Waste not, want not: A waste audit of three buildings at the University of British Columbia

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CONS 330 Research Project

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Introduction:

For the year 2012, it was estimated that the 35 landfills located in British Columbia cumulatively generated 153,000 tonnes of methane or the equivalent of 2,872,000 tonnes of CO_2 annually which is approximately the emissions of 957,000 automobiles (Golder Associates Ltd 2008). With increasingly more research and public discussion about climate change and the impacts of methane and CO_2 emissions in the forefront, the buzzword of "sustainability" has been incorporated into the operational mandate of many different institutions, particularly at universities (ULSF 2006).

Research has shown that a consumers' attitude towards recycling has a significant effect on waste recycling behaviour (Biswas et al. 2000). This is due to the success of waste management initiatives depending on public participation. Thus it is worthwhile to analyze the drivers of environmentally responsible behaviour and characterize waste in universities. McCarty and Shrum (1994) found that the more an individual perceived recycling as inconvenient, the less likely individuals were to recycle.

In an effort to reduce ecological footprints, universities use the concept zero waste which focuses on solid waste reduction and landfill diversion (Rees 1992). One such development has been the upgrading of waste disposal methods (Smyth et al. 2010). One of the biggest challenges faced by the waste management departments of universities is that there can be confusion because students may not know which materials are recyclable and the result is that recyclable or compostable materials often are put into the garbage bin. (Mason et al. 2004). The disadvantage in this is that compost materials have the highest greenhouse gas emitting potential and are also costly when extracting from the waste stream (Diaz et al. 1993).

In 2010, a waste audit was conducted on the UBC campus and the main materials found being sent to the landfill were organics, paper and plastic (UBC Sustainability 2013). Organics was the number one material being sent to the landfill; it comprised of 70% of the projected waste stream, followed by paper and plastics (Felder et al. 2001). Results also showed that only 5% of UBC's overall waste was considered non-recyclable (UBC Sustainability 2013). This lack of efficiency suggested room for improvement and so, as part of this zero waste initiative, four-bin waste stations have been introduced campus-wide. These stations are comprised of four bins which include garbage, compost, paper and recyclable containers and replace individual garbage bins. However, many individual garbage bins still remain on campus due to a variety of reasons including space limitations (a four compartment station is significantly larger than a single garbage bin).

As a focus for our project we decided to see if the newly-implemented UBC sorting bins help reduce the amount of recyclables from going to the landfill. As a group our research was conducted on the University of British Columbia campus investigating how the locational convenience of recycling stations in proximity to garbage bins affects the amount of recyclables found within the garbage. We hypothesized that we would find no compost, no paper or recyclable containers (non-waste material) in an integrated four bin receptacle; some non-waste material would be present in a separated four bin receptacle and the most amount of non-waste material would be present in an individual garbage can.

Methods:

The location of this study was at the University of British Columbia (UBC) in Vancouver, British Columbia. Garbage bags were collected from bins in the following on-campus buildings: Neville Scarfe building, Macleod building and the Forest Sciences Center (Figure 1).

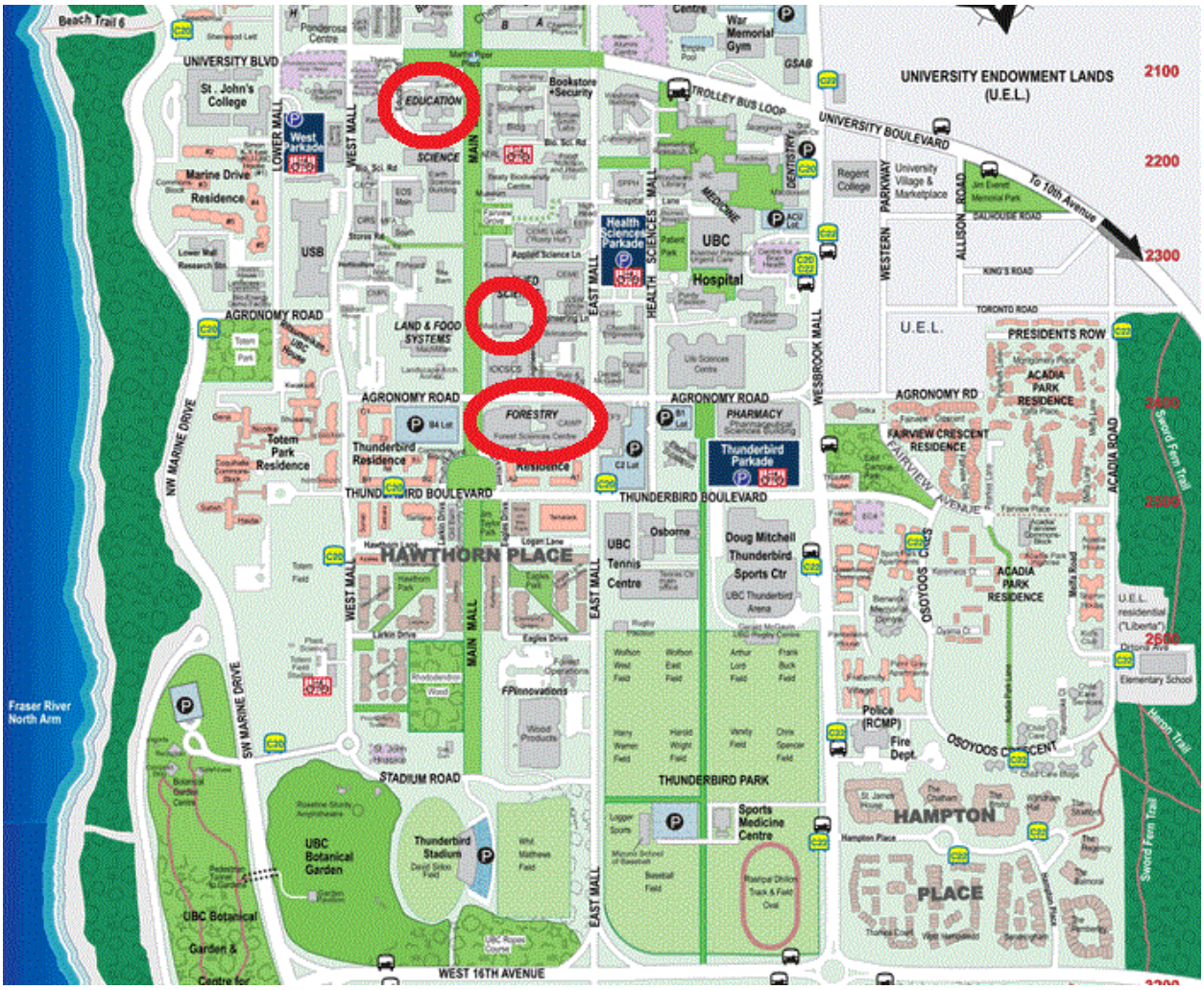

Figure 1: Locations of buildings at the University of British Columbia (UBC) where garbage bins were collected (Campus and Community Planning 2014).

Three different types of bins were used in this study and all bin types were present in the three buildings for total of nine garbage bags collected to allow for replication. The first type was a single garbage bin with no additional compost, paper or recyclable container bins nearby (Figure 2a). The second bin was a "Sort It Out" four bin receptacle which had two pairs of bins (food scraps and recyclable containers were one pair and paper material and garbage were another pair) separated by a distance greater than or equal to 1 meter (Figure 2b). The third type of bin was a "Sort it Out" four-bin receptacle with a bin for garbage, compost, paper and recyclable containers (Figure 2c).

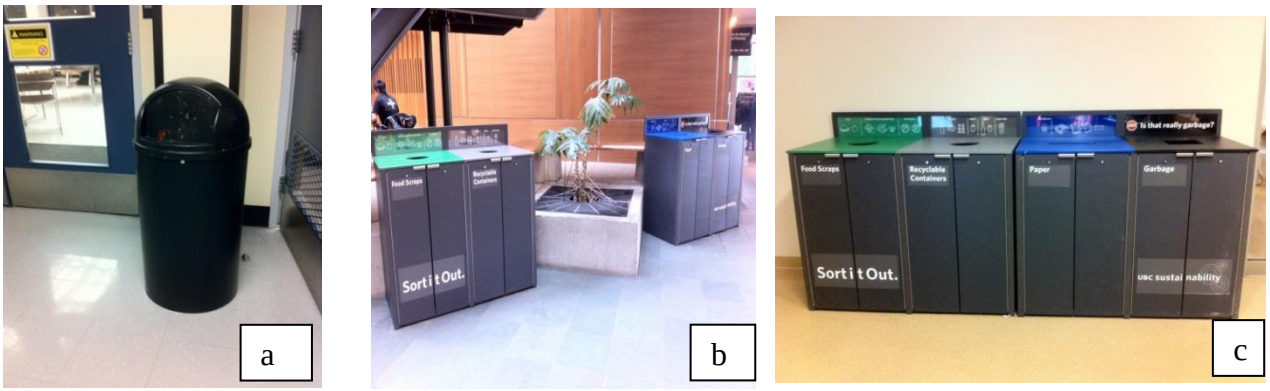

Figure 2: Individual garbage bin (a), separated garbage bin (b), integrated garbage bin (c).

Garbage bags from the bins were collected in the afternoon (between 1:00 pm - 2:00 pm) to allow materials to accumulate in the garbage bags from the time the buildings opened to the time the bags were removed by the study team. Before sorting the garbage bags, each garbage bag was weighed using a hanging scale. Next, each garbage bag was sorted and compostable material, paper material and recyclable containers were removed. The amount of compostable

material, paper material and recyclable containers per garbage bag were then weighed. Compostable material, paper material and recyclable containers were then separated and the amount of compostable material per garbage bag, the amount of recyclable containers per bag, and the amount of paper materials per bag were then weighed separately.

Afterwards, calculations were performed to determine the mean percent weight of non-waste materials (compost, paper, recyclable containers) per garbage bag per bin type. A one-way analysis of variance (ANOVA) test was performed in Microsoft Excel for calculations (Microsoft 2010).

Results:

There was twice the average percent of food scraps found in separate garbage bins than in individual garbage bins (Figure 3). Of all the treatment types, separate garbage bins had the highest average percent of food scraps and the individual garbage bins had the lowest average percent of food scraps present. Standard deviation was twice as high in the separate garbage bins as it was in the individual garbage bins.

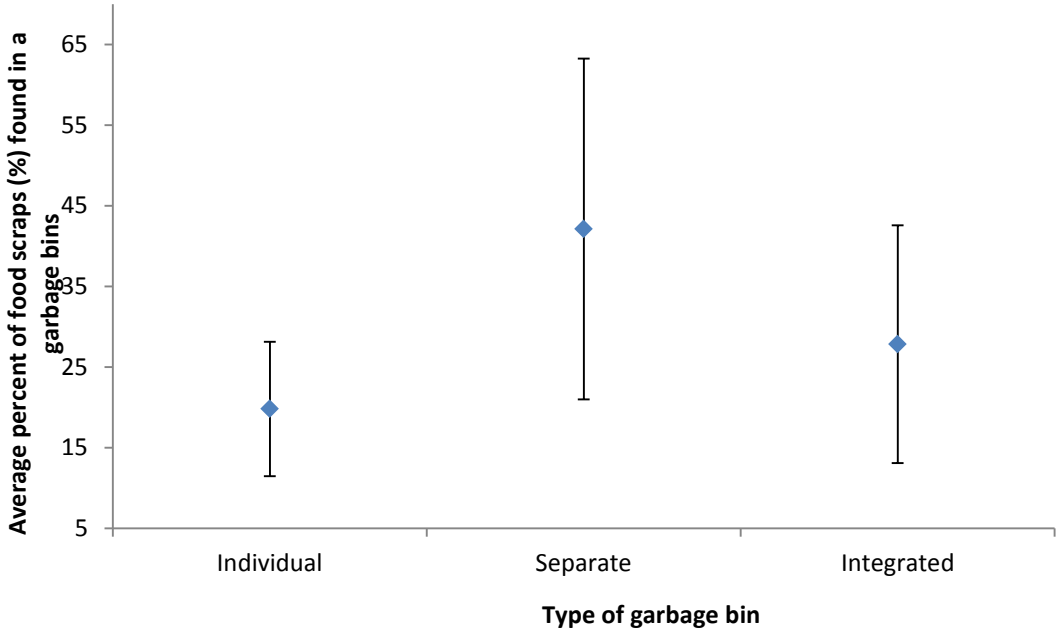

Figure 3. Average percent of food scraps found in three different types of garbage bins located in Neville Scarfe, Macleod, and Forestry buildings in the University of British Columbia, Vancouver (N= 3) .The standard error is the standard error of the means.

The one-way ANOVA showed there was no significant difference in the percent of food scraps found in the three different types of garbage bins (P=0.62) (Table 1).

Table 1: ANOVA test for the average percent of food scraps found in three different types of garbage bins. (Individual, Separate, Integrated).

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	766.38	2.00	383.19	0.52	0.62	5.14
Within Groups	4405.15	6.00	734.19			
Total	5171.53	8.00				

The average percent of recyclable containers found in garbage bins displayed a decreasing trend as we moved from the individual garbage bins to the integrated garbage bins (Figure 4). The same trend held true for the standard deviation.

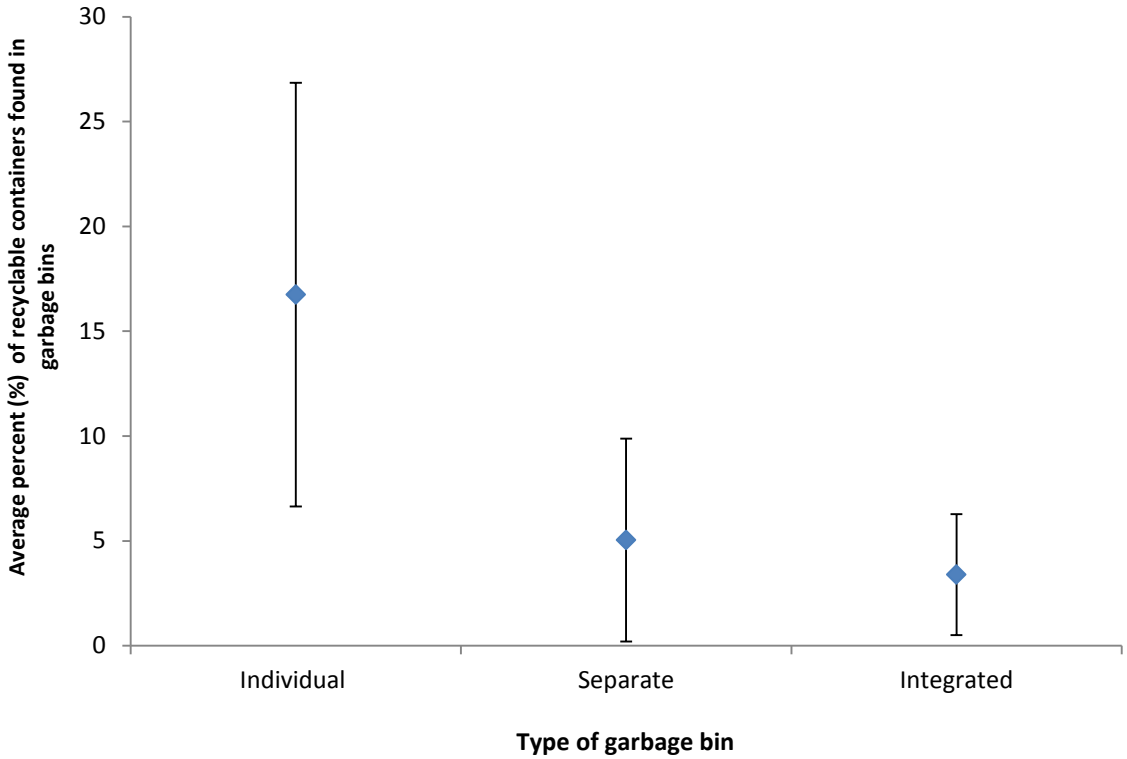

Figure 4. Average percent of recyclable containers found in three different types of garbage bins located in Neville Scarfe, Macleod, and Forestry buildings in the University of British Columbia, Vancouver (N= 3). The standard error is the standard error of the means.

The one-way ANOVA showed there was no significant difference in the percent of recyclable containers found in the three different types of garbage bins (P=0.37) (Table 2).

Table 2: One-way ANOVA test for the average percent of recyclable containers found in three different types of garbage bins. (Individual, Separate, Integrated).

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	318.03	2.00	159.02	1.19	0.37	5.14
Within Groups	802.95	6.00	133.83			
Total	1120.99	8.00				

The individual and integrated garbage bins contained similar amounts of the average percent of paper recyclables while the separated garbage bins were found to have the highest amount of paper recyclables (Figure 5).

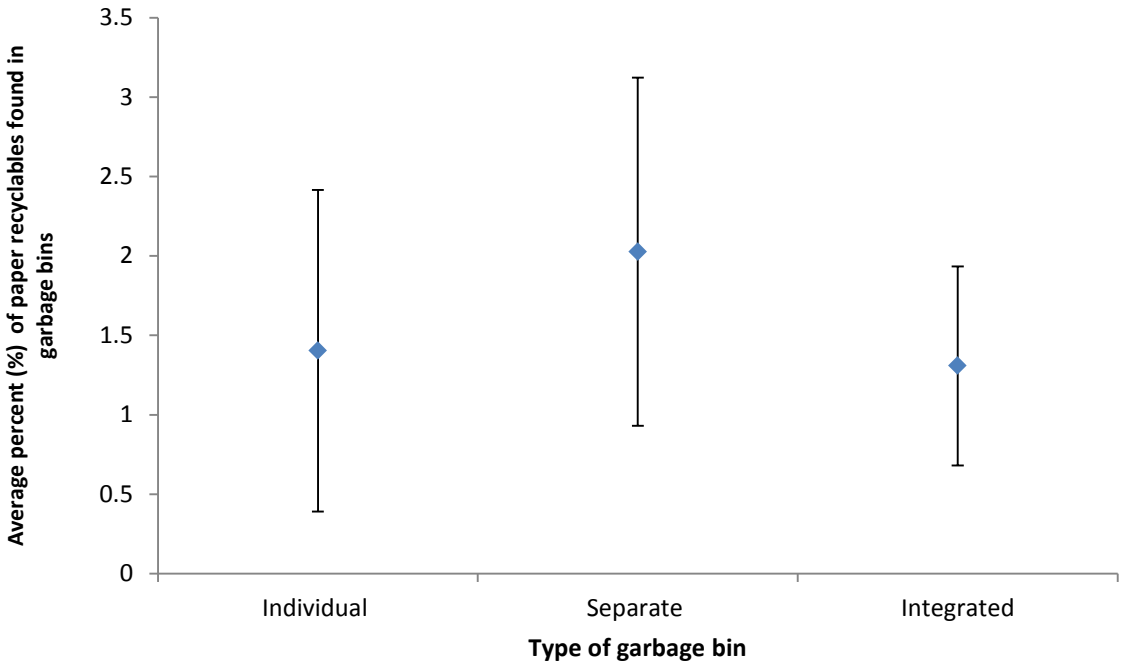

Figure 5. Average percent of paper recyclables found in three different types of garbage bins located in Neville Scarfe, Macleod, and Forestry buildings in the University of British Columbia, Vancouver (N= 3). The standard error is the standard error of the means.

The one-way ANOVA showed there was no significant difference in the percent of paper recyclables found in the three different types of garbage bins (P=0.8) (Table 3).

Table 3: One-way ANOVA test for the average percent of paper recyclables found in three different types of garbage bins. (Individual, Separate, Integrated).

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	0.91	2	0.46	0.17	0.8	5.14
Within Groups	15.7	6	2.61			
Total	16.6	8				

Discussion:

With the emergence of zero waste initiatives on university campuses, the importance of studying the waste composition will be critical for development of current and future waste programs (Mason et al. 2003). This experiment sought to discover the relationship between the proximity of garbage bins to compost, recyclable containers and paper bins. We hypothesized that no compost, paper or recyclable containers would be present in an integrated four bin garbage receptacle; very few non-waste materials would be present in a separated four bin receptacle and a large amount of non-waste materials would be present in an individual garbage receptacle.

Of our three hypotheses, the strongest support was shown for integrated four bin receptacles. That is, two out of the three non-waste material types (paper and recyclable containers) was found to be lowest in the integrated garbage can. Generally, it was found that on a university campus, people do sort their non-waste items from garbage; however, the proper infrastructure like a four bin integrated garbage receptacle must be provided in order for this to occur. We had several unusual results which did not conform to our expectations. One result was that individual bins had a lower average percent of food scraps than the separate and integrated bins. Another finding was that separate garbage bins had a higher average percent of paper overall than the individual or integrated.

Our findings support the idea of convenience. That is to say, people are more likely to properly sort their waste and recycle when the bins are located in close proximity to one another or closer to the point of consumption (O'Connor et al. 2010, McCarty and Shrum 1994, Luyben et al. 1979). The rates of waste sorting could possibly be attributed to the characteristics of an individual in which if a high amount of effort was required to recycle, an individual with environmental inclinations is more likely to do so (Schultz and Oskamp 1995). The labelling of plastics (i.e., 1-7) may have confused people and resulted in a higher level of recyclables present in the garbage bin. Vining and Ebreo (1990) found that individuals who have a high knowledge of recycling are more likely to sort their garbage than those with no prior knowledge. For example, plastics labelled 1-5 and 7 can be recycled but plastics labelled 6 cannot. We found that there was little uniformity for the types of plastics used as coffee lids. Some coffee lids were Plastic 6 whereas others were labelled Plastic 5. Typically, both Plastic 5 and Plastic 6 were thrown into the garbage. The content of the garbage bins were often influenced by the proximity to the area of purchase, for example, a coffee shop. In our study, the forestry garbage bins are located close to a high-traffic Tim Hortons, which resulted in a high concentration of disposable coffee cups in the garbage bins.

Several unexpected items were found in the garbage bin including two metal utensils and batteries. This would likely skew the weight results. One factor which may have introduced error into our results would be the presence of liquid. Liquid was often present in the bags which, upon the opening and emptying of the bags, resulted in the removal the liquid. This could have l resulted in a lower weight measured than the actual initial weight. It is suggested for future studies that the liquid is either completely drained before the initial weighing or account for

liquid weight throughout the audit. Two other shortcomings were a very short time frame and the small number of study areas.

Frequent waste audits are recommended in order for UBC administrators and waste managers to understand the amount of sorting which is being performed by individuals on campus. There is also a lot of potential for developing educational initiatives which engage the campus population and encourage proper waste sorting as well as encourage the use of a four bin integrated receptacle. As well, given the amount of non-waste materials present in separated four bin receptacles, it is suggested that four bin receptacles are always integrated. Where space may be an issue for implementing a four bin receptacle, it is suggested that a smaller version of the integrated four bin receptacle is used to avoid separation of the receptacle.

This study can provide insight for implementing future waste infrastructure on university campuses. The need for higher rates of recycling and re-use will become more important in the future as institutions focus on achieving zero waste initiatives and diverting potentially high-value waste material from landfills.

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