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Waste Management Practices and Carbon Footprint among Households of Senior High School Students of Regional Science High School for Region VI

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Abstract:

This study was conducted to describe the waste management practices and carbon footprint among households of Senior High School students of Regional Science High School for Region VI. A 22-item checklist questionnaire for the level of waste management practices and a 9-item questionnaire adapted and modified from the Institute for Global Environmental Strategies (IGES) 2013's 2006 IPCC Guidelines were used to collect information on waste management practices and level of carbon footprint of the respondents. Data were gathered and analyzed using the weighted mean. The results showed that the level of waste management practices among Senior High School students of Regional Science High School for Region VI in three sub-variables combined; namely, recycling, composting, and open burning was "Highly Practiced." Among the waste management practices, "Open burning" has the highest mean on Grade 11 respondents; meanwhile, "Recycling" has the highest mean on Grade 12 respondents with a level of waste management practice both labeled as "Very Highly Practiced." The level of carbon footprint among households of Senior High School students of Regional Science High School for Region VI was "Uncertain" because of an uncertain mean for the Grade 11 students.

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Introduction

With global warming and climate change becoming an important environmental concern, several studies and researches have been conducted in order to determine the most efficient way to reverse its environmental impact; and all of these lead to the same answer – reduction of carbon footprint. Carbon footprint reduction can be done through various means such as food management, transportation, and energy consumption (Berners-Lee, 2019). While food, transportation, and energy indeed contributes to carbon emission, only few studies directly focused on the waste management sector, yet many researchers identified indirect carbon emissions from upstream industries (Dong et al., 2014; Long and Yoshida, 2018, as cited in Sun et al., 2018). Moreover, carbon emission reduction from waste recycling was rarely

considered in the carbon footprint analysis of the waste management sector (Sun et al., 2018).

Before discussing waste management, it is important to understand the concept of wastes and the problems underlying with it. Solid wastes are any rubbish or refuse generated from undesirable or useless materials or substances (Desa et al., 2011). As an inevitable byproduct of human activities, solid wastes can be classified as biodegradable, recyclable, residual, and special according to the composition. When humans continue to manufacture, distribute, produce, and consume goods, the end result is waste.

This problem continues to exist and is becoming more serious, adversely impacting our quality of life. For example, in the Philippines, uncollected solid waste ends up in drains, creating blockages, resulting in waterborne and water-induced diseases such as floods and insanitary conditions impacting their quality of life (Sarmiento 2018; Agarwal and Agarwal, 2012). Specifically, in Boracay, Abbey (2019) observed the drastic difference from when they first stepped on Boracay as compared to now. They noted that Boracay saw an explosion of development leading to a construction boom. As hotels, clubs, and resorts rise, rise also the litter abuse which is caused by overcrowding as parties extend from day to night. The waters, due to poor waste management and weakly enforced island policies, soon became infested with dangerous algal blooms, or “green tide”.

In a positive note, effective waste management practices provide numerous public health, safety, and environmental co-benefits by simultaneously reducing GHG emissions and improving quality of life, promoting public health, preventing water and soil contamination, conserving natural resources, and providing renewable energy benefits (Bogner et al., 2008).

Becoming good caretakers of Mother Nature is among the qualities established in science students. Even so, environmental and health issues continue to emerge due to inadequate waste management. Carbon footprint estimation in developing countries is abundant in the literature as the relationship between waste management practices and the carbon footprint of students has been explored by several international studies which have provided sufficient evidence for other studies. However, in developing countries such as the Philippines, lack of information on the relationship between carbon footprint and waste management practices is still a problem.

In the light of the above considerations, the main purpose of this research was to determine the waste management practices among households of Senior High School students of Regional Science High School for Region VI and describe how it affects their carbon footprint. This is why the researchers aimed to uncover how waste management as a source of greenhouse gases consequently reflects to the carbon footprint of the said school.

Statement of the Problem

The primary purpose of this study was to describe the waste management practices and carbon footprint among households of Senior High School students of Regional Science High School for Region VI.

Specifically, this study sought to answer the following questions:

1. What is the level of waste management practices among households of Senior High School students of Regional Science High School for Region VI in terms of:

a. Recycling;
b. Composting; and
c. Open burning

2. What is the level of carbon footprint among households of Senior High School students of Regional Science High School for Region VI?

Methodology

Research Design

A descriptive survey method was used as the research design for this study.

Participants

The respondents of this study composed of 190 STEM and ABM students out of 372 Senior High School students of Regional Science High School for Region VI with the use of Slovin’s formula and 0.05 or 5% margin of error. Simple random sampling and stratified proportion sampling was used to determine the respondents of this study.

Data-Gathering Instrument

The data for the study were collected by combining researcher-made and adapted and modified

questionnaires that were self-administered. The questionnaire composed of three (3) parts. Part I, was to determine the demographic profile of the respondents. Part II, was the Level of Waste Management Practices Checklist. Part III, was the Data Collection Survey for the Quantification of carbon footprint from Household Waste Management Practices of Senior High School Students of Regional Science High School for Region VI.

Demographic Profile Questionnaire. This was used to assess the respondents' personal data and characteristics in terms of age, sex, grade level, strand, and number of members per household.

Level of Waste Management Practices Checklist. This was a 22-item questionnaire which is a combination of researcher-made and adapted and modified questionnaires. It determined and measured the level of waste management practices in terms of recycling, composting, and open burning.

Quantification of Carbon Footprint. This was a 9-item questionnaire adapted and modified using the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Intergovernmental Panel on Climate Change from the Institute for Global Environmental Strategies (IGES) 2013. It is divided into three (3) sub-variables: recycling, composting and open burning, respectively. To calculate the data required, the version II of Institute for Global Environmental Strategies (IGES) Greenhouse Gas (GHG) Calculator or IGES GHG Calculator was used. Users should input the corresponding answer in each sheet in order to calculate GHG emissions in each aspect such as recycling, composting, and open burning.

Results and Discussions

Level of Waste Management Practices among Senior High School Students of Regional Science High School for Region VI

Overall, the results found in Table 1 indicate that the respondents in Regional Science High School for Region VI "Highly Practiced" proper waste management in terms of recycling, composting, and open burning. This shows that the students, intentionally and unintentionally, are making small steps in order for them to not become a contributor to the waste management challenge not only in the Philippines, but in the world as well. Their practices include buying eco-friendly and recycled products, purchasing pre-loved items, making their own compost, and not practicing open burning.

Furthermore, "Open burning" has the highest mean with a description of "Very Highly Practiced" among Senior High School respondents. This means that the manner in which the respondents treat their dry wastes is proper and is not causing potential harmful effects not just for the planet but their own health as well. In terms of dry waste processing, the respondents segregate their wastes, and avoid the practice of open burning because it emits harmful particles for humans and the environment.

This result affirms to the findings of Dolipas et al. (2018) where it was found out that among the waste disposal practices of the Benguet State University students in their households, "waste disposal through pick-up by trucks" are always practiced; "segregate the recyclables then burn the rest" is sometimes practiced, while "burning all types of wastes" and "all wastes placed in a compost pit" are seldom practiced.

Additionally, "Recycling" has the highest mean with a description of "Very Highly Practiced" among Senior High School respondents. This implies that the respondents were practicing the most important aspect of 5R's which is to recycle, that could save them lots of money while simultaneously minimizing landfill wastes and raw materials expenditure which ultimately reduces net greenhouse gases emissions. In terms of recycling, the respondents recycle paper, glass, aluminum, plastic, textiles, and fabric in order to save money and energy.

This finding conforms to the study of Wilcox (2014) which explored how college students across different universities behave regarding the practice of recycling. The said study then found out that college students had an overall positive attitude towards recycling. In addition, it was also found out that there was no significant difference with the students' attitude towards recycling across the three different institutions where the study was conducted. Moreover, the study emphasized how the respondents repeatedly stated the importance of recycling which conforms to our findings.

Finally, placing on the last was "Composting" among Senior High School respondents with the

lowest mean and a description of "Highly Practiced". In actuality, having an accurate knowledge on how to compost is uncommon to everyone and even more so when applying the skills necessary to compost. Despite this, the respondents still had a positive attitude towards composting to have a positive impact in the environment. In terms of composting, the respondents save up biodegradable materials to make their own compost pit because they prefer making compost over commercialized ones.

This finding agrees to the study of Kunn (2017) wherein it was found out that the undergraduate students of University of Maine students had positive feelings and attitudes toward composting and sustained positive interest in practicing environmentally conscious behavior. However, it was apparent that students do not know the entire process of composting which led to the researchers suggesting that students should be provided with learning opportunity and engagement on campus.

Table 1

Means of Level of Waste Management Practices in terms of Recycling, Composting, and Open burning of SHS Students

Variables	Mean	Description
Recycling	4.00	Highly Practiced
Composting	3.71	Highly Practiced
Open burning	4.36	Very Highly Practiced
Overall	4.02	Highly Practiced

Mean Score	Scaling
4.21 - 5.00	Very Highly Practiced
3.41 - 4.20	Highly Practiced
2.61 - 3.40	Practiced
1.81 - 2.60	Low Practice
1.00 - 1.81	Very Low Practice

Level of Carbon Footprint among households of Senior High School students of Regional Science High School for Region VI

Overall, the results found in Table 2 indicate that the respondents in Regional Science High School for Region VI has an "Uncertain" level of carbon footprint in all variables namely recycling, composting, and open burning. This shows that the students were unable to identify the contribution of their waste management practices to their carbon footprint implying that they need more time to be aware of the importance of each of their waste management practices such as recycling, composting, and open burning. The researchers noted that only Grade 11 respondents either responded by stating either "I don't know", "I am unsure", or "N/A" as their answers in the survey form. Due to this, the researchers added another descriptor to answers expressing uncertainty and labeled those as "Uncertain".

It is evident as shown in the results below that the Senior High School students of Regional Science High School of Region VI could not identify their estimated inputs needed for the calculation of their carbon footprint, resulting to an overall "Uncertain" level of carbon footprint.

The result of this study is directly proportional to the research conducted by Cifrian et al. (2012), which they concluded that the information available on carbon footprint is uncertain and inconsistent which leads to significant differences in CF estimations among different models. Moreover, they stated that the use of different CF models and the application of a sensitivity analysis would improve the decision-making process in the subject of municipal solid waste management.

Furthermore, even though the data shows that Senior High School students of Regional Science High School for Region VI have a descriptor of "Uncertain", Grade 12 students both in STEM and ABM, have a "High" description of quantification of carbon footprint as compared to the quantification of carbon footprint among Grade 11 students from STEM and ABM which is "Uncertain". Due to this, an overall "Uncertain" level of carbon footprint was the result because the researchers were unable to compute the carbon footprint of both grade levels.

The results of this study support the research conducted by Pulles et al. (n.d.), Any emission inventory will be inaccurate by its very nature (Pulles and Baars, 1991, as cited by Pulles et al., n.d.). The data collected are mostly based upon extrapolation of sample measurements or upon the use of emission factors and activity data. The accuracy of the data will be determined by uncertainties occurring in all stages of the inventorying process.

These uncertainties are caused by "naturally" occurring emissions variances. Since most

emissions are calculated by sampling, extrapolating the sample to the total emission can result in errors. Uncertainties in emission measurements, emission factors, and activity are two other sources of uncertainty stemming from the fact that no calculation or inventory can be perfect.

The results of this study is directly proportional to the published article of Henriksson et al. (2015), the broad uncertainties surrounding these quantitative calculations are another explanation for not communicating GHGs as point values. Even if they follow the same methodological guidelines, PCFs of similar products can differ by an order of magnitude between studies (de Koning et al., 2010, as cited by Henriksson et al., 2015). This is largely due to data sourcing and modeling assumptions (de Koning et al., 2010, as cited by Yoshida et al., 2014), but in some cases also to different characterization factors used to translate the environmental emissions into impacts (Hertwich et al., 2000). The characterization factors for carbon footprints are typically the global warming potentials (GWPs 100-year) reported by the IPCC, based upon the radiative forcing of different gases.

However, the study's finding of an "Uncertain" carbon footprint contradicts to a simulation conducted by Menikpura & Sang-arun (2013), which they used the same GHG emission estimation method. They were able to measure their respondents' carbon footprints and determine that a systemic approach would be more useful in terms of providing comprehensive methodology and then quantifying possible GHG reduction from an integrated waste management system. Local governments will find the results of the GHG emissions estimation highly useful in making decisions about climate-friendly waste management technologies.

Unfortunately, according to The World Bank (2016), in developing countries like the Philippines, local waste management authorities do not fully understand the connection between waste management and carbon footprint. Furthermore, while it has successfully implemented a number of activities and programs to address climate change, it still faces a number of challenges and constraints. Therefore, such concerns present new opportunities for the country to improve its efforts toward greenhouse gas mitigation and abatement in line with its focus on sustainable development (Ishigaki et al, 2011).

Table 2

Means of Quantification of Carbon Footprint in terms of Recycling, Composting, and Open burning of Senior High School Students

Carbon Footprint	Mean	Description
Recycling	uncertain	Uncertain
Composting	uncertain	Uncertain
Open burning	uncertain	Uncertain
Overall	uncertain	Uncertain

Average CO2 emissions per waste management practice	Scaling
uncertain	Uncertain
below -0.36	Low
-0.36-1.02	Average
above 1.02	High

Conclusions

Based on the findings of the study stated above, the following conclusions were made:

1. The level of waste management practices among households of Senior High School students of Regional Science High School for Region VI in terms of recycling, composting, and dry waste processing was "highly practiced" based on the garnered overall mean of the Grade 11 and Grade 12 students, both STEM and ABM. The above findings indicate that students are adhering to the required waste management guidelines. Additionally, this may lead to a sufficient understanding of proper waste management practices learned at school and at home. As a result, students were more likely to practice and follow proper waste management practices like recycling, composting, and dry waste processing, which will help them reduce their waste's carbon footprint. Furthermore, because they are exposed to proper waste management practices at a young age, they become more disciplined and responsible in these practices, leading them to understand that because they all generate waste, and they all share responsibility for it, because waste is not only the duty of those who transport, manage, or disposes it for us. Overall, this study will aid Senior High School Students of Regional Science High School for Region VI in reducing greenhouse gas emissions, which are one of the key drivers of global warming and environmental damage. Furthermore, it will contribute in the prevention of

infections spread by poorly dispersed garbage. Students will also become more responsible in terms of waste management, which is one of the first steps in becoming responsible citizens.

2. Based on the overall mean of Grade 11 and Grade 12 students, an "uncertain" result was shown on the carbon footprint level among Senior High School students of Regional Science High School for Region VI. Despite being aware of proper waste management practices, the results suggest that students still have a poor understanding of their carbon footprint or the amount of greenhouse gas they emit into the atmosphere. These came not only from waste management practices but also from various sources, such as transportation, food, electricity, etc. Therefore, due to being unsure of how much waste they produce, students were also uncertain of the level of their carbon footprint. Furthermore, due to these uncertainties, the researchers cannot calculate and conclude the level of carbon footprint of households of Senior High School Students of Regional Science High School for Region VI. These results may lead to an uncontrollable increase in greenhouse gas emissions since students were not sufficiently aware of its possible environmental impacts. Moreover, an uncontrollable increase in greenhouse gas emissions causes global warming, which leads to climate change, and manifests itself in the melting of polar ice caps, increasing sea levels, disruption of animal habitats, extreme weather events, and a slew of other harmful consequences.

Recommendations

Based on the findings and conclusion presented, the following recommendations are suggested:

1. To the students, it is recommended to assess the level of their waste management practices and to calculate their carbon footprint through the version II of Institute for Global Environmental Strategies (IGES) Greenhouse Gas (GHG) Calculator or IGES GHG Calculator. It is also recommended for them to follow the rules and regulations of the Philippine Ecological Solid Waste Management Act of 2000.

To the teachers, it is suggested that they teach the students how to separate wastes. Recycling is a very important aspect of reducing carbon footprint in schools. This may be helpful as significant amount of the things they use can actually be recycled. They may launch a recycling scheme and set up bins for the different kinds of waste, and make sure the right bins are used. In addition, it should have clearly labelled bins for glass, paper, plastic, cans and for organic waste.

To the school community, it is recommended to set up a composting scheme at the school, it can help to reduce landfill methane emissions. Additionally, it is recommended to practice composting to reduce waste to landfill, greenhouse gases and dependency upon peat-based growing media and chemical fertilizers, and to save the environment. Furthermore, composting is good for school gardens.

To the waste management sectors, it is recommended to increase consumer awareness to waste minimization issues by implementing public education programs about waste management to help consumers better understand smart recycling and composting practices.

2. To the students, it is highly recommended to continuously practice how to manage waste and to reduce carbon footprint. Separating, reducing, reusing, recycling and composting are good options for managing wastes. In that way, they could further improve their level of waste management practices and carbon footprint.

To the teachers, it is recommended for them to support this study to educate students to become conscious about our planet. Students can be involved in sustainable workshops where they participate in environmentally-friendly projects within the school. Furthermore, they may also join a campaign such as “Zero Waste”, an advocacy campaign that aims to guide people in changing their lifestyles and practices towards sustainable systems in an ethical, economical, and efficient ways, and to ensure that wastes become valuable for other uses. By joining the campaign, they can promote sustainable waste management.

To the waste management sectors, it is recommended to implement an effective waste management system in every school.

To the school community, it is highly recommended to raise awareness of these things like greenhouse gases, carbon footprints, waste, or climate change. Things like school projects and fundraising events can help educate students and their families about the importance of protecting the

environment. This may help them to manage their waste and carbon footprint.

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