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An Analysis of a Waste Audit performed on UNL Campus Buildings

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Abstract

This is a research paper that analyzes data collected during a waste audit on two buildings located on the city campus of UNL. Two academic buildings known as Bessey Hall and Burnett Hall were audited for four days during two separate weeks. The total trash collected for each day was searched through and the actual waste was separated from the material that could have been recycled to see how much recyclable material was wasted each day in the building. This data collected will show the rate at which recyclable material is being thrown away. At the conclusion of the audit, the total amount of recyclable material was weighed and then recycled materials were sorted and weighed in different categories of plastic, paper, cardboard, and aluminum to see what type of recyclable material was thrown away the most. Waste amounts and recycling material amounts were compared for each building.

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Introduction

This is a research project whose goal is to conduct a waste audit of specific areas around the campus of UNL to research and analyze what is being thrown away and figure how much of that waste are materials that could instead be recycled. There are many buildings that are located on both UNL campuses. What will be studied is the different amounts of recyclable goods that have been thrown to waste. An audit will be performed on the waste and on the recyclables to determine how much recycling is ended up in the waste. This research is important because it will give data on how sustainable students and staff are on campus and provide information on how wasteful people are being. The reader of this essay should care because it is their world too. The more waste that gets collected, the more waste ends up in landfills, polluting our lands and air with greenhouse gases. The prime GHG from landfilling is methane generated by anaerobic degradation of the waste inside the landfill body (Manfredi, Christensen, Scharff, 2009). Landfills are an important global source of the greenhouse gas methane. These emissions are especially caused by inadequate gas collection systems, uncontrolled emissions from old dumps and unauthorized open dumping. The subsequent capturing and disposal of landfill gas from old landfills is technically difficult and very costly. Methane is the second most important greenhouse gas after carbon dioxide as having an impact on the changes in global climate. Since 1978 methane concentrations in the atmosphere have steadily increased by about 1% each year (Humer, Lechner, 1999). This should not make just the reader care, but everyone else in the world because this is a global issue that affects everyone living on earth. Methane is a product of landfilling municipal solid waste (MSW). “Most of the global MSW is dumped in non-regulated landfills and the generated methane is emitted to the atmosphere. Some of the modern regulated landfills attempt to capture and utilize landfill biogas, a renewable energy source, to generate

electricity or heat. As of 2001, there were about one thousand landfills collecting landfill biogas worldwide. The landfills that capture biogas in the US collect about 2.6 million tonnes of methane annually" The objective of this research project is to determine how much of the waste thrown away could potentially be separated and recycled to help ensure a low waste collection and more clean sustainability. The prediction for this experiment is that the ratio of waste to recycling material will be a 70-30 ratio. The use of these encouraging tactics to recycle could help remind people daily to recycle certain things instead of throwing them away and thus create a more recyclable, greener, and more sustainable behavior.

Background

Previous research done on waste audits in the past have given an idea of what all gets thrown away and goes to waste. To help compare to what gets thrown away on college campuses, research has been done on waste audits of hotels and a hospital ICU unit to compare what is being thrown away. For what is known about hotels, around 88% of what is thrown away is either recyclable goods, or materials that could be composted (Singh, Cranage, Lee, 2014). These include hotels that both do and do not have recyclable material collectors come and take it away. Of the hotel industry, the most accumulated recyclable material that goes to waste is plastic (Singh, Cranage, Lee, 2014). It is interesting to learn how much gets thrown away in the medical industry such as this, when so much of this material is being used daily. Related to this data which would be the waste audit for an ICU in a hospital in Australia. In all hospitals that that throw away recyclable materials, 30% of the waste is plastic, 30% is carboard and paper. An audit was done for ICU waste and of the 540 kg of total waste that was collected, 240 kg or 44% was material that could have been recycled. Currently in most nations, most plastics, and a significant amount of cardboard from hospitals are sent to landfill (McGain, Story, Hendel,

2009). From what research has shown it appears that in most cases plastic is the most common recyclable material that gets thrown away the most. It appears plastic is increasing in its amount as well. "In 1960, plastics made up less than 1% of municipal solid waste by mass in the United States; by 2000, this proportion increased by an order of magnitude. By 2005, plastic made up at least 10% of solid waste by mass in 58% (61 out of 105) of countries with available data" (Jambeck, Geyer, Wilcox, Siegler, Perryman, Andrady, Law, Perryman, Narayan, 2015). These examples of ICU and hotel waste audits were used to see how they could compare to the audits of certain University campuses. Plastic appears to be a large recyclable material that ends up in the trash. "Roughly half of the annual global production of solid plastics, or 150 million tons, is thrown away worldwide each year. The United States generates ~20% of the global amount of plastic solid waste generated. Not only is plastic waste residing in landfills harmful to the environment, but it also represents missed economic opportunities" (Garcia, J. M., & Robertson, M. L.2017). Now starting with college campuses at a Canadian University. A waste audit was performed on certain areas of campus to see what areas they should target for better sustainability. The goal that this project was trying to accomplish was to see what is the amount and kind of waste that is generated in certain areas of the campus. Special areas were mapped out and planned so the researchers could do waste sampling in those areas. Primary categories included paper, disposable hot beverage cups, plastics, expanded polystyrene, Styrofoam, glass, ferrous metals, non-ferrous metals, organic material, hazardous by-products, electronic waste, and other. The results of the research showed that, recyclable materials made up ≥37% of waste in 14 of the 15 activity areas; compostable materials made up ≥19% of waste in 11 of the 15 activity areas; and non-recyclable materials made up ≤35% of waste in 13 of the 15 activity areas (Smyth, Fredeen, Booth, 2010). In this article it was learned that just like the hospital and

hotel waste audits, this university found plastic as being one of the largest recyclable materials thrown away. Learning more about the attitude of recycling of students can be determined by what is thrown away. At the campus of University of Missouri-Kansas City, 53% of incoming freshmen lived in residence halls. To assess student's attitude toward recycling and "green living" a Waste Audit was designed as a term project for students. The results of the project showed that Solid waste generated at the three residence halls was dominated by paper and paper products (32.3%); followed by plastics (21.5%); organics, mostly food waste (16.6 %); glass (9.8%), and aluminum cans (3.9%); with electronics comprising a meager 0.2% (Hasan, Johnston, 2010). Many research projects have tried to figure out more encouraging ways to get people to recycle. More research has shown that trying to implement behaviors in kids can also increase the amount of recycling that is done. The research goal was to develop methods that would impact behaviors by students to make them contribute less waste and recycle more. The research proved by simply pairing recycling receptacles with garbage cans within treatment buildings resulted in a dramatic increase in recycling volume (65%–265%) over the eight-week study (Largo-Wight, Johnston, Wight, 2013). Research has also shown that the initial attitude towards recycling of students is a big aspect on if they will do it or not. The research experiment was created to see how much students really care about recycling and see if it is something they would do. The method was a questionnaire was created and filled out by 134 students at a large university. All of students that filled out the form had the opportunity to recycle. The categories of recycling that were ranked and rated were, Collectivism, self- gratification, Fun and enjoyment, security, inconvenience, importance, and behaviors. A percent of each category had subcategories listed that were mentioned the most by students. Collectivism included: working hard for the goals of your group, Self- gratification included: self-fulfillment, self-respect, and sense of accomplishment,

Fun/excitement: excitement, warm relationship with others, fun and enjoyment (McCarty, Shrum, 1994). This research article is interesting because it shows how the students feel about recycling and what their attitude and belief is towards it. Research shows that visuals can help spike the amount of recycling. Emoticons are defined as a representation of a facial expression such as:-) (representing a smile), formed by various combinations of keyboard characters and used to convey the writer's feelings or intended tone. Researchers hoped by placing frowning face emoticons on the lids of trash cans throughout a university, it would deter them from throwing it away and encourage them to recycle more. A four- week study was connected. Two of the weeks served as a baseline without the emoticons to see how much waste was accumulated on a normal basis. The next two weeks served as the controlled experiment with the emoticons. As a result of the experiment, it was learned that the emoticons placed on the trash cans doubled the proportion of recycling by students (Meng, 2017). Recycling bins and signs have also shown to help encourage recycling. In 2011, the U.S. Environmental Protection Agency estimated that the United States produced approximately 250 million tons of solid waste (EPA, 2012). Of this, roughly 87 million tons were recovered through recycling and composting. In a recent study, O'Connor et al. (2010) compared rates of recycling in university academic buildings when recycling bins were located either inside classrooms or in other areas. The bins were introduced in three different buildings, and in each case, approximately twice as many plastic bottles were placed in the recycling bins when those bins were located in classrooms. The authors demonstrated an impressive change in recycling behavior simply by moving bins to locations in which individuals were consuming beverages. The study took place in a four-story academic building on the campus of a public university in the mid-south. Participants included the population of students, staff, and faculty who used that building. Classrooms on the first and

fourth floors of the building were selected for inclusion in the study based on the relatively high volume of garbage and recycling they produced. In addition to placing the same recycling bins in each classroom as described above, a visual prompt was attached to the top of each recycling bin in the form of two empty beverage containers representing the type of items that could be placed there (a plastic bottle and a paper coffee cup). These two items were selected for the sign because they had been among the most common recyclable materials that had previously been found in the trash cans. When the bins were reintroduced with the addition of the signs, there was again a reduction in the amount of recyclable materials in the trash cans. With the introduction of the bins plus signs, there was a reduction in the amount of material going into the trash cans (Miller, Meindl, Caradine, 2016). A recent study by is directly relevant to the present research in that it was directed at beverage container recycling in college residence halls. Three "low rise" undergraduate residence halls were selected as target dorms. The criteria for selection were that the three residence halls were virtually identical in design. The results showed that during the four weeks of baseline, these totals ranged from 166 to 319 containers per week. However, when the intervention phase was introduced there was a modest increase to 426 containers during the first week, followed by a much greater increase (to 986 containers) the following week. These data then "settled" at about 575 containers per week for the last two weeks during this phase, or about 325 containers more than were obtained during the average week during baseline (Luyben, Cummings, 1981). The research that this project will observe will be looking into the amount of recyclable materials that have been wasted by people on campus. More research has been done looking into a waste audit that has been done in the past by the University of British Columbia. “Several options were proposed to address waste minimisation goals. These included: enhancing

the current recycling program, source reduction of plastic materials, and/or diverting organic material to composting" (Felder, M. A., Petrell, R. J., & Duff, S. J. 2001).

Methods and Materials

The design and approach to this research will be simple. Run a waste audit on those buildings to determine an initial audit of what gets thrown away on a daily normal basis, and how much of that waste are materials that could have been recycled and not thrown away. To perform the audit, first a by laying out a tarp to cover the floor. After that, the trash collected will be dumped to be sorted. By going through all the trash, waste will be taken out and thrown in on garbage bag and then recyclable material will be separated and put into a different bag. Prior to separating these, the trash collected overall should be weighed on a scale and after everything has been separated, weigh the trash and recyclables separately to make sure the first weight has been achieved. Then determine how much recyclable material was thrown away and not recycled. The audit will provide what was a part of the waste and how much of that waste could have been recycled. After that data has been analyzed, the recycling bins will be collected and measured to determined how much has been recycled. Overall, this research project will give the opportunity to decrease waste, and increase recycling to help create a more green, sustainable atmosphere within the university campus.

Materials that will be used are a large, plastic tarp to put over the ground the dump out the trash and separate. Next, a scale that will allow the weighing of the trash and the recyclable materials and bags to separate waste and recyclables into. Finally, gloves to wear for sanitation. For each bag used to separate waste, there are stands that keep the bags standing up and open, so the disposal of trash and the collection of recyclable materials is made more efficient.

Results

The collection of data took place over a took week period. Data collection started the week of March 1st and audits were run for four different day starting on Monday and ending on Thursday. The UNL janitorial staff starts cleaning buildings starting at 10:30 at night. The waste audit began at 3:00 in the morning and usually lasted around an hour. Recycling was separated into four different categories that included: plastic, aluminum, paper, and carboard. The first day of running the audit, Burnett hall accumulated three trash bags of waste. Prior to running the audit, the overall weight of the first bag was 19 pounds. After separation, the recyclable materials were measured, the first bag produced 3 pounds of recycling material with 16 pounds being trash. The second bag contained 2 pounds of recycling material with 11.5 pounds of trash and the third bad had 2 pounds of recycling material with 10 pounds of trash. On the second day of the audit, Burnett again produced 3 trash bags of waste. The first bag contained 3 pounds of recyclable material and 17 pounds of trash. The second bag held 3 pounds of recycling material and 8 pounds of trash. The third and final bag of day 2 contained 3 pounds of recyclable material with 2.5 pounds of trash. Day 3 of the Burnett hall waste audit had an accumulation of 2 trash bags collected. The first bag contained 4 pounds or recycling material with 11 pounds of trash. The second bag held 1.5 pounds of recyclables with 11 pounds of trash. Day 4 of the Burnett Hall waste audit had an accumulation of 3 trash bags. The first bag contained 5 pounds of recycling material with 11 pounds of trash. Bag 2 held 2.5 pounds of recycling material with 12.5 pounds of trash, while the third bag contained 0.5 pounds of recyclables and 5.5 pounds of trash.

When the waste audit was being run initially, glass was separated from the waste and taken into account as a recycled material. Upon further research it was discovered that Nebraska

and UNL follow a policy that glass is not considered a recycled item. Therefore, having it in the data set as a recyclable would be inaccurate. Since this was the case, glass was taken out as a recyclable and added to total waste. In the tables below there are tables containing the data sets with glass not counted as a recyclable item and glass counted as a recyclable item to see how the data and recycling rate changed. It should be noted that the tables and data showing glass as waste and not recycling are the correct and more accurate data set.

Burnett							
(In Lbs)	Total Waste	Plastic	Glass	Paper	Carboard	Aluminum	Recycling Rate
Day 1 Monday	46	2.5	0	2.5	0.5	0.5	13%
Day 2 Tuesday	39.5	3	0	1	1	1	15%
Day 3 Wednesday	29	3	0	0	0.5	0.5	14%
Day 4 Thursday	39.5	4	0	0	0.5	1	14%

The table above shows the data collection each day and the amount collected for each recycling category. Also included is the recycling rate for each day the audit was run. The rate was collected by taking the sum of the weight in each recycling category and then dividing that by the total weight for each day. The average recycling rate for the week was 14%.

Burnett							
(In Lbs.)	Total Waste	Plastic	Glass	Paper	Carboard	Aluminum	Recycling Rate
Day 1 Monday	45	2.5	1	2.5	0.5	0.5	16%
Day 2 Tuesday	36.5	3	3	1	1	1	25%
Day 3 Wednesday	27.5	3	1.5	0	0.5	0.5	20%
Day 4 Thursday	37	4	2.5	0	0.5	1	22%

The table above shows the data before the glass had been taken out and added to the total waste. The recycling rate for this data showed a higher average at 21%.

Data collection for Bessey Hall started on the week of March 8th and audits were run four times during the week starting on Monday and ending on Thursday. The buildings were cleaned at 10:30 at night and the audits started at 3:00 in the morning and lasted around an hour. Day one of the audit on Bessey contained 3 bags of trash. The first bag held 0.5 pounds of recycling and 8 pounds of waste. Bag 2 held one pound of recycling material and 5.5 pounds of trash, and the third bag contained 0.5 pounds of recyclable material and 7.5 pounds of waste. Day 2 of audits held only one bag of trash. This single bag of trash contained 3.5 pounds of recycling material and 5.5 pounds of waste. Day 3 of the waste audit contained 4 pounds of recycling and 6 pounds of waste, the second bag held 1 pound of recycling material and 7 pounds of waste. The final day of the waste audit only held one bag of trash. This single bag held two pounds of recycling material and 10 pounds of waste.

Bessey							
(In lbs)	Total waste	Plastic	Glass	Paper	Cardboard	Aluminum	Recycling Rate
Day 1 Monday	23	1.5	0	0	0.5	0.5	11%
Day 2 Tuesday	10.5	1	0	0	1	0	19%
Day 3 Wednesday	19	2	0	0.5	1	0.5	21%
Day 4 Thursday	12.5	1.5	0	0	0	0	12%

Here is the chart showing the values for the recycling categories and the recycling rate for the waste audit of Bessey Hall. The average recycling rate for the week was 16%.

Bessey							
(In lbs)	Total waste	Plastic	Glass	Paper	Cardboard	Aluminum	Recycling Rate
Day 1 Monday	23	1.5	0	0	0.5	0.5	11%
Day 2 Tuesday	9	1	1.5	0	1	0	39%
Day 3 Wednesday	18	2	1	0.5	1	0.5	28%
Day 4 Thursday	12	1.5	0.5	0	0	0	17%

The table above shows the data before glass was taken out and added to the total waste. The average recycling rate shown for this data set was 24%.

Discussion

The data and results that showed up in this research showed that the waste to recycling ratio was lower than the expected prediction. The prediction for this experiment was that the waste to recycling ratio would be 70-30. 70% of that being waste and 30% of that being recycling material. The average recycling ratio for Burnett Hall was 14% and the ratio for Bessey Hall was 16%.

The amount of the categories of recycling material thrown away relates to other buildings and companies in different fields that showed up in the literature. Related to this data which would be the waste audit for an ICU in a hospital in Australia. In all hospitals that that throw away recyclable materials, 30% of the waste is plastic, 30% is carboard and paper. An audit was done for ICU waste and of the 540 kg of total waste that was collected, 240 kg or 44% was material that could have been recycled. Currently in most nations, most plastics, and a significant amount of cardboard from hospitals are sent to landfill (McGain, Story, Hendel, 2009). At the campus of University of Missouri-Kansas City, 53% of incoming freshmen lived in residence

halls. To assess student's attitude toward recycling and "green living" a Waste Audit was designed as a term project for students. The results of the project showed that Solid waste generated at the three residence halls was dominated by paper and paper products (32.3%); followed by plastics (21.5%); organics, mostly food waste (16.6 %); glass (9.8%), and aluminum cans (3.9%); with electronics comprising a meager 0.2% (Hasan, Johnston, 2010). Plastic is a dominating recyclable material that gets thrown away often. It also proved to be in the audit of Bessey and Burnett Hall. Of all the recycling materials there were thrown away, plastic had the highest percentage in each building. In Burnett, the percent of plastic thrown away was 41% of all recycling materials and 60% in Bessey.

Overall, this project showed the type of waste that goes into the trash in Burnett and Bessey Hall. This project and data set does not represent all of UNL, however. Bessey and Burnett Hall were chosen for this project because the amount of trash that gets accumulated throughout the building is manageable for one person to go and do a waste audit and not be overwhelmed with large masses of trash. Larger buildings such as the College of Business and Hamilton Hall, the chemistry building on campus are much larger buildings and hold more people than Burnett and Bessey Hall do. If a waste audit were to be done on those two buildings, it may show different data in terms of how much recycling is thrown away. Also, in terms of this research, this project is also a subset of a waste audit done on Bessey and Burnett Hall. What is meant by that, is that the part of data collected from the waste audit is not the full data that could have been collected. Both buildings contain recycling containers inside that give individuals the opportunity to recycle what they can. The material from those containers was not collected and analyzed in this research project so it cannot be said that all data was considered for this waste audit collection process.

Conclusion

In conclusion, a waste audit was performed on Bessey and Burnett Hall on UNL's city campus. The initial prediction of the waste to recycling material was a 70-30 ratio, 70% being waste and 30% being recycling material. The actual ratio turned at to be lower than the prediction since the average recycling ratio for Burnett Hall was 14% and the average recycling ratio for Burnett Hall was 16%. The amount of trash collected in both buildings came out to be 10 pounds from Bessey and 44 pounds from Burnett. Lastly, the recyclable material that showed up the most in both buildings was plastic which was 41% from Burnett Hall and 60% from Bessey Hall. One thing that was not measured in this audit was composting which accounted for most of the waste leftover after recycling was taken out. The percentage of the remaining waste that would have accounted for compost material would be estimated to be around 45-50%. Since compost material makes up for a lot of the overall waste, new ideas and ways of implementing it across the campus could help make UNL more sustainable.

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