percentages were used as tools for the descriptive analyses. Spearman correlation was utilised to determine the socioeconomic correlates of the weekly generated wastes. Mann-Whitney U Test and Kruskall-Wallis H Test were used in the comparison of generated waste across types of barangay and income classes, respectively. Lastly, Dunn-Bonferroni was used for Post-hoc comparisons.

Figure 1. Research Locale



Results and Discussion

Household waste characterisation and disposal, relationships between socioeconomic profiles and weekly generated wastes, and some comparisons of generated wastes across income class and types of community are thematically discussed herein.

Waste Characterisation and Disposal

Characterisation of the household generated wastes in kilograms per week classified as either Biodegradable, Non-recyclable, Recyclable and Special Wastes across varying types of wastes are presented in Table 1 below.

The total volume of generated wastes for each household per week summed up to 6.2955 kg. Top types of waste generated per week are the Biodegradable Kitchen/Canteen Wastes (1.3716kg), Plastic Film Packaging (1.2785kg), Nappies (0.7288kg), and Dense Plastic Bottles and Jars (0.6987kg) which have contributed more than half a kilo. The non-recyclable waste (2.28kg) provide the highest contribution to the total waste, followed by the biodegradable waste (2.2212kg). On the other hand, special wastes with less than ¼ of a kilo are the least generated. A similar pattern of waste distribution across waste classification was observed by Miezah, et al. (2015), wherein biodegradable wastes outnumbered the others.

Table 1: Volume of Household Generated Wastes in Kg per Week in Butuan City, Philippines

Type of Wastes	**Generated Wastes**
Biodegradable	**2.2212**
Organic (Biodegradable Kitchen/Canteen Waste)	1.3716
Organic (Biodegradable Garden/ Park Waste)	0.3239
Wet Paper, Cardboard and Cartoons (Paper/card- packaging)	0.3159
Wet Paper, Cardboard and Cartoons (Other paper/ card- non packaging)	0.1047
Wet Paper, Cardboard and Cartoons (High gloss paper/ card and wallpapers)	0.0463
Wood (Treated Wood)	0.0281
Wet Paper, Cardboard and Cartoons (Newspapers)	0.0177
Organic (Other Biodegradable Waste)	0.0128
Wood (Untreated wood)	0.0003
Non-recyclable	**2.2800**
Plastic A (Plastic Film-packaging)	1.2785
Nappies, Health Care/ Biological Waste (Nappies)	0.7288
Plastic A (Plastic Film- non packaging)	0.0939
Complex Products (Composite/ Complex Packaging)	0.0718
Complex Products (Composite/Complex No Packaging)	0.0363
Glass (Broken)	0.0330
Nappies, Health Care/ Biological Waste (Health Care/ Biological Wastes)	0.0256
Inert/ Fines (Miscellaneous inert)	0.0119
Recyclable	**1.5629**
Plastics B (Dense Plastic Bottles/ Jars (P)	0.6987
Glass (Glass Container Packaging Clear/ Saleable (non-broken)	0.2781
Dry paper and Cardboard (Paper/ Carton - Packaging)	0.1211
Metals B (Ferrous Packaging)	0.1092
Plastics C (Dense Plastic - non packaging)	0.0722
Plastics C (Dense Plastic - other packaging)	0.0647
Glass (Glass Container Non-Packaging (non-broken))	0.0588
Metals B (Non-Ferrous Packaging)	0.0359
Textiles (Non-Clothing textiles)	0.0328
Textiles (Clothes)	0.0282
Metals A (Miscellaneous Non-Ferrous)	0.0148
Dry paper and Cardboard (High gloss paper/ card and wallpapers)	0.0124
Glass (Glass Container Packaging and Non-Packaging (broken))	0.0117

Dry paper and Cardboard (Other paper/ card - non packaging)	0.0104
Metals A (Miscellaneous Ferrous)	0.0103
Dry paper and Cardboard (Newspapers)	0.0022
Dry paper and Cardboard (Bond papers)	0.0014
Special Waste	**0.2314**
Hazardous Waste, Household, and Toxic (Miscellaneous Non packaging Glass)	0.1658
E-Waste (Mixed WEEE)	0.0440
Hazardous Waste, Household, and Toxic (Miscellaneous Hazardous Waste)	0.0176
Hazardous Waste, Household, and Toxic (Batteries/ Accumulators)	0.0040

Top contributing wastes for the biodegradable, with at least 0.3 kg per week include the Kitchen/Canteen Wastes (1.3716kg), Garden/Park Waste (0.3239kg), and Paper/Card Packaging (0.3159). On one hand, the top main types of waste for Non-recyclables are the Plastic Film Packaging (1.2785kg) and Nappies (0.7288kg). Meanwhile, Dense Plastic Bottles/Jars with 0.6987kg contribute the highest for the recyclable waste. Similar results were found by Yoada, Chirawurah, and Adongo (2014), wherein the wastes generated by households included food debris, plastics, bottles, and cans. In the same study, food debris ranked first. Moreover, large proportions of the waste generated for a household include the kitchen waste and food remains, and the packing waste and plastic waste (Mukama, et al., 2016; Wegedie, 2018; Miezah, et al., 2015). Other waste such as food/kitchen waste, papers, bottles, metals, cans, boxes or cartons, glass bottles, cellophane or plastics, and yard or garden wastes were among the types of waste in Manila (Bernardo, 2008).

It was revealed in the previous results the amount of wastes generated by every household in Butuan City per week. How these wastes are being managed is depicted in the succeeding findings. Table 2 displayed the Solid Waste Management practices that are carried out at least weekly, while Table 3 enumerates the means of disposal of solid wastes.

Table 2 depicts that segregation is the most common practice of solid waste management identified among the other practices across types of community and classification of income class. There is a relatively high level of practice among those from the urbanising households for Recycling, Reusing, Composting and Dropping at the MRF, compared to those residing in the urban areas. Almost similar percentages of the households practice recycling across income classes. Reusing and dropping at the MRF were shown to be the least practiced by the households from the high income compared to those from the low- and middle-income classes. The results of the study of Yoada, Chirawurah, and Adongo (2014), agreed that the majority of the households use the separation of solid wastes as one of the main solid waste

management practices. Recycling of plastic waste and kitchen waste, however, were mainly used by the households in Central Uganda (Mukama, et al., 2016). Composting was also not carried out by the households. The same was also observed in the study by Reyes and Furto (2013).

Table 2: Percentage of Respondent Households Employing Solid Waste Management Practices at Least Weekly

	Type of Community		**Income Classification**		
	Urban	**Urbanising**	**Low**	**Middle**	**High**
Segregation	97.80	87.80	86.40	94.30	90.70
Recycling	44.40	54.90	47.60	51.80	48.80
Reusing	53.60	59.80	56.30	59.80	41.90
Composting	38.70	52.80	40.80	49.50	44.20
Dropping at the MRF	43.60	45.70	53.90	44.50	25.60

Sell out has been considered as the main type of waste disposal across types of community and income class classification for glass and plastic bottles, metals, wires, and nails. The same observation can also be deduced for tin cans, only that those coming from high-income classes usually put them in the trash. This concurs with the study of Reyes and Furto (2013), that selling of bottles, plastics, cans and other scraps to junk shops is a common practice for such types of waste.

On one hand, putting in the trash or mixing with the other trash is the usual means of waste disposal for batteries, bulbs, rubbers, slippers, and expired medicines. Hazardous waste including the batteries should be placed in different containers, separated from the nonhazardous wastes (Tinmaz & Demir, 2006). Food leftovers were usually being fed to the animals while animal wastes were usually left on the lawn, or thrown on the compost pit. Feeding of food leftovers to animals was also observed in the study of Mukama, et al. (2016) and Reyes and Furto (2013).

Fabrics and textiles were usually reused, while cardboards were sold, except for those households from the urbanising areas, because they tended to burn them. The main waste disposal for rubber tyres across all types of community is putting them in the trash. This is very different from other countries. For example, rubber wastes were recycled and were subjected to various methods of treatments which will then be used as rubber powder for asphalt pavements, etc. (Abbas, 2007). On one hand, reusing of textiles compared to other means, including recycling, is way more beneficial (Sandin & Peters, 2018).

Several solid waste management practices across types of wastes were recommended by researchers. For instance, Desa, Abd Kadir and Yusooff (2012), recommended increasing the

participation of constituents in recycling and composting, reducing waste produce and promoting the 3Rs – reduce, reuse and recycle. Tinmaz and Demir (2006), suggested that to maximise recycling, thereby minimising landfill use, a system shall include waste separation or segregation, which is highly done by the respondents of the present study, among others including recycling and composting. The same study advised using containers instead of the use of plastic bags.

Table 3: Usual Means of Waste Disposal of Identified Types of Wastes Across Types of Community and Income Classes

Type of Wastes	**Type of Community**		**Income Classification**		
	Urban	**Urbanising**	**Low**	**Medium**	**High**
Glass Bottle	Sell Out (55.25%)	Sell out (57.32%)	Sell out (60.19%)	Sell out (57.65%)	Sell out (39.53%)
Plastic Bottle	Sell out (51.38%)	Sell out (52.66%)	Sell out (52.43%)	Sell out (54.80%)	Sell out (39.53%)
Tin Cans	Sell out (44.20%)	Sell Out (47.97%)	Sell out (53.40%)	Sell out (45.91%)	Put in trash (48.84%)
Food Leftovers	Feed to the Animals (70.16%)	Feed to the Animals (78.46%)	Feed to the Animals (80.58%)	Feed to the animals (74.73%)	Feed to the animals (62.79%)
Vegetable /Fruit Peels	Drop off at the MRF (35.91%)	Throw in the Compost Pit (34.96%)	Throw in the compost pit (33.01%)	Put in trash (36.65%)	Put in trash (34.88%)
Battery	Put in Trash (50.28)	Put in Trash (30.49%)	Put in trash (32.04%)	Put in trash (41.28%)	Put in trash (39.53%)
Cellphone	Put in trash (42.54%)	Sell out (26.02%)	Sell out (39.81%)	Put in trash (33.10%)	Put in trash (46.51%)
Metals	Sell out (59.67%)	Sell out (44.72%)	Sell out (55.34%)	Sell out (50.89%)	Sell out (41.86%)
Wires	Sell out (46.41%)	Sellout (28.86%)	Sell out (36.89%)	Sell out (37.01%)	Sell out (30.23%)
Paint Cans	Put in Trash (35.36%)	Sell out (21.54%)	Sell out (29.13%)	Put in trash (26.69%)	Put in trash (27.91%)
Bulbs	Put in Trash (62.43%)	Mixed with other trash (11.38%)	Put in trash (42.72%)	Put in trash (48.75%)	Put in trash (48.84%)

Nails	Sell Out (41.44%)	Sell out (38.62%)	Sell out (44.66%)	Sell out (39.15%)	Sell out (32.56%)
Fabrics/Textiles	Reuse (48.07%)	Reuse (29.27%)	Reuse (41.75%)	Reuse (36.65%)	Reuse (30.23%)
Paper/Cardboard	Put in Trash (53.59%)	Burn (39.84%)	Put in trash (44.66%)	Put in trash (54.45%)	Put in trash (48.84%)
Rubbers/ Slippers	Put in Trash (59.12%)	Put in trash (38.21%)	Put in trash (36.89%)	Put in trash (49.82%)	Put in trash (53.49%)
Rubber tyres	Put in Trash (35.91%)	Put in trash (17.48%)	Drop off at the MRF (18.45%)	Drop off at the MRF (17.79%)	Put in trash (30.23%)
Expired Medicines	Put in Trash (59.67%)	Put in trash (36.99%)	Put in trash (39.81%)	Put in trash (49.47%)	Put in trash (44.19%)
Animal Wastes	Throw in the compost pit (19.89%)	Throw in the compost pit (21.54%)	Leave on lawn or elsewhere (17.48%)	Throw in the open pit (12.10%)	Throw in the compost pit (25.58%)

Relationships between Socioeconomic Variables and Weekly Waste Generation

Relationships between household size, monthly income (in Philippine Peso), and monthly expenditure (in Philippine Peso) to weekly generated wastes (in kilograms) either classified as biodegradable, non-recyclables, recyclables, special wastes, and the total wastes.

Results showed that the household size is not significantly related to the weekly generation of wastes of biodegradable and special wastes. The same is observed for the total wastes. Nevertheless, it has a significant positive relationship with the weekly generation of non-recyclable and recyclable wastes. The higher the household size, the higher the waste to be generated. Results concerning the positive relations between family size and volume of waste can also be found in the other studies (Jaffar, et al., 2018; Sivakumar & Sugirtharan, 2012; Singh, et al., 2016; Afroz, Hanaki, & Tudin, 2010; Trang, et al., 2017; Xiao, et al., 2015).

The weekly generation of total wastes has a significant relationship with the family's monthly income. Weekly generated wastes classified as non-recyclable, recyclable, and special wastes were found to be related to the family's monthly income (in Php). This means that families with higher incomes tend to generate more non-recyclable, recyclable, and special wastes.

Income was also viewed as one of the contributory elements in the generation of waste (Singh, et al., 2016; Afroz, Hanaki, & Tudin, 2010; Trang, et al., 2017).

Table 4: Relationship Between Socio-Economic Variables and Weekly Waste gGeneration

Independent Variable	Dependent Variable	Correlation Coefficient	P-Value	Remarks
Household Size	Biodegradable	0.081	0.095	Not Significant
	Non-recyclable	0.112	0.020	Significant
	Recyclable	0.102	0.036	Significant
	Special Wastes	0.024	0.624	Not Significant
	Total Wastes	0.123	0.011	Not Significant
Monthly Income (in Php)	Biodegradable	0.064	0.185	Not Significant
	Non-recyclable	0.118	0.014	Significant
	Recyclable	0.122	0.012	Significant
	Special Wastes	0.172	0.000	Significant
	Total Wastes	0.187	0.000	Significant
Monthly Expenditure (in Php)	Biodegradable	0.110	0.023	Significant
	Non-recyclable	0.177	0.000	Significant
	Recyclable	0.119	0.014	Significant
	Special Wastes	0.184	0.000	Significant
	Total Wastes	0.236	0.000	Significant

Lastly, monthly expenditure (in Php) is correlated with the total weekly generated wastes and the same observation can be made for each of the classifications of wastes. A higher amount spent on expenditures would mean the increase in the weekly generated biodegradable, non-recyclable, recyclable and special wastes. Weng, et al. (2007), revealed in their study that an individual's expenditure on food, household appliances, and others are factors of household waste generation.

Comparison of Waste Generation across Types of Community and Income Classifications

This section presents the difference in the volume of waste generation per week across types of community (Urban or Urbanising) and income class (Low, Middle, or High).
Findings show that the difference in the weekly waste generation is seen for biodegradable wastes generated from the urban and urbanising barangays. Households from urban barangays tend to produce more biodegradable wastes than those from the urbanising barangays. On the contrary, similar wastes generated from urban and urbanising can be inferred for non-recyclable, recyclable, and special wastes.

Table 5: Comparison of the Generation of Wastes Across Types of Community

Type of Wastes	Type of Community[a]		P-Value[b]	Remark
	Urban	Urbanising		
Biodegradable	1.800	1.002	0.001	Significant
Non-recyclable	1.400	1.400	0.875	Not Significant
Recyclable	0.450	0.625	0.058	Not Significant
Special Wastes	0.000	0.000	0.934	Not Significant
Total Wastes	4.850	4.250	0.322	Not Significant

[a]Figures indicate the median values [b]Tested at 0.05 level of significance

Weekly non-recyclable waste generated across income class classification showed no significant difference. On the other hand, waste classified as biodegradable, recyclable and special waste exhibited significant differences across income classes.
Recyclable wastes generated weekly are comparably the same among households from the low and middle income classes. However, significant differences in the wastes generated by households from low- and middle-income classes to those from the high-income class were observed. Similar results can be inferred for the special waste category. Higher volumes of recyclable and special wastes were produced by the households from the high-income class compared to those from the low- and middle-income classes.

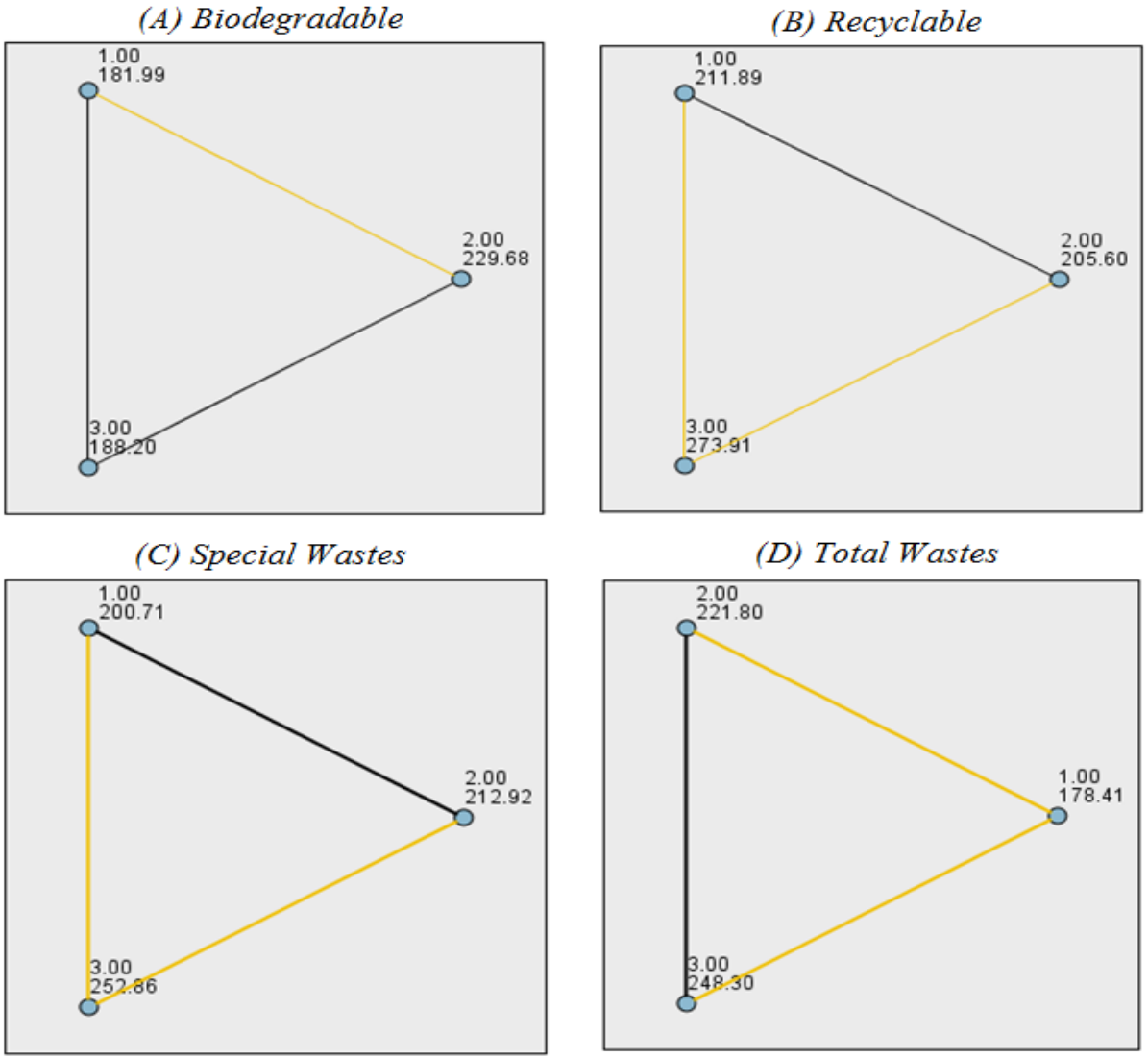
Table 6: Comparison of the Generation of Wastes Across Income Classes

Waste Classification	Income Class[a]			P-value[b]	Remark
	Low	Middle	High		
Biodegradable	0.750	1.500	1.003	0.001	Significant
Non-recyclable	1.200	1.450	1.750	0.120	Not Significant
Recyclable	0.500	0.500	1.350	0.003	Significant
Special Wastes	0.000	0.000	0.000	0.000	Significant
Total Wastes	3.510	4.550	5.450	0.001	Significant

[a]Figures indicate the median values [b]Tested at 0.05 level of significance

Middle-income households produced higher biodegradable waste than low-income households. In terms of the total wastes generated weekly, the households from the low income are comparably higher than those from the middle- and high-income classes. Total wastes generated by the households from the low- and middle-income classes are not significantly different. The study of Trang, et al. (2017) revealed that families of higher income generate less organic wastes. However, other waste classifications and income shows a direct relationship. These studies also confirm that waste generation varies across income levels (Singh, et al., 2016; Afroz, Hanaki, & Tudin, 2010; Trang, et al., 2017).

Figure 2. Post hoc Comparisons in Waste Generation Across Income Class Classification (1) Low-Income Class, (2) Middle-Income Class, and (3) High-Income Class; figures below the income classes indicate the mean ranks; yellow colored lines indicate statistical significance using Dunn-Bonferroni Test.



Conclusions

Kitchen/canteen waste, plastic film packaging, nappies, and dense plastic bottles and jars are among the type of waste that contribute highly to the total waste generated by a household weekly. Selling out, putting in trash, reusing and throwing into compost and open pits are the usual means of waste disposal. Socioeconomic-correlates of weekly generated wastes includes the household size, monthly income (in Php) and expenditure (in Php). Households from urban barangays tend to produce more biodegradable waste than those from the urbanising barangays. Higher volumes of recyclable and special wastes can be produced by

the households from the high-income class compared to those from the low- and middle-income classes.

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