Evaluating school eco-centers at elementary schools in Calamba City, Philippines, and their impact on students' solid waste disposal practices

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Abstract

In the Philippines, solid waste management (SWM) is gaining importance given the increase in solid waste generation caused by rapid urbanization and population growth. Republic Act (RA) 9003, the country's latest law on SWM, decentralizes the management system to tackle problems on solid waste. RA 9003 mandates local government units to establish their own Materials Recovery Facilities that can segregate, reduce waste by composting, and recycle a variety of waste streams. In response to the Act, Calamba City initiated the establishment of "eco-centers" that meet the sole function of segregation. The city installed these eco-centers in many schools, subdivisions, resorts, and hospitals in the city. RA 9003 also emphasizes the importance of environmental education for raising environmental awareness and encouraging action among the people. In this study, we conducted interviews with key informants and provided a questionnaire survey to students in a model elementary school of school eco-centers, and to other elementary schools equipped with or without school eco-centers to evaluate the educational benefits produced by the school eco-centers. The results showed that the students in the model school practiced proper segregation and had a sense of responsibility which affected the students' littering behavior and waste segregation. In addition, we found that the activity of the school eco-center, together with the "Eco-waste sa Eskwela" school waste education program provided students, teachers, and parents with the opportunity of practicing proper segregation, and also provided schools with economic benefits from managing recyclable waste.

1. Introduction

Solid waste is generated by the common daily activities of human beings and its rate and composition change depending on the economic situation, industrial structure, waste management regulations, and lifestyle of individual countries (IPCC, 2006). It is important that those involved understand and take into account environmental impacts, financial and economic calculations, and social and cultural issues; as well as the institutional, political, and legal frameworks in place when officials of a country make a plan for solid waste management (SWM) (Zurbrügg, 2002). In general, municipal SWM is an intensive service because the local governments have to be charged with enormous tasks from the generation to the final treatment of solid waste. In addition, if the service is not well managed, solid waste will lead to negative impacts on public health, the local and global environment, and the economy via such as air and water pollution and local flooding (Hoornweg et al., 2012).

The concept of "Integrated Solid Waste Management" (ISWM) appeared and had become a standard worldview by the middle 2000s (Wilson et al., 2013). It takes into account "the need to approach solid waste in a comprehensive manner with careful selection and sustained application of appropriate technology, working conditions, and establishment of a 'social license' between the community and designated waste management authorities (most commonly local government)" (Hoornweg et al., 2012). The concept of ISWM is considered differently in developed and developing countries. According to Wilson et al. (2013), the term "ISWM" in developed countries mainly means technical aspects, for example, focusing on the integration of the waste hierarchy or combination with other sources of waste. On the other hand, in developing countries, ISWM means the accepted paradigm in practice, for example, targeting both the physical elements and the governance aspects, accomplishing some form of financial sustainability, and enhancing institutions to perform their public tasks. The reasons for this difference are believed to be that technologies have failed in many developing countries because of the ignorance of soft governance aspects essential for implementing local sustainable solutions. In particular, a lot of cities in developing Asian countries face serious SWM problems with their rapidly increasing populations. The composition of solid waste has changed from mainly organic waste to plastics, paper, and packaging materials because of rapid development and changing public lifestyles (Idris et al., 2004). Moreover, Idris et al. (2004) also mentioned that "both the quantity and composition of waste varied widely from day to day and season to season, and considerable differences may be observed not only between countries, but also between neighboring localities and between

types of property within the same city." Although the composition of solid waste has been changing, a typical SWM system in developing Asian countries can be described as including the following elements (Zurbrügg, 2002)[1].

- Household waste generation and storage
- Reuse and recycling on household level (includes animal feed and composting)
- Primary waste collection and transport to transfer station or community bin
- Management of the transfer station or community bin
- Secondary collection and transport to the waste disposal site
- Waste disposal in landfills

SWM has become more important in the Philippines, a developing country with a rapidly growing population. In the year of 2001, the Philippine government enacted "Republic Act 9003" (RA 9003), also known as the "Ecological Solid Waste Management Act (ESWMA) of 2000". The Act declared the aim of the country to adopt a systematic, comprehensive, and ecologically compatible SWM program to ensure the protection of public health and the environment (Republic of the Philippines, RA 9003, Chapter I, Article 1, Section 2, 2001). The solid waste in RA 9003 refers to "all discarded household, commercial waste, nonhazardous institutional and industrial waste, street sweepings, construction debris, agricultural waste, and other nonhazardous/nontoxic solid waste" (Republic of the Philippines, RA 9003, Chapter I, Article 2, Section 3, 2001); in other words, the Act does not include hazardous solid waste. This Act, as the latest SWM law, stipulates the system to be used for SWM[2] and decentralizes the implementation of SWM. One of the actions provided by RA 9003 is the establishment of Materials Recovery Facilities (MRFs), which provide a solid waste transfer or sorting station, drop-off center, a composting facility, and a recycling facility in every barangay[3] (or cluster of barangays) to encourage source reduction and recycling (Republic of the Philippines, RA 9003, Chapter III, Article 4, Section 32, 2001). However, there are some difficulties, such as financial limitation and institutional issues, in expanding the establishment of MRFs.

Due to financial limitations, the city of Calamba, the research site of this study, has been establishing "eco-centers" [4] with only the function of segregation (instead of MRFs), in

[1] Adapted from Zurbrügg, 2002
[2] Solid waste in this study also refers to all discarded non-hazardous solid waste.
[3] Barangay: the smallest political unit in the Philippines
[4] "Eco-centers" in Calamba City are different from the "Eco-Centers" in the study by Acosta et al. (2012b).

many places in the city such as hospitals, resorts, schools, subdivisions, and the city hall. The city aims to encourage public participation in proper segregation through the activities of the eco-centers, but the effects and the significance of them have not yet been assessed. Moreover, in Chapter VII of RA 9003, Section 55 and 56 stipulate the provision of education and information campaigns or programs on SWM for the citizens, and the strengthening of the integration of environmental concerns in school curricula at all levels. However, city officials are still struggling in the attempt to encourage citizen participation in the use of these facilities, for various reasons. The objectives of this study were 1) to assess the linkage between the school waste education program and activities regarding school eco-centers in elementary schools, 2) to determine the significance of school eco-centers in terms of awareness, participation, and attitude toward recycling through comparison of the model elementary school for the school eco-center and other elementary schools, and 3) to elucidate educational effects of school eco-centers on students.

2. Study Area

2.1 Solid Waste Management System in the Philippines

The Philippines comprise 7,109 islands with land area of 299,404 km^2 (Ministry of Foreign Affairs of Japan, 2016). As of September 30, 2016, the country is divided into 18 regions, 81 provinces, 145 cities, 1,489 municipalities, and 42,036 barangays. The population of the country is 100.98 million (2015 census) and the annual population growth rate from 2010 to 2015 is 1.7 percent (Philippines Statistic Authority, 2016). With the increasing population, the projected waste generation is also expected to increase (Figure 1) and is calculated considering predictions of rapid increase in the population, industrialization, and development of the Philippine economy (National Solid Waste Management Commission, 2016).

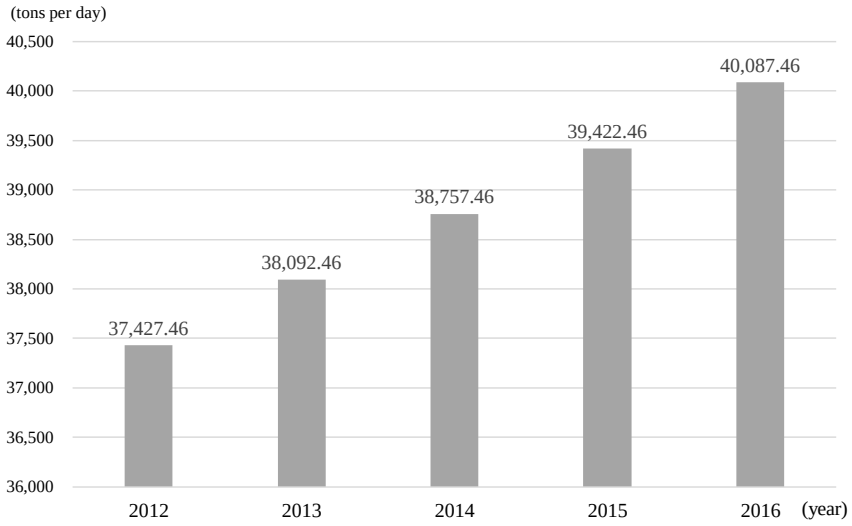

Figure 1. Projected Waste Generation in the Philippines from 2012 to 2016 (Source: National Solid Waste Management Commission, 2016)

The Philippine government has enacted various laws to protect the environment and the health of citizens from diseases caused by improper solid waste disposal since 1938, in particular, RA 9003 is the latest SWM policy in the Philippines (Atienza, 2011). RA 9003 was enacted after a disaster related to solid waste disposal happened in Metro Manila in 2000, called the "Payatas Tragedy" (Pagunsan, 2012). According to Acosta et al. (2012a), "this law provides the necessary institutional support mechanisms and instructs all local government units (LGUs) to establish an ecological solid waste management program within their jurisdiction." Figure 2 shows the institutional arrangement mandated by RA 9003. In order to supervise the implementation of the Act, the National Solid Waste Management Commission (NSWMC), to be chaired by the Department of Environment and Natural Resources (DENR), was established. RA 9003 also prescribes supplemental policies and guidelines (Acosta et al., 2012a). Because the Act has completely decentralized the implementation of SWM (Acosta et al., 2012b), each LGU has to take responsibility to achieve the goals of the Act, for example, ceasing to use dump sites. In 2004, the National Solid Waste Management Framework (NSWMF) was released by the NSWMC. The framework gives priority to encourage solid waste avoidance, reduction, and recycling, to close all dump sites, and to establish sanitary landfills as highlighted in the Act. The framework also encourages LGUs to participate in composting biodegradable waste and to establish MRFs in the barangays (or village-based political subdivisions) to improve resource recovery (Acosta et al., 2012a). Figure 3 shows the number of solid waste disposal facilities (such as MRFs and sanitary landfills) in the country from 2004 to 2014.

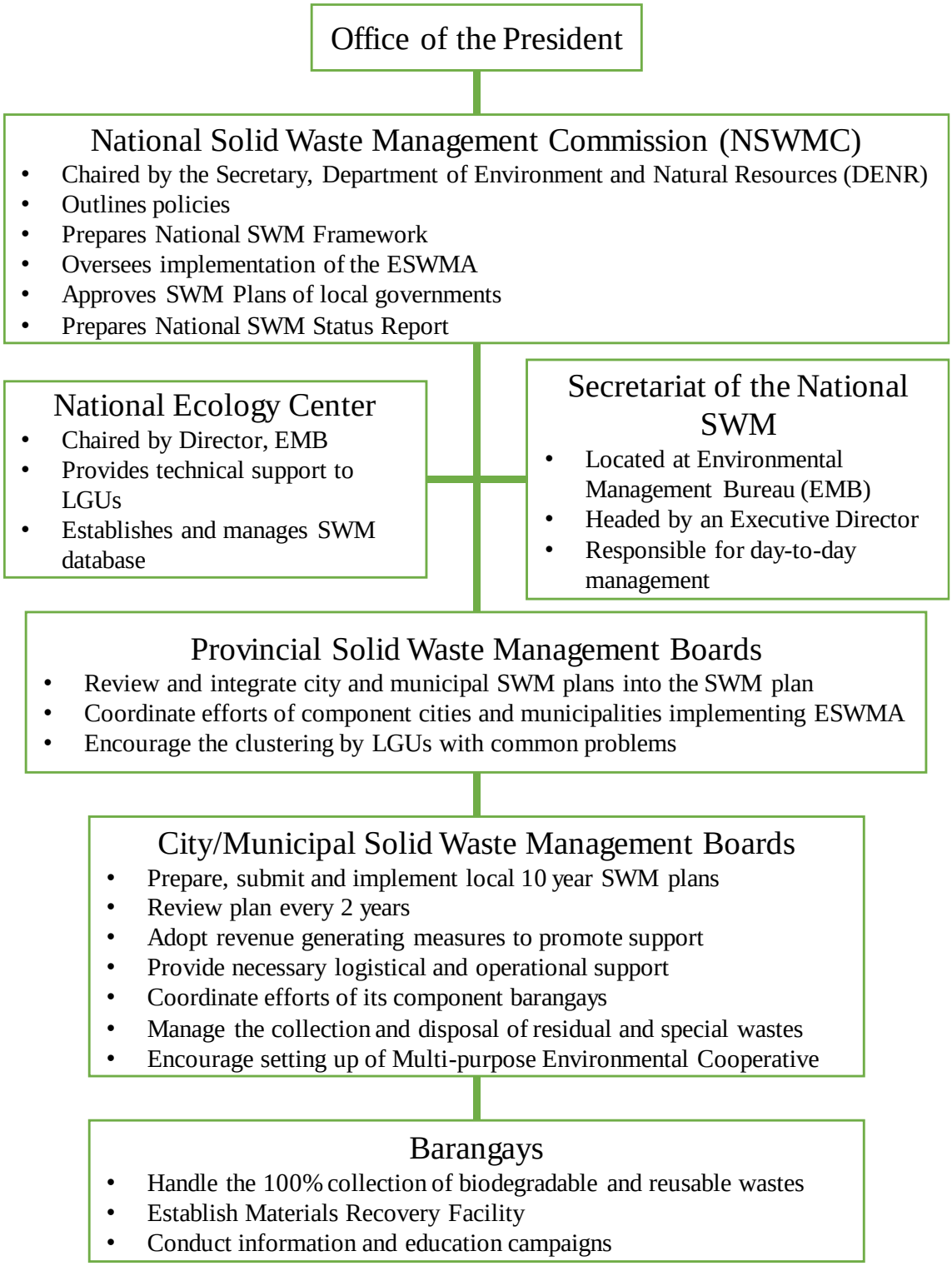

Figure 2. Institutional Arrangement Mandated by RA 9003

(Source: World Bank, Philippines Environmental Monitor 2001)

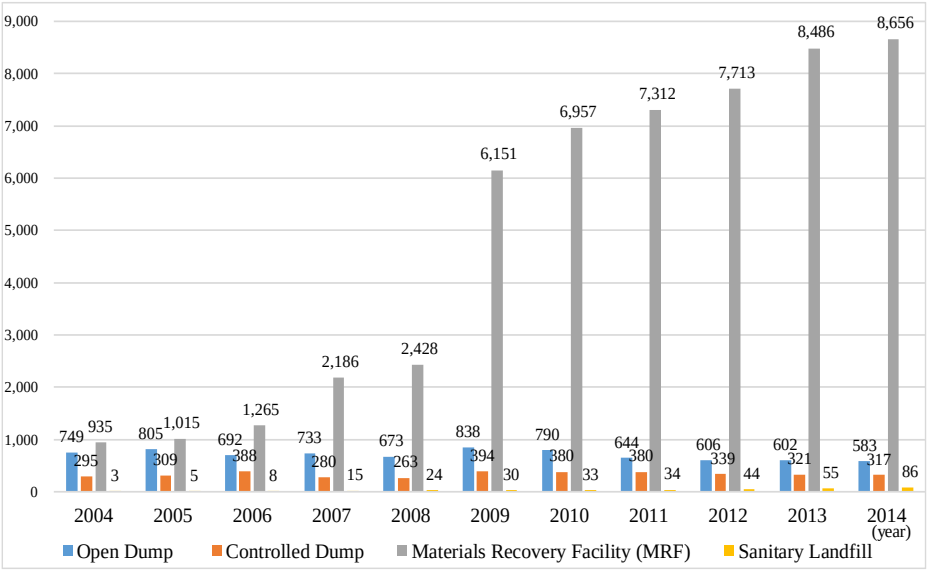

Figure 3. The Number of Solid Waste Disposal Facilities
(Source: Department of Environment and Natural Resources, 2016)

Considering the characteristics of municipal solid waste, composting is one of the most effective measures for waste diversion. Municipal solid waste in the country from 2008 to 2013 was generated from residential (56.7%), commercial (27.1%), institutional (4.1%), and industrial (12.1%) sources. Furthermore, based on available data, the typical composition of municipal solid waste in the country from 2008 to 2013 was biodegradable waste (52.31%), recyclables (total 27.78%, including: paper and cardboard 8.70%, plastics 10.55%, metals 4.22%, glass 2.34%, textile 1.61%, and leather and rubber 0.36%), residual 17.98%, and special 1.93% (NSWMC, 2015). As part of the salient features of RA 9003, the final disposal sites for residual waste should be converted from dumpsites to sanitary landfills and each LGU was ordered to divert 25% of their generated waste (Atienza, 2011). Thus, composting and recycling through the use of MRFs are expected to play important roles for achieving the mandatory waste diversion requirement as highlighted in the Act. Implementation of the Act by LGUs, however, lags because of remaining issues and concerns related to current conditions.

2.2 Solid Waste Management System in Calamba City

Calamba City in Laguna Province (Figure 4) is the research site of this study and is located 54 km away (an hour drive) from Metro Manila which is a major metropolitan area of this country. The city consists of 54 barangays of which 37 are categorized as urban and 17 as rural (City Government of Calamba, 2015) within a total land area of 149.5 km^2 (Philippines Statistic Authority, 2016). The population of the city was 454,486

and the population density was 3,040 persons per km^2 in 2015 (Philippines Statistic Authority, 2016). The city is bounded on the east by *Laguna de Bay* which is the largest lake in the Philippines; furthermore, there are two rivers of which tributaries connect to *Laguna de Bay*, along with two creeks. The 32 barangays located in the northeastern part of the city are prone to flooding and indiscriminate dumping of solid waste into the lake, rivers, and creeks is considered one of the aggravations from flooding (City of Calamba, 2014).

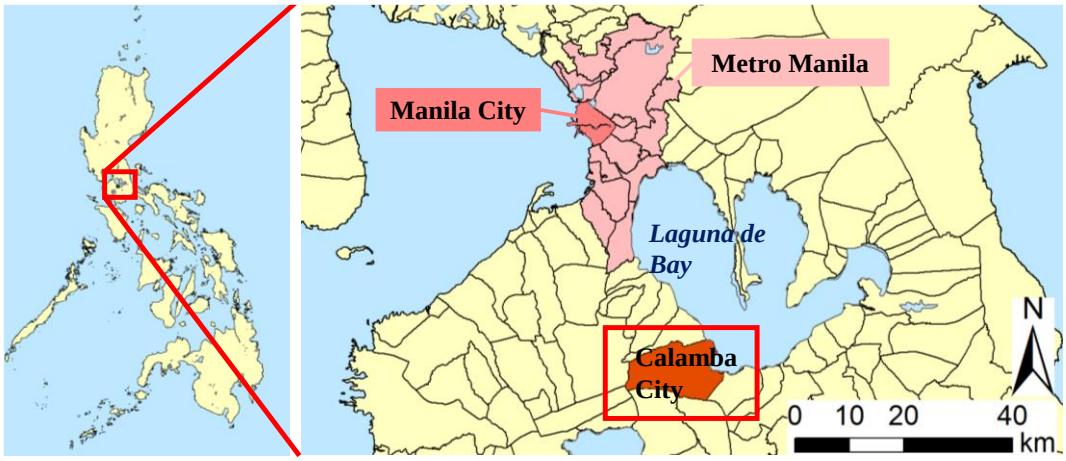

Figure 4. Map of Study Site

Due to its rapidly increasing population, the city government has made SWM a priority program because gross waste generation and population number are often closely related. In Calamba City as well, this close relationship has been estimated (Figure 5).

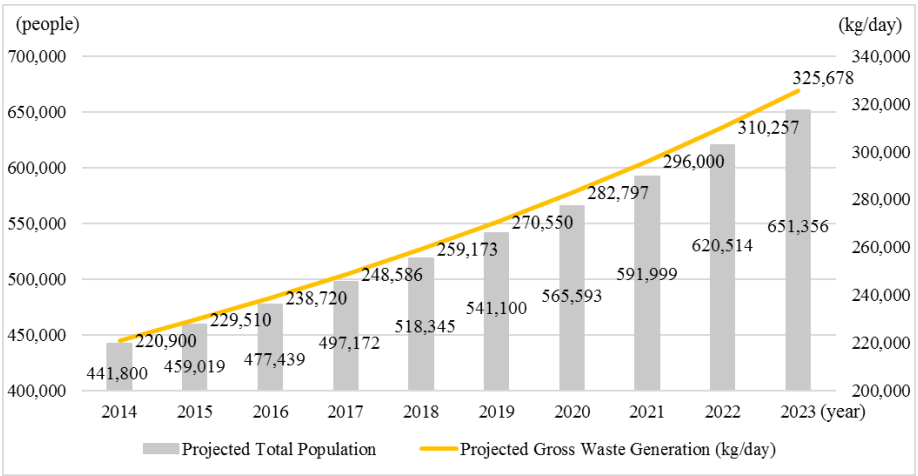

Figure 5. Projected Population and Gross Waste Generation in Calamba City (Source: The City Solid Waste Management Plan [2014–2023], 2014)

Management of the SWM system of the city is currently handled by the City Environment and Natural Resources Office (CENRO). The city government of Calamba has a contract with "RC Bella Waste Management and Collection Services" which provides waste collection service to the 54 barangays of the city. RC Bella Waste Management and Collection Services is a private company that collects and disposes of mixed waste at their sanitary landfill located outside the city, in the municipality of Norzagaray (Bulacan Province). The city spends 84 million Philippines pesos (PHP) annually for the collection and hauling of mixed waste (City of Calamba, 2014). According to the City Solid Waste Management Plan (2014–2023) (City of Calamba, 2014), the waste collection on roadways is conducted every day, and in subdivisions and on barangay roads, is conducted once a week. The city and RC Bella Waste Management and Collection Services together have developed the collection schedule, and the company now collects mixed waste along different routes using 30 trucks. Industrial sites, shopping malls, restaurants, hospitals, clinics, and high-end residential subdivisions have their own private haulers to collect and dispose of their waste including special/hazardous waste. In addition to providing mixed-waste collection service to the citizens for free, the city has been encouraged to establish MRFs and eco-centers, especially eco-centers. In accordance with RA 9003, CENRO has been establishing MRFs, which have the functions of composting, segregation, and recycling (Figure 6). However, the city has faced difficulties increasing the number of MRFs because of budget limitations, and finding appropriate sites for the MRFs has taken a great deal of time. Eco-centers that have only the function of segregation (Figure 6) were introduced instead of MRFs because the cost of their establishment was cheaper than for MRFs, and because compost (which smells bad) is not handled at those locations. As of 2014, there were 21 school eco-centers, 8 hospital eco-centers, 11 subdivision eco-centers, and 10 resort eco-centers. The citizens are expected to segregate recyclable waste and bring it to MRFs or eco-centers in their barangays or subdivisions. For biodegradable waste, they are expected to bring it to MRFs for composting. After the collection of segregated waste at MRFs and eco-centers, that which is collected will be sold to junk shops. Then, the income derived from the segregated waste will be paid to the barangay. The product from composting will be sold to private companies for fertilizer for 5 PHP per kilogram. Special/hazardous waste and residual waste will be collected by the city waste collection service. As for recycling, waste pickers also play an important role in the daily collection of solid waste in the city. They travel house-to-house to collect recyclable materials to sell to the junk shops.

a: Entrance of MRF b: Composting area inside MRF c: Subdivision eco-center d: Resort eco-center e: School eco-center

Figure 6. MRF and Variety of Eco-centers

To increase public awareness of environmental issues among citizens, CENRO provides them with various programs and campaigns, coordinating with other city departments. One of them is the "Eco-waste sa Eskwela" ("Eco-waste in School") program presented with the City Department of Education (DepEd). In 2010, CENRO and DepEd started the program to educate the students in the city on the importance of proper segregation through its practice. Installing eco-centers in each school for students to practice proper segregation aimed to achieve one of the objectives of the program. Figure 7 shows the process flow of the school eco-centers[5]. The school principal was the decision maker for the program and was assigned as manager of the program in the school. Each school assigned a teacher as co-manager of the program. Students were assigned roles as marketing manager, bookkeeper, treasurer, and environmentalist; sometimes student organizational groups (e.g., School Pupil Government[6]) assumed these roles. The schools had to prepare at least four kinds of receptacles, which were mostly located in each classroom, to segregate and collect biodegradable, recyclable, special, and residual waste. All the students were taught by environmentalists to segregate the waste in each classroom; thereafter, the segregated waste was collected (generally) once a week and was taken to the school eco-center. After collecting the waste at the school eco-center, the bookkeeper recorded the weight of the waste and the marketing manager sold it to the junk shop. The treasurer recorded the income from selling the segregated waste to the

[5] The information was derived from the program handout provided by CENRO in September 2016.
[6] "One school, one supreme pupil/student government" policy by the DepEd in 2010

junk shop, and afterwards this income entered the school budget. This could be an income-generating opportunity for the schools, thus there was no financial support from CENRO for the establishment of the school eco-centers. In 2015, CENRO and the DepEd requested all schools in the city to establish such eco-centers to ensure proper implementation of the program, and since then, the number of such facilities has been increasing. For the purpose of motivating the students, the program set "Shopping Day" which was the point exchange system. The students could earn points depending on the volume of the segregated waste, specifically per 3 kg of biodegradable waste for 1 point and per 1 kg of recyclable waste for 1 point. Points were recorded in a passbook. The students had opportunities to exchange their accumulated points for certain items every three months. The items and points needed for exchange were a ballpoint pen (3 points), a pencil (3 points), a bag (50 points), a pad of paper (20 points), and an umbrella (50 points).

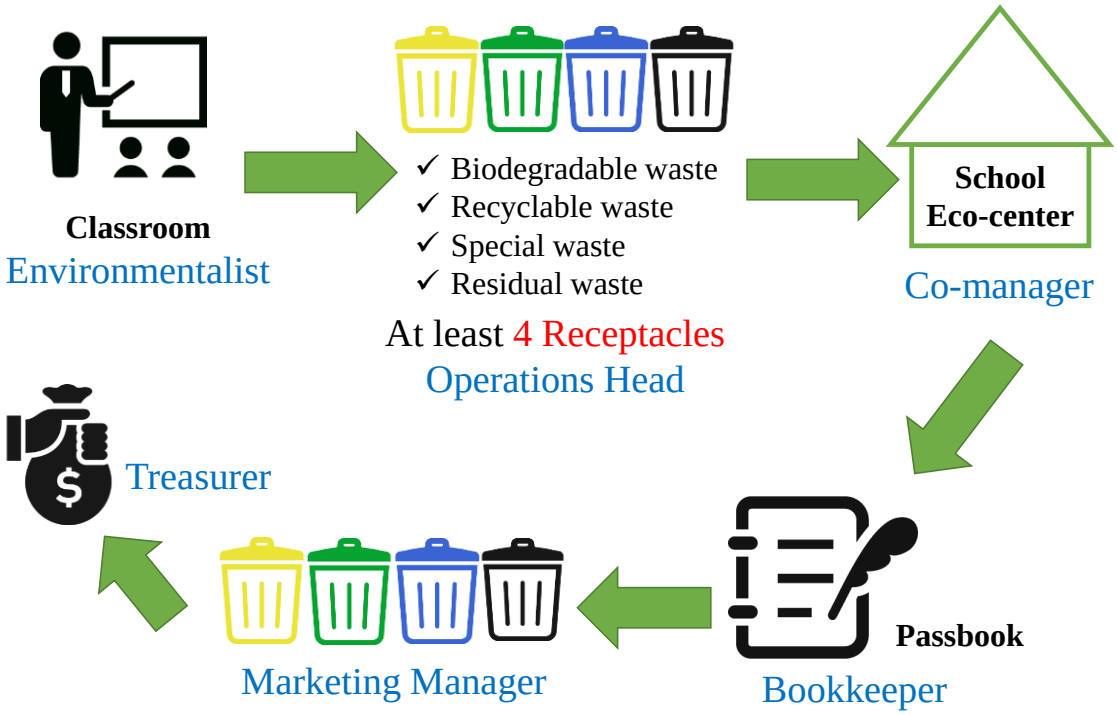

Figure 7. Process Flow of the School Eco-center

3. Methodology

This study conducted Key Informant Interviews (KIIs) and provided a questionnaire survey to students in 10 target elementary schools selected based on the list of school eco-centers in the city SWM plan (2014–2023). The school eco-centers have already been

installed at 8 of 10 elementary schools.
The KIIs were conducted to collect data about the contents of the school waste education program and management of the school eco-centers by interviewing the city officers, school eco-center managers and coordinators of the school waste education program, and school principals.
A questionnaire survey was provided to 6th-grade students to collect data on their awareness, self-reported participation, and attitude with respect to recycling and segregation. The resulting answers for these questions were tabulated (number and percentage of respondents). For the analysis in this study, we employed the Chi-square test using SPSS Statistics 19 software to test the differences in proportions with 99, 95, and 90 percent confidence levels, at P value < 0.01, 0.05, and 0.1 as the levels of significance.

The formulas of the Chi-square test and the degrees of freedom used in conjunction with the Chi-square table are (Fisher et al., 2011, Kishi, 2012, and Ishimura et al., 2014).

$$\chi^2 = \sum \frac{(f_o - f_e)}{f_e}$$

where[7]:
f_o equals the observed frequency distribution
f_e equals the expected frequency distribution of the null hypothesis

$$\text{The degrees of freedom} = (R-1) \times (C-1)$$

where[8]:
R equals the number of rows
C equals the number of columns

The null hypothesis in this study was:
H_0: The proportion rates of the two samples are equal.
P-values assist to determine the statistical significance of the results. If $P < 0.01$, 0.05, or 0.1, the null hypothesis was rejected, and the alternative hypothesis (H_1): The proportion rates of the two samples are different, was accepted.

Regarding the comparison among the elementary schools, the model school which was

[7] Adapted from Fisher et al. 2011
[8] Adapted from Fisher et al. 2011

only the elementary school that had continuous activity of its school eco-center since 2010 was selected. This study also selected other schools equipped with school eco-centers but the activities were suspended at some of these schools and they do not have long history like the model school since the schools installed the school eco-centers.

4. Results and Discussion

All target elementary schools installed three or four types of waste boxes for recyclables in each classroom and the residual waste was collected by the city government. Then students were able to practice basic solid waste segregation. In 4 of 10 elementary schools, parents were involved in managing and using the school eco-centers. Some parents reported to school eco-center managers that the students taught proper segregation at their home after learning it at their schools and their suggestions were mostly teaching their families the way of proper segregation, the value of recyclable waste, and antilittering attitudes. Hence, it could be said that the "Eco-waste sa Eskwela" program brought about positive effects affecting both students and their parents regarding their knowledge and behaviors toward recycling. This result supports the findings of Grodzinska-Jurczak et al. (2003) that the school waste education program brings about positive effects, not only to the students but also to the parents, in terms of their knowledge, attitude, and behavior toward recycling when the students share their learning and discuss the environmental problems with their parents at home. The activity of the school eco-center together with the "Eco-waste sa Eskwela" program provided the opportunities for practicing proper segregation and generating income from the recyclable waste. Figure 8 shows the roles of the school eco-centers the result from solid waste segregation in each classroom, to giving back to the students their profits for such as sponsoring student organizations and buying school supplies.

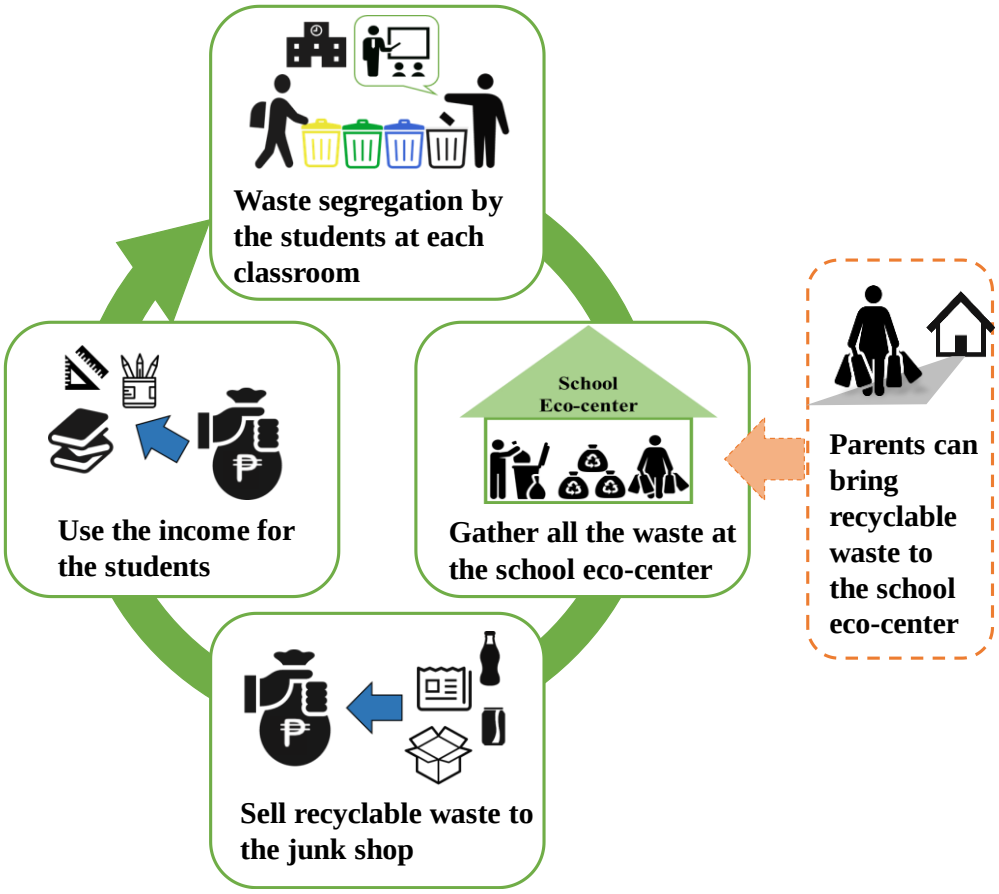

Figure 8. Roles of School Eco-center

From the questionnaire survey results, we recognized the significance of school eco-centers in terms of student awareness, participation, and attitude; and made clear the educational effects of the school eco-centers on student solid waste disposal practices. The students of the model school were more aware of the "Eco-waste sa Eskwela" program and the existence of MRFs and eco-centers, compared to the students at the groups of schools equipped or unequipped with school eco-centers (Figure 9 and 10).

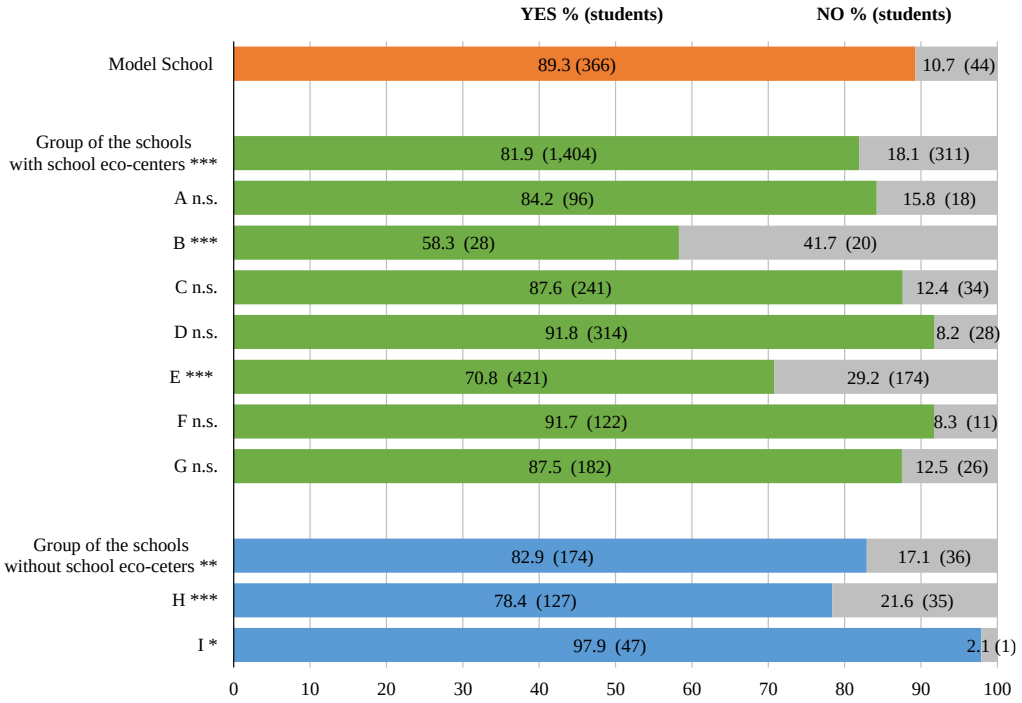

Figure 9. Awareness of "Eco-waste sa Eskwela" Program

(Note: n.s.—not significant, *p < 0.1, **p < 0.05, ***p < 0.01)

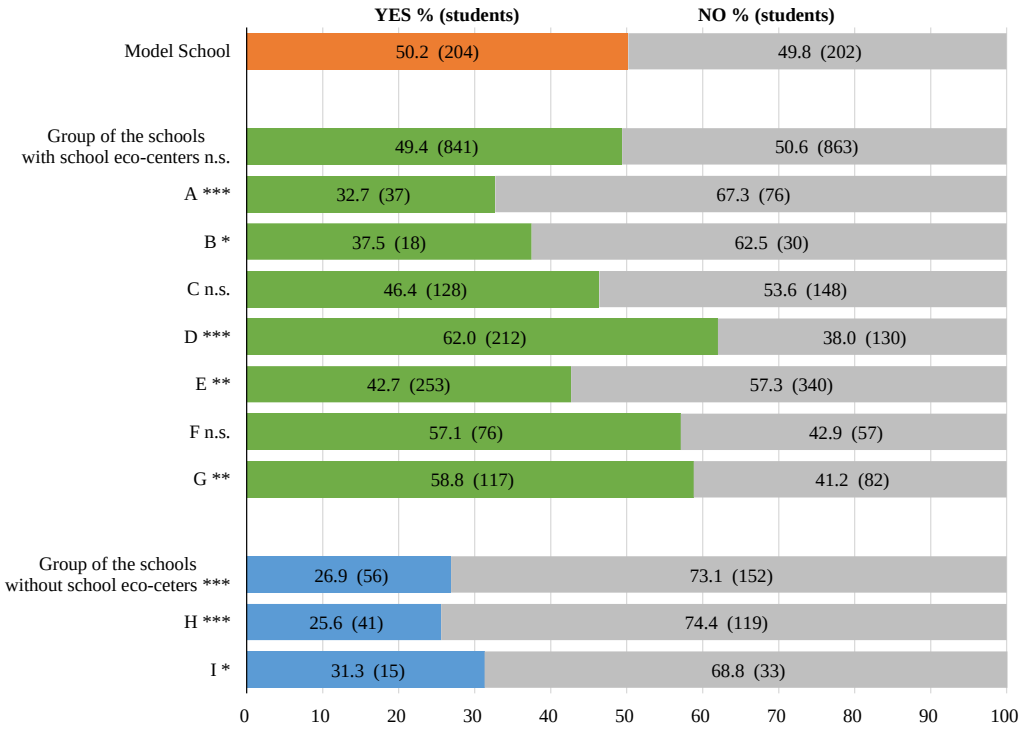

Figure 10. Awareness of the Existence of MRFs and Eco-centers

(Note: n.s.—not significant, *p < 0.1, **p < 0.05, ***p < 0.01)

On the other hand, the groups of schools equipped or unequipped with school eco-centers showed higher participation rates in the use of waste boxes at their school than did the model school (Figure 11). Desa et al. (2010) pointed out that student awareness did not always lead to change in their behavior. In this case as well, student awareness of SWM related matters was not associated with their behaviors. In particular, H and I elementary schools unequipped with the school eco-centers indicated lower percentages of student awareness and higher percentages of participation compared to the model school. The reason for these results was thought to be that the teachers conducted waste segregation as their own projects in each classroom at the H and I Elementary Schools, during which they could monitor the students closely. In addition to that, C, D, F and G Elementary Schools that were equipped with the school eco-centers also showed higher participation rates than did the model school. These schools, except for the D Elementary School, were located along *Laguna de Bay* and suffered from annual flooding. Based on the results of the KIIs, the students and the teachers shared the belief that improper SWM would aggravate the impact of flooding. The belief therefore could be considered one of the factors encouraging them to practice proper segregation. Although D Elementary School was not located near *Laguna de Bay*, the elementary school implemented the program focusing strictly on the students and each Grade Level Adviser (GLA) (8 GLAs in Grade 1, 9 GLAs in Grade 2, 10 GLAs in Grade 3, 10 GLAs in Grade 4, 9 GLAs in Grade 5, and 8 GLAs in Grade 6) monitored the students together with the school eco-center manager. Hence, the close monitoring of student practice by teachers could be considered the key factor for successful school eco-centers. Campanes-Palme (2015) also found the importance of close monitoring by school principal, teachers, staff, and concerned parents in the case of Rosario West Central School in Batangas Province.

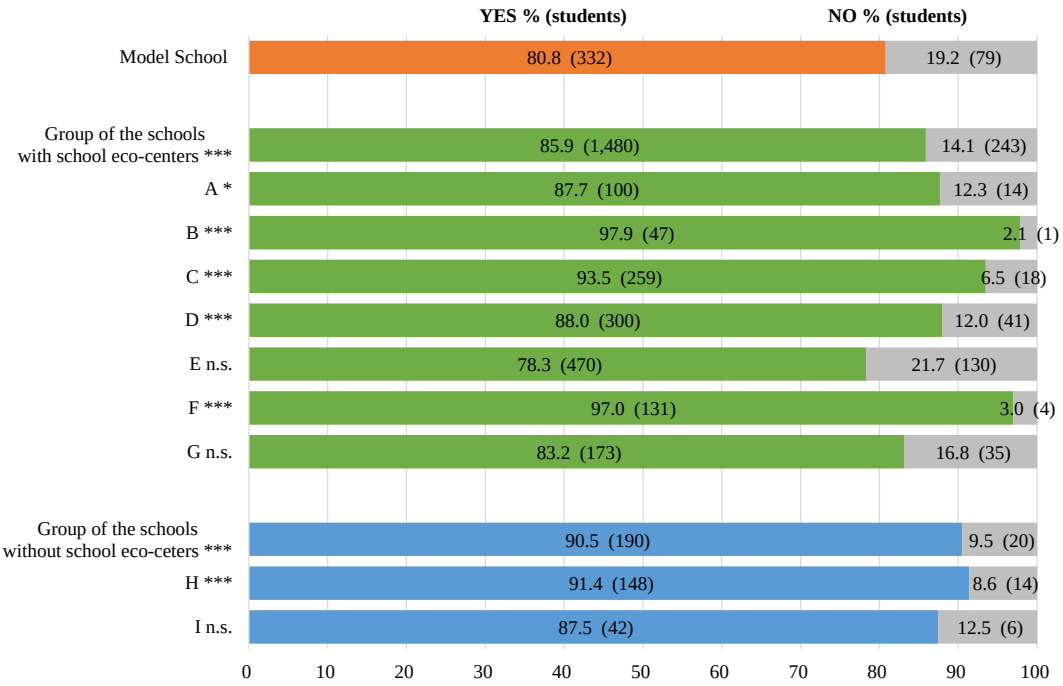

Figure 11. Participation in the Use of Waste Boxes

(Note: n.s.—not significant, *p < 0.1, **p < 0.05, ***p < 0.01)

We also detected other two features of the model school. First, the students of the model school practiced proper segregation (Figure 12); the students recognized and had confidence that they could practice proper segregation. Second, the students of the model school had a sense of responsibility for waste generation that affected the students' littering behavior and waste segregation (Figure 13). Milea (2009) confirmed the importance of the sense of responsibility for waste generation, for solving SWM problems.

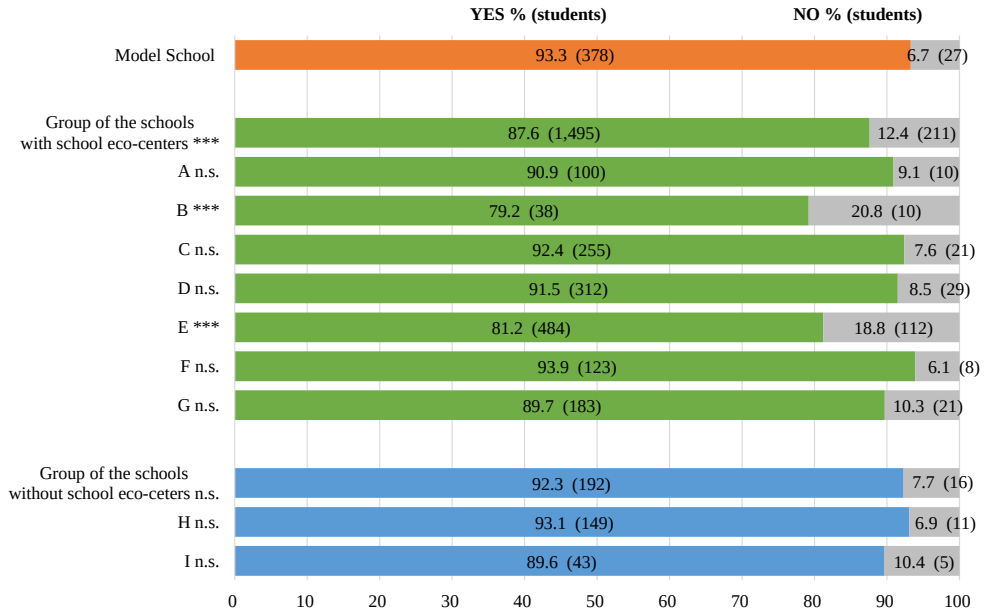

Figure 12. Participation in Proper Segregation

(Note: n.s.—not significant, *p < 0.1, **p < 0.05, ***p < 0.01)

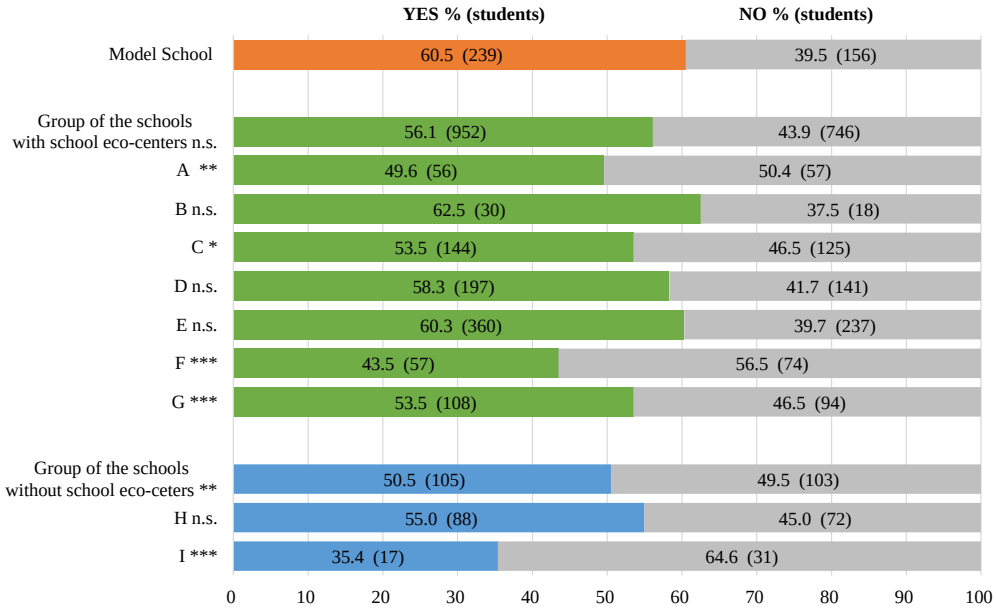

Figure 13. Attitude of Responsibility for Waste Generation

(Note: n.s.—not significant, *p < 0.1, **p < 0.05, ***p < 0.01)

Taking into consideration the features above, the continuation of activity of the school eco-centers together with the “Eco-waste sa Eskwela” program may train students to practice proper segregation and may cultivate in students a sense of responsibility for waste generation.

5. Conclusions

In this study, we analyzed the linkage between the “Eco-waste sa Eskwela” school waste education program and the activities regarding school eco-centers, to determine the significance of school eco-centers in terms of awareness, participation, and attitude toward SWM. The analysis was also used to elucidate the educational benefits of school eco-centers for students’ solid waste disposal practices. It was found that all target elementary schools installed 3–4 types of waste boxes in each classroom, which provided students with basic waste segregation practice. The activity of the school eco-center, together with the “Eco-waste sa Eskwela” program, provided opportunities for both students and parents to practice proper segregation, as well as the economic opportunity for the elementary schools to generate the income from the recyclable waste. This income was used by the students for such as sponsoring student organizations and buying school supplies.

Through comparison between the model school and other target elementary schools by the questionnaire survey, this study detected two features of the model school. The students of the model school practiced proper segregation and had a sense of responsibility for waste generation that affected the students’ littering behavior and waste segregation. Although the awareness and attitudes toward SWM did not always lead to change in student behavior toward recycling and the practice of segregation, the continuation of the activity of the school eco-centers together with the “Eco-waste sa Eskwela” program could be expected to train students to practice proper segregation and to cultivate in students a sense of responsibility for waste generation.

Acknowledgements

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