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Pre-COVID 19 Pandemic Solid Waste Management and Characterization in Caraga State University, Ampayon, Butuan City, Philippines

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A B S T R A C T

Improper utilization of resources and inadequate solid waste management could lead to the increasing growth of waste and seriously affect the environment. This study aimed to assess its Solid Waste Management (SWM) using the Solid Waste Analysis (SWA) Tool and evaluate its implementation of the RA 9003 at Caraga State University before the COVID-19 pandemic. Results show that CSU was responsive to the national and local government policies on SWM in issuing memos and orders and providing facilities and manpower. Observations of reduction at source and vermicomposting were also being practiced. However, despite the provisions of color-coded and categorically labeled metal bins in specific collection points, wastes were still unsegregated, probably due to public indifference where people don't care or lack knowledge of the possible effects of improper SWM. The personnel working in collecting and transferring waste, while utilizing a single track in hauling all types of waste, also lacked proper training and adequate Personal Protective Equipment (PPE) in handling different kinds of waste. Waste Analysis and Characterization Study (WACS) revealed that CSU could generate 31.22 tons of solid waste per year with an estimated bulk density of 470 x 103 kg/m3, hence, an average waste generation per capita of 0.018kg/day. The results imply that CSU is generating a small amount of waste compared to the estimated average per capita of 0.40 kg/day in the Philippines. Provisions of adequate facilities and implementing more reduction at source, reusing, and recycling projects in the university would be beneficial in decreasing waste generation.

Keywords: *CSU, Waste Analysis Characterization, In-campus*

1 Introduction

Inadequate solid waste management (SWM) has a serious effect on the environment and serves as one of the major problems in the world (Tinmaz & Demir, 2006). The World Bank estimates that by 2025 humans will produce five trillion pounds of trash yearly in urban areas alone (Worldbank, 2019). This problem could bring about environmental challenges in developing countries (Rana et al., 2015). The term solid waste, as defined by the Philippines Republic Act of 9003 (R.A.9003), known as "Ecological Solid Waste Management Act of 2000," refers to all discarded waste from the household, commercial, institutional, industrial, street sweepings, construction debris, agriculture, and other non-hazardous/non-toxic solid (Republic of the Philippines 2006).

In the Philippines, the implementation of R.A.9003 was enacted to address the solid waste issues in the country. The act provides an ecological solid waste management program, creating the necessary institutional mechanisms and incentives and declaring certain act funds for other purposes. Nonetheless, the R.A. 9003 did not get specific attention to implementing and adopting systematic, comprehensive, and ecological solid waste management in many regions in the Philippines Republic of the Philippines 2006. Solid waste generation and composition analysis are critical first steps toward developing successful and effective planning of waste management services and strategies across the university campus (Atienza, 2011).

Caraga State University (CSU), as a center for learning, research, and dynamic communities, Caraga State University (CSU) aims to lead in environmental science studies and address ecological concerns in the country. CSU promotes ecotourism within the campus, providing an avenue for other institutions or individuals to come and visit its vicinity. This movement is an excellent opportunity to showcase best practices, particularly in SWM. Therefore, this study aimed to assess the existing SWM practices and characterize the solid waste generated at the University. The data obtained from this study could serve as baseline information for creating policies and designs for waste remediation anchored to the circular economy design.

2 Materials and Methods

Locale and Duration of the study

The study was conducted at the main campus of Caraga State University, Ampayon Butuan City. The campus has a total area of 232 ha. The 200 ha. is intended for production, research, and extension projects, while the remaining 32 ha. is allocated for academic buildings and support facilities. The designated waste collection points (Figure 1) were considered sampling points during the study. The campus has 19 waste collection points and a Material Recovery Facility (MRF) for waste collection points. The study was conducted before the COVID-19 pandemic in Academic Year (AY) 2017-2018.

Solid Waste Analysis-tool (SWA-tool)

The implementation of SWM in CSU was generally assessed using the Solid Waste Analysis tool (SWA-tool), a significant instrument designed for organizing data flow and conducting said the study. The SWA-Tool methodology considers more comprehensive requirements and essential components of a waste analysis at different stages: Pre-Investigation, Analysis design and planning, Execution of waste analysis or Waste characterization, and Evaluation of waste analysis. The provisions in RA 9003 served as the primary guide in assessing solid waste management, while the Waste Analysis Characterization Study (WACS) manual was utilized for solid waste characterization.

Pre-Investigation

Supporting information about the University, such as the general description of the area under investigation, general population information,

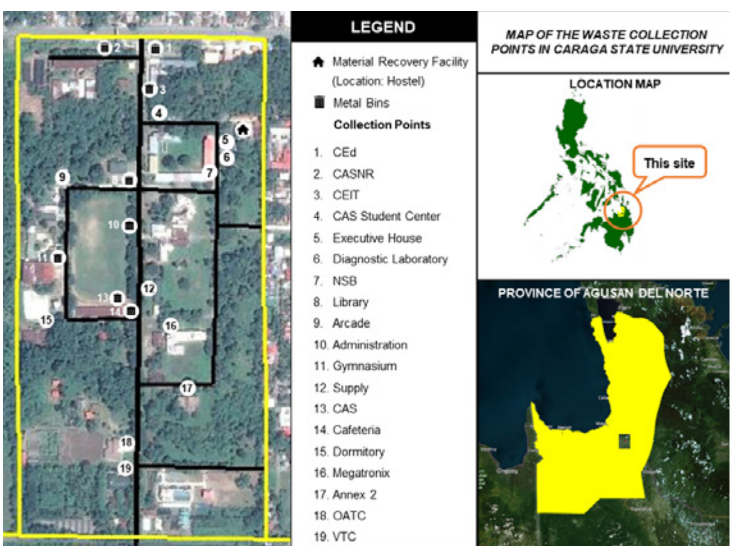

Figure 1. The waste collection points in Caraga State University

and waste management information, was obtained during the pre-investigation. Pertinent documents, such as Board of Regents (BOR) Resolutions, Memorandum Orders (MO), and Special Orders (SO) relating to environmental policies, were collected. Observations on the implementation of solid waste management in the University were also noted through the actual site and walk-in inspections and interviews with the concerned office designated for its implementation.

Design and Planning Analysis

A checklist of guide points required in RA 9003 was developed to assess the implementation of solid waste management in CSU. The checklist includes the characteristics and conditions of collection, storage, processing, and disposal, operating methods, techniques, and practices, the location of facilities where such working methods, techniques, procedures, and the nature of waste generated. The sampling schedule was patterned from the actual waste collection schedule set by the University, that is, every Monday and Thursday. A complete collection cycle was conducted two times per week to cover a minimum of one week of waste generation for the entire sampling area. At least three full collection cycles were done for each collection station.

Execution of Waste Analysis or Waste Characterization

The Execution of Waste Analysis was performed through the collection of wastes per collection station, segregation and classification of waste, and quantification of waste generated per category, including the percentage by weight and its volume equivalent. Based on RA 9003, the collected wastes were classified as biodegradable, recyclable, non-recyclable, and special wastes. Further classification per category was done according to WACS.

Collection of waste

Sampling was conducted at each of the determined collection points of the waste collectors in the university (Figure 1). The recording was done by emptying the wastes into a provided container and tagging the same with the following information: Location per collection point, Identification, Date of collection, Number and type of waste containers collected, and visual estimation of % filling level of waste containers.

Sorting and Analysis of Samples

The collected waste samples were sorted into categories according to a developed Sorting Catalogue based on the SWA-tool. The same were weighed using a digital weighing balance with an accuracy of +/- 0.001 kg and filled into a container with a pre-determined volume to estimate the volume of said waste in cubic meters.

Evaluation and Waste Analysis

The waste analysis was evaluated by comparing waste weights, volumes, and bulk density per classification for each category at every collection point. A statistical comparison of percent composition by mass for the various types in different collection cycles was also conducted.

3 Results and Discussion

Pre-investigation

The Caraga State University has released several memorandum and special orders in response to the national and local government's policies. The legal and policy frameworks governing waste management in CSU are summarized in Table 1.

The university issued orders for the Constitution of the Chemical Safety and Waste Disposal Management Committee per SO no. 305, s. 2013 aims to establish a policy on the use, handling, and storage of chemicals and hazardous materials and to review and make recommendations regarding the safe disposal of chemicals and hazardous materials. The SO no.513, s.2014 was released to create a task force in ecological solid waste management. The committee was tasked to generate information needed for the development of CSU SWM, including waste characterization and quantification, the baseline on the current waste management system, identification of stakeholders' issues and concerns for ESWM, and Vermicomposting and Trichoderma-aided decomposition, and formulate CSU SWM Policy and Plan not later than April 15, 2015.

Right after the city of Butuan issued the EO no.191, s.2016, CSU issued the MO no.37, s.2016, which called for a meeting as an immediate action to the EO. The University then issued SO no.501, s.2016, which established the university disposal committee following the revised administrative code of the Philippines and the Government auditing code. CSU recently released MO no.12, s.2018 on the implementation of the "Eco-Friendly University Policy," which was about the take-off of the soft implementation of the "No Plastic University ."This policy specified that takeout orders be served in non-disposable containers. It further stipulated that only glass bottled soft drinks be sold, no use of plastic straws and that consumers must bring their garbage and dispose of it properly. This policy aimed to minimize waste generation and encourage waste reduction at the source.

Solid Waste Management Implementation

An actual site inspection and walk-in observation were performed to establish the current SWM practices on campus. CSU provided garbage bins in designated areas, including lecture halls, restrooms, offices, the canteen, the fields, and the roadway. The institution generally has three types of solid waste facilities around the campus: the PET bottle towers, garbage bins, and an MRF. Following RA 9003, the General Services Office (GSO) provided an inventory of current solid waste facilities on campus (Table 2).

Five fabricated PET bottle towers are designed to collect waste from plastic bottles. Eight sets of metal bins were deployed in different strategic areas, and space designated as MRF by the University was also utilized as a drop-off station for wastes. The metal bins are labeled and categorized into four classifications according to the following color codes: green for biodegradable, red for residuals, blue for recyclables, and yellow for dry paper in compliance with RA 9003, which requires containers depending on its use shall be appropriately marked or identified for on-site collection as "compostable," "non-recyclable," "recyclable" or "special waste," or any other classification.

The campus has 19 waste collection points (Figure 1). However, not all collection points were provided with a set of metal bins and sufficient waste bins. According to RA 9003, adequate waste bins should be easily retrieved by the waste collector and available waste segregation with proper tagging. The collection points which do not have the provision of the set of metal bins utilized the other types of containers provided by the campus. It includes plastic bins, sacks, polyethylene bags, cartoons, and large plastic bags. RA 9003 mandated that wastes be segregated at source, segregated as to categories, and a separate container for each type of waste from all sources, provided that in the case of bulky waste, said container will suffice, that the same be collected and placed in a separate designated area.

Notwithstanding the provision of labeled and color-coded metal bins, at different collection points, many types of wastes were still found in metal bins not following their designated category. Unsegregated wastes in other collection points were filled up with assorted garbage. According to Reyes and Furto (2013), unsegregated wastes were

Table 1. Legal and Policy Frameworks Governing Waste Management in CSU

Memorandum Order and Special Order	Title/Subject
Special Order (SO) No. 305, s. 2013:	Constitution of the Chemical Safety and Waste Disposal Management Committee
Special Order No. 513, s.2014:	Creation of task force in ecological solid waste management
Memorandum Order No. 37, s. 2016:	Garbage management in the University
Special Order No. 501, s. 2016:	Reconstitution of the University Disposal Committee
Memorandum Order No. 12, s. 2018:	Implementation of the "Eco-Friendly University Policy"

Table 2. Inventory of Existing Solid Waste Facilities in CSU

Type	Location
Polyethylene (PET) Bottle Tower	CARSUADPMCO Canteen Gymnasium CEd NSB Ecopark
Garbage Bins	CASNR CEd CEIT CAS Gymnasium CARSUADPMCO Canteen Library Administration
Material Recovery Facility (MRF)	Hostel

often due to public indifferences by which people don't care about the possible effects of the improper SWM.

In compliance with E.O.101, s 2016 from the City Government of Butuan on the strict implementation of waste segregation and reduction at source, CSU released a memorandum order No. 37 series of 2016. Source reduction is referred to as the reduction of solid waste before it enters the solid waste stream through product design, materials substitution, materials reuse, and packaging restrictions. Some components include strategies for reducing the volume of solid waste generated at the source, measures for implementing such strategies and the resources necessary to carry out such activities, and other appropriate waste reduction technologies that may also be considered, provided that such technologies conform to the standards set according to RA 9003. A waste reduction practice in different offices uses the clean side of used papers to print memos, announcements, and test questionnaires. Some waste reduction efforts for electrical surplus and IT equipment were also practiced on the campus.

The University also implements vermicomposting. Vermicomposting is the biological decomposition of biodegradable solid waste under controlled, predominantly aerobic conditions to a state that is sufficiently stable for nuisance-free storage and handling and is satisfactorily matured for safe use in agriculture (Carmel, 2005). Carabao manure and other organic wastes were utilized instead as food for the worms, i.e., African nightcrawler. Nevertheless, organic waste, especially food waste and littered leaves that were recovered upon collection and segregation of waste, were not utilized in vermicomposting. Common compostable materials found in CSU were kitchen waste such as bread, cooked or uncooked food items, food leftovers, fruit and vegetables, meat and fish, garden/park waste such as flowers, fruit, and vegetable garden waste; grass cuttings; hedge trimmings, leaves, pruning, tree branches. Organic waste recovered was disposed of at the side portion of MRF.

The traces of burning waste were also observed in the backyard of certain establishments, offices, or canteens. According to Reyes and Furto (2013), the burning of waste is one of the common practices done in communities. The open burning of solid waste is prohibited as stipulated in R.A 9003. The most popular waste management practice, especially for solid waste, was the collection and disposal of waste by the designated waste collector (Susan, 2009). The waste collection should ensure 100% efficiency through the availability and provision of properly designed containers or receptacles in selected collection points for the temporary storage of solid waste while awaiting collection and transfer to processing sites or final disposal sites. RA 9003 provides requirements for efficient waste collection and disposal as follows: segregation of different types of solid waste for reuse, recycling and composting, hauling and transfer of solid waste from source or collection points to processing sites or final disposal sites, issuance and enforcement of ordinances to effectively implement a collection system, and provision of adequately trained officers and workers to handle solid waste disposal. The collection of solid wastes further requires that collectors and personnel dealing with an array of solid wastes be equipped with protective equipment and necessary training and that the collection of solid wastes shall be done to prevent damage to the container and spillage as stipulated in RA 9003.

The CSU, through the GSO, performs a collection of waste in different collection points twice a week all over the campus using a single truck intended for such purpose. The collection and handling of waste disposal were done every Monday and Thursday. All sorts of wastes were collected during the schedule since there were no separate collection schedules, trucks, or haulers for a specific type of waste. Recyclable wastes, specifically plastic bottles inside the PET tower, were not included during the regular collection. Accordingly, the PET tower must be filled first before the bottles are collected. Said recyclable items were also personally sold by the collectors.

Wastes placed in sacks or polyethylene bags were more accessible to collect than the wastes in metal bins. In the latter, the waste content had to be transferred in the truck, followed by re-sacking, which was more laborious. While in transit, all waste collected was combined in the collection truck regardless of its primary classification. This scenario was also observed by Hazra (2009), where the collection and transfer of wastes were affected by improper bins, poor route planning, poor roads, and the number or design of vehicles for waste collection.

Three personnel were working in the collection and transfer of wastes: the truck driver and the two waste collectors. The collectors wore personal protective equipment (PPE) such as face masks, gloves, and boots. However, said PPEs were not enough to equip them against waste handling hazards. The collectors also have not undergone proper training to ensure that the solid wastes are handled adequately according to RA 9003. The same Act also requires a separate collection schedule and different trucks or haulers for specific types of garbage. Vehicles used for the collection and transport of solid wastes shall have the appropriate compartments with cover to facilitate efficient storing of sorted wastes while in transit which shall be designed to consider road size, condition, and capacity to ensure safe and efficient collection and transport of solid wastes. However, CSU only has a light truck with a single compartment to collect all the wastes. It took two to three shifts to fully gather all the wastes on the campus, which may be accounted for fuel consumption, thereby increasing the cost of the operation.

The wastes collected were transported to the CSU MRF located at the developing hostel of the University. The facility served as the drop-off station for all wastes on the campus. The facility has an estimated area of 5X8 m for waste segregation and temporary storage of recyclable waste. The current MRF is situated in the developing Hostel, just around the vicinity of classrooms, residents, and even a cafeteria. In terms of internal flow, the area for the MRF is also small to hold waste sorting and storage of recovered waste materials. There is also no existing storage for specific categorized waste. RA 9003 stipulates that MRF shall be designed to receive, sort, process, and store compostable and recyclable material efficiently and environmentally sound; the building or land layout, including equipment, must be designed to accommodate efficient and safe materials processing, movement, and storage. Lastly, the building shall be designed to allow efficient and secure external access and to accommodate the internal flow.

Characterization of wastes

One of the reasons for the persistent problem with solid waste was the increase in population (Punongbayan et al., 2014). The universities were similar to small towns because of their large size, population, and various complex campus activities. The CSU has a higher population in every first semester (Figure 2) for the time series of CSU student population from AY 2010-2011 to AY 2017-2018. An increasing student population was observed for the first semester, second semester, and summer. Before the COVID-19 pandemic, the CSU had a total student population of 4,734 in the first semester and 4,548 in the second semester. Waste quantities generated in educational institutions do not depend on the number of students and the total built surface but are influenced by the educational institution type (Loan, 2011).

The waste collection stations with their respected areas are classified into waste source categories. The collection point in the CAS building has the highest percentage of waste generation (Figure 3). One of the possible reasons for this observation is that CAS is a service college that caters to the student populace on campus. The collection point in the Gymnasium, categorized as a recreational center on the campus, holds the second highest waste generation. In most collection points, recyclable waste accounts for the most generated waste, followed by non-recyclable or residual waste. The recyclable wastes, primarily plastic bottles and dense plastics were the highest generated waste on the campus at 46%. It is followed by non-recyclable waste (30%), commonly plastic bags and wrappers, biodegradable waste (23%), food waste, tree litter, and grass trimmings.

The recyclable wastes were classified as plastic B, plastic C, straw, glass, metal (cans), tin can, paper (dry), cartoon and cardboard, textiles, metals, glossy paper, and rubber (Figure 4). These materials are viable waste sources for recycling which can be sold to junkshop outlets. The plastic B, with 85.647kg, covered the highest mass among the three (3) cycles (Figure 5A). This waste consists of plastic bottles for alcohol, juices, and soft drinks. It is the second world's most abundant waste, mitigated commonly by recycling, reusing, and selling at the nearby junkshop outlets.

Nonetheless, dry paper accounts for the second-highest waste generated at CSU. The existing practice implemented to lessen this is reusing the printed dry papers by utilizing the clean page for local memos, announcements, and test questionnaires. Smyth et al. (2010) also indicated a similar observation at the Prince George campus of the University of Northern British Columbia, where a diversified waste stream consisting of paper and paper products, disposable drink containers, and compostable organic material was also generated.

The second-highest amount of waste generated was non-biodegradable waste (Figure 5A-B). These were further classified as Plastic A, Styrofoam, complex products, nappies, broken glass, and inert. Plastic A, with 111.980kg of waste generated, commonly consists of plastic film packaging and non-packaging such as biscuit wrappers; packaging plastic film; plastic bags; refuse sacks; shopping bags; etc., while plastic B mainly consists of plastic bottles.

The results were the same in the study of Abarico

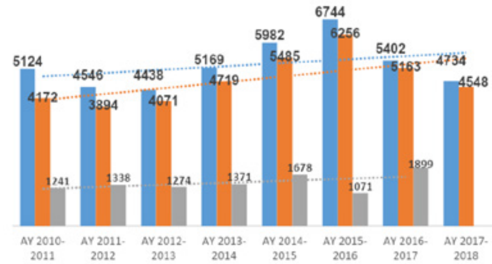

Figure 2. CSU Student Population from AY 2010-2011 up to AY 2017- 2018

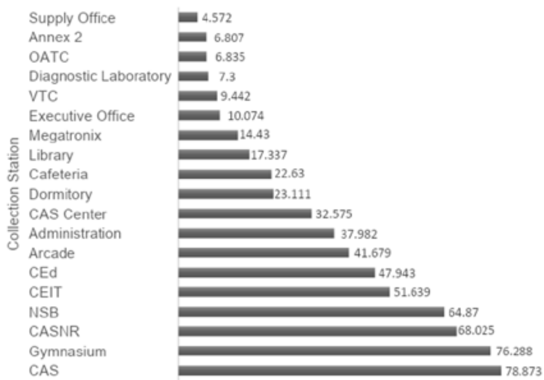

Figure 3. Summary of generated waste per collection station in Caraga State University Main campus

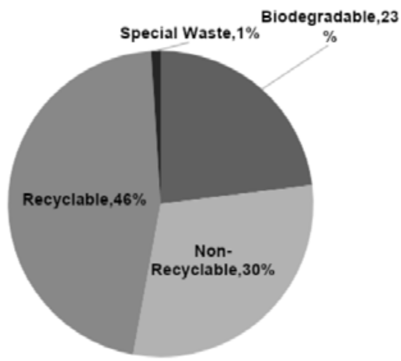

Figure 4. Percentage of solid waste generation per category in Caraga State University per primary category generated

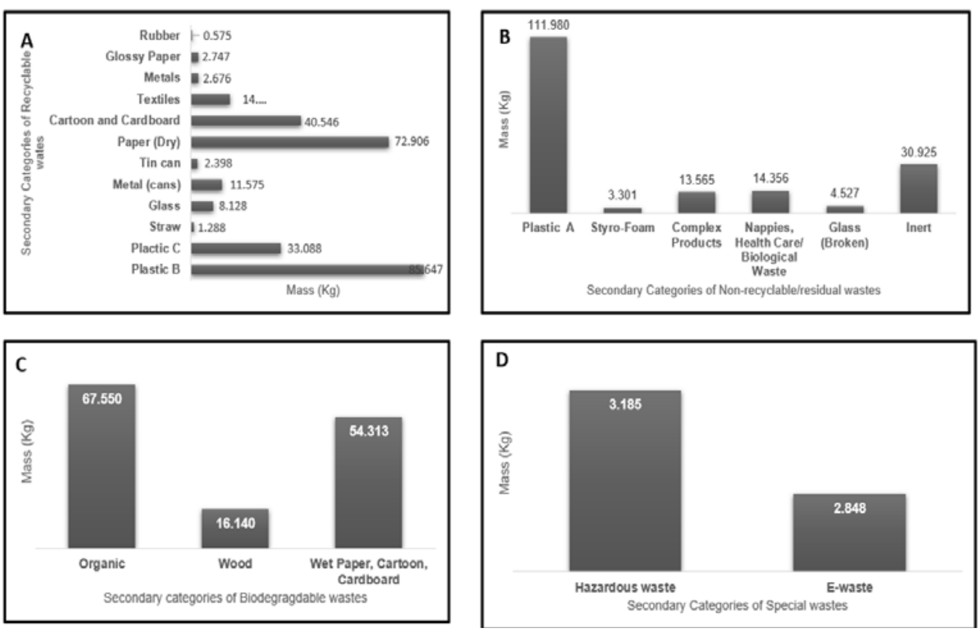

Figure 5. Secondary categories of wastes in terms of the average of three collection cycles in Caraga State University Campus. (A-B) Non-Recyclable Wastes (C) Biodegradable wastes (D) Special wastes

et al. (2009) about the WACS on a selected point source in Ampayon, Butuan City, wherein, in the institutional areas, plastic/cellophane waste was the most abundant obtaining a 39.50% concentration, followed by plastic bottles and another plastic type of waste. The production of plastics is plentiful, and it is because plastics are inexpensive, lightweight, and durable materials that can readily be molded into a variety of products that find use in a wide range of applications. Mostly, people choose to buy packaged foods because of the availability of packaged foods and the minimal effort required in carrying them. Packaging plays a vital role in maintaining food quality and preventing bacterial contamination, which also helps extend food's shelf life. Most importantly, it helps to reduce food wastage to a great extent. However, the use of packaged foods is due to various chemicals in packaging materials that can contaminate foods and lead to serious health consequences. Wastes such as plastics and paper waste were viable targets for waste reduction and recycling efforts. The municipalities of Hinatuan, Surigao Del Sur, and Santo Tomas, Davao del Sur, practiced shredding aluminum-coated plastics and using these as additional ingredients in the making of bricks and hollow blocks, while non-aluminum-coated plastics were sold into remanufacturing factories for recycling in making other plastic bags or called plastics eco-bags (National Solid Waste Management Strategy, 2016; ESWM Hinatuan, 2016; ESWM Sto. Thomas, 2010).

Organic waste was also highly present in the classification of biodegradable waste (Figure 5C). Biodegradable waste was classified into organic, wood and wet paper, carton, and cardboard. Organic waste and damp paper, cartoon, and cardboard account for the highest amount of mass in the classification of biodegradable waste. Organic waste, such as garden waste, food residues, and wet paper, can be treated in bioconversion systems and transformed into energy-rich biogas and valuable, reproducible biofertilizers (Gajdoš,1998). The same at the University of British Columbia in Vancouver that because of academic and research, paper and paper products represent the most significant component of the waste stream (Elfithria et al. 2011).

Special waste, further classified into hazardous and E-waste, was the least amount of waste generated by the University. Hazardous waste has the highest mass in the classification of Special waste. Moreover, hazardous waste and e-waste obtained the lowest quantity among other types of waste generated since hazardous wastes, especially the chemical wastes in the laboratory, were kept and prohibited from discharging used chemicals into streams. This observation was signified by the issuance of special order No. 305 series of 2013, by which there exists a constitution of the chemical safety and waste disposal management committee.

The average waste in CSU in terms of bulk density presented per waste sub-classification is shown in Figure 6. Bulk density is a physical property of matter expressed in mass per unit volume, typically in grams per milliliter, and signifies the compactness of an object. Mass is a measure of the quantity of matter and differs from weight in that weight is the force exerted on a body by gravitational attraction. Low bulk density, therefore, means that a body possesses a low mass concentration. The higher the bulk density, the lower its volume and the higher its mass, while the lower the bulk density, the higher its volume and the lower it's mass.

The bulk density per waste was determined to know the appropriate compartments or size of the vehicles used for the collection and transport of solid waste to facilitate efficient storing of sorted waste and to consider the condition and capacity to ensure the safe and efficient collection and transportation of solid wastes. Moreover, there is a need to establish an MRF designed to accommodate efficient and safe materials processing, movement, and storage, allowing efficient and secure external access and accommodating the internal flow.

The CSU has a waste estimation of 85.527kg per day, and 31,217.372kg was the estimated waste/year on the campus, equivalent to 31.22 tons of waste generation (Table 3). Meanwhile, the total waste generated on the campus in bulk density has a waste estimation of 1.287 x 103 kg/m3 per day, and 469.961 x 103 kg/m3 is the estimated waste/year on the campus. The NSWMC calculated that from 37,427.46 tons per day in 2012, the country's waste generation steadily increased to 40,087.45 tons in 2016, with an estimated average per capita waste generation of 0.40 kilograms per day for both urban and rural (NSWMC, 2015). In CSU, based on the calculated results, the capita of waste generation per day was 0.018kg and the capita of waste generation per year was 6.594kg (Table 4).

According to Loan et al. (2011), the generated

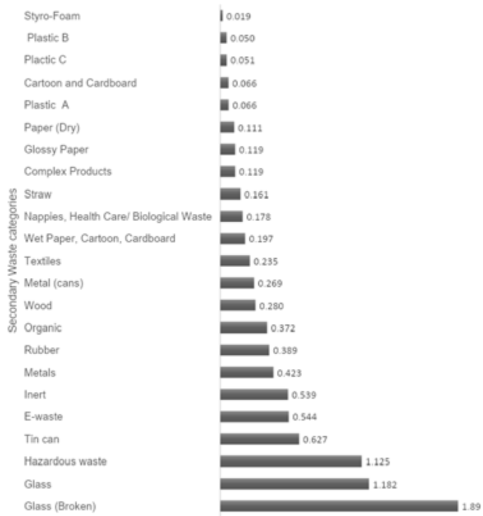

Figure 6. Average waste densities per subclassification in Caraga State University

Table 3. Total waste generation of wastes in CSU in terms of mass and bulk density.

	Average for mass (kg)	Average bulk density (kg/m^3 x 10^3)
Estimated Waste/Day	85.527	1.287
Estimated Waste/Week	598.689	9.009
Estimated Waste/Year	31,217.372	469.961

Table 4. Waste Generation per capita in terms of mass (kg)

Waste Generation per capita/ Day	0.018
Waste Generation per capita/ Week	0.126
Waste Generation per capita/ Year	6.594

waste in educational institutions was more influenced by the type of educational institution rather than by the number of pupils/students attending the classes. Pre-schools and high schools tend to produce more waste than all the other educational institutions, as evidenced by the long program characterizing pre-schools (5-10 hours per day) and high schools (6-7 hours per day). In 2010, waste generation rates varied from as low as 0.10 kg/capita/day in the municipalities outside Metro Manila to 0.79 kg/capita/day in Metro Manila and HUCs. The average per capita generation rate for the Philippines is 0.40 kg (NSWMC, 2015).

Application of Life Cycle Assessment (LCA) is a viable tool for turning waste into an economic asset for the university. The support of the administration for waste management is critical. It is recommended that the implementation of waste disposal, collection, and proper segregation of waste may strictly be implemented and monitored in all offices/colleges (Punongbayan et al. 2014).

4 Conclusion and Recommendations

Solid Waste Management must be practiced in an educational institution because it represents sustainability promotion in the society. The Caraga State University has been responsive to the national and local government policies on Solid Waste Management. Several memorandums and special orders have been issued, and various source reduction techniques have been adapted to meet the requirements of RA 9003. However, their implementation still requires additional enforcement. Nevertheless, these initiatives resulted in a capita of waste generation per day (0.018kg) that is lower than the country's average capita waste generation per day of 0.40kg.

This study recommends a circular economy design in waste management. Strong support from top management is necessary to practice separating wastes at the source. Four different, labeled or color-coded, bins should be placed at the exact location for the segregation of trash to be effectively carried out, i.e., for re-use, recycling, composting, and special wastes. Moreover, the "No Burning Policy," as stipulated in R.A 9003, as well as the hierarchy of waste minimization approaches (UNEP, 2005), must be observed. The following waste reduction initiatives are recommended to reduce the quantities of waste generation:

1. Provision of quick and easy access to information electronically to reduce paper requirements should be encouraged to reduce the printing of messages.
2. The "No plastic policy" practice must be fully implemented and sustained. Waste reuse initiatives are equally necessary, and this can be done by reusing scrap paper for printing draft copies, internal notices, and making notes.
3. Recycling programs such as the waste to cash program must be observed on the campus, which will support the provision of PET towers and recovered recyclable waste items in the university.
4. If possible, the university should use separate schedules for a specific type of waste. In addition,

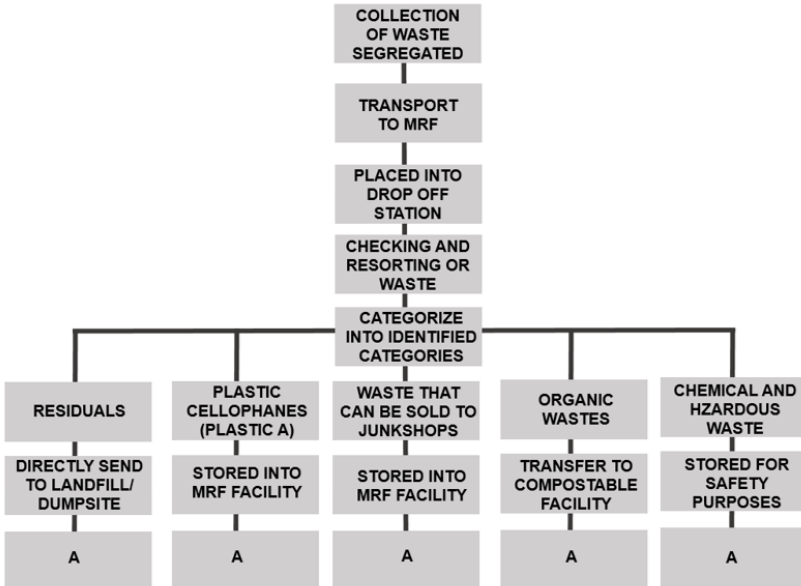

Figure 7. Proposed flow chart for waste collection and for waste categories
Note: "A" refers to recommended strategies applied to specific waste categories

the truck must have compartments that facilitate segregated waste items while in transit and prevent the mixing of wastes. The personnel must be adequately trained in the solid waste disposal and equipped with proper PPE that can protect them from the hazards of handling waste.

5. Organic wastes recovered during waste collection must be managed with other alternative practices aside from vermicomposting. If the recovered organic wastes are not appropriate for a feeding source of the composting method, passive techniques (Indian Bangalore method) and rapid methods (Berkley Rapid Composting' and 'North Dakota State University Hot Composting) may be adapted (Raabe, 2001).

6. Careful handling of waste, in particular, special waste which could be toxic and hazardous, must be applied. Maintaining and repairing the product should be considered for as long as possible to keep the item in circulation before deciding on disposal. E-waste contains precious and special metals such as gold and silver, including potential toxic substances. Thus, e-waste must be separated from the rest of solid waste, and end-of-life management of e-waste is a way to recover the valuable components and adequately manage the hazardous and toxic components.

7. CSU MRF must be improved to accommodate efficient and safe materials processing, movement, and storage. Furthermore, it shall be designed to receive, sort, process, and store compostable and recyclable material efficiently and in an environmentally-sound manner. The study recommends relocation of the MRF since the facility is located near the institutional vicinity and Hostel inside the campus. The study suggests a flow chart for MRF (Figure 7) to enable the efficient flow of collected wastes. "A" in Figure 7 refers to strategies or techniques applied to the specific waste category, such as recyclable items to be sold to junkshops.

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Statement of Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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