UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Visual Interventions on Compost Bin Contamination

Group 4: Caroline Pilat, Shannon Hogan, Ece Ikiz, Meher Arora and Brenda Huynh

University of British Columbia

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Themes: Waste, Buildings

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Executive Summary

Posters have been shown to have a marginally positive effect on viewers behavior. This experiment examines whether visual interventions can improve the contamination rates of compost disposal by university students. The study had an experimental condition of placing visual interventions in 35 floors of a university residence, and measuring the contamination rate of the compost bins both before and after the introduction of the posters. Contamination rate was measured as number of contaminants per kilogram of compost. The results were shown to be statistically insignificant, disconfirming the hypothesis of the study. Our results may be explained by the "information overload" effect, wherein increased quantities of signage decrease comprehension. Our findings can be used to inform the design of waste sorting stations, and to help guide focus on reducing waste contamination away from visual interventions and towards higher impact interventions.

Keywords: visual signage, informational overload, compost waste, contamination, environment

Literature Review

Increasing waste generation, decreasing landfill space, and restrictions on disposal sites, makes it necessary to implement comprehensive and cost-effective waste diversion programs (Lakhan, 2015). The University of British Columbia (UBC) diverts an estimated 33 percent of organics on campus (Fraser, 2016). Contamination (i.e. inorganic items disposed in the compost bin) poses a barrier to increasing diversion rates of organic waste, as all the materials in the compost bin is landfilled if contamination is detected (Zelenika et al., 2018).

Research indicates that consumers are becoming increasingly aware of environmental issues, while recycling and waste diversion rates remain low, indicating barriers to recycling (Lakhan, 2015). Studies have tested the effectiveness of different nudges to overcome such barriers, such as the use of social norms (Dupre and Meineri, 2016), increase in ease and convenience (DiGiacomo, 2017), environmental cues (Wu et al., 2013) and graphics or texts (Zelenika et al., 2018). for increased recycling.

Visual aids can provide viewers with persuasive or practical information and behavioral cues for decision making (Sussman et al., 2012). Sussman et al. (2012) investigated the improvement in composting behavior with the presence of signs in a university cafeteria setting. They found that the the presence of both signs and informative posters significantly increased the ideal composting behavior. One of the tools employed was displaying pictures of commonly mis-disposed items. Wu et al. (2018) examined the influence of pictures on composting behavior. In this study, where participants were placed in word-only or pictures-only conditions, authors found that participants exposed to picture-only posters had higher rates of correct composting compared to those exposed to the word-only conditions. This suggests that signs, provided that they use images to convey information, can be effective at improving composting behavior.

Past literature generally finds that posters and signage can be effective. However, a limitation to the effectiveness is identified as "information overload", which describes the reduced per-message attention and comprehension with an increase of cluttered signs (Cole et al., 2009). In this study, hikers were exposed to one of six conditions of cluttered signage and their retention of the information in posters was tested. They found that as the quantity of information increased, attention per message as well as retention of the message content both declined (Cole et al., 2009). Keller & Staelin (1987) investigated whether information overload impacted decision effectiveness, which is defined as the ability to accurately assess the value of available alternatives . Results showed that the presence of too much available information decreased decision effectiveness (Keller & Staelin, 1987). In summary, the literature on information overload suggests that the quantity of visual aids should be minimized for effectiveness.

The purpose of the current study is to examine how the negative impacts of "information overload" interacts with the positive effects of visual interventions. This would help UBC achieve its zero-waste goals and increase waste diversion from landfill.

<div align="center">**Research Question and Hypothesis**</div>

Do visual interventions (posters and signage) reduce the contamination rate in compost bins (eg: plastic bags, cutlery, etc.)? We hypothesise that the use of visual interventions will reduce compost contamination in the short term.

<div align="center">**Methods**</div>

Participants and Conditions

This study was conducted in Orchard Commons on UBC Vancouver campus, which houses 1054 first year students in its two residential buildings, Bartlett (18 residential floors) and Braeburn (17 residential floors). Each floor contained a waste sorting unit with four types of waste bins; recyclable containers, paper recycling, garbage and compost. The compost bin was the focus of this experiment. Each waste unit was sampled for 10 days (N=350).

The experiment had two conditions: Week 1 (March 4-8) was the control week with no visual interventions; Week 2 (March 18-22) in which the visual interventions were implemented in the form of a signage and posters (see intervention posters and signage in Appendix D) in the waste sorting units.

Measures

The independent variables were the posters and signage that were implemented during the second week of our data collection. The dependent variable was a weight-based contamination rate (number of contaminants per kilogram of compost waste). The controlled variables included the time of day of data collection, the measuring equipment (Smart Weigh Digital Heavy Duty Shipping and Postal Scale), and discrepancies in the baseline conditions of waste sorting units by engaging floor-by-floor comparison.

Procedure

Waste sorting units were emptied everyday (8:30am - 10:30am) by Orchard Commons Custodial Staff. In the afternoon (3pm - 9pm), two researchers visited each waste sorting unit in order to: weigh the bags of compost waste (± 0.02kg), count the number of contaminants, categorise the contaminants as 'plastic', 'paper', 'metal' or 'other' and control for the visual interventions in place. Contamination was identified by eye and by handy, where appropriate, under protective gear. We define contaminants according to the UBC Sorting Guides (available at www.sustain.ubc.ca/sortitout).

Statistical Method

Due to the non-normal distribution of data, non-parametric statistical analysis were used to determine the significance of visual intervention on compost contamination: Kruskal-Wallis test for equal medians and Wilcoxon-sign-ranked test for equal distributions. The contamination rate (item/kg compost) for each waste sorting unit was compared, before and after the visual

intervention. Python and PAST (Hammer, 2001) software were used to process the data. (See Appendix A for link to Github repository with the code to clean and analyze the data).

Results

The Wilcoxon-signed-rank test is a non-parametric test used when the assumptions of a t-test fail. This test confirmed the null hypothesis that there is on average no difference between the distribution of contamination rate before and after the visual intervention (*Df*= 122, Wilcoxon's *W*= 1235, *p(H$_0$)*= 0.3157). The Kruskal-Wallis test for equal medians is a non-parametric test used when the assumptions of a one-way ANOVA are not met. This test confirmed the null hypothesis that there is no significant difference between the median contamination rate before and after the visual intervention (*Df*= 122, *Chi^2*= 0.07765, *p(H$_0$)*= 0.7506). Results are presented graphically in Appendix E.

Discussion

The results for the non-parametric tests conducted did not detect any significant difference between the sample distributions and medians before and after our visual intervention. Therefore, we cannot conclude whether the interventions were effective or ineffective. While visual interventions have been effective (Sussman et al., 2018), this experiment may have been interfered by the cluttering of posters and signage (Cole et al., 2009; Keller & Staelin, 1987). The effect of information overload may interfered with the visual efficacy of the intervention.

This study had a variety of limitations. The primary limitation was the presence of multiple posters in the control week (see Appendix C). This clouded the control data meant to establish the baseline contamination rates without posters. Additionally, these posters were also present after the intervention posters were added, meaning that participants would have seen the informational overload effect. Both of these limitations mean that the actual effect of the posters was incorrectly minimized. Another important limitation was that the custodial staff was unable to accomodate data collection during the week of March 10-16. This meant that there was a full week in between the introduction of the intervention poster and the start of data collection. The initial effects of the new poster, which would likely be larger, were therefore lost. There were also several smaller limitations related to the inconsistency of controls between floors. Some floors had inconsistent bin order, some bins with lids and some without, and inconsistent information about which types of waste were considered contaminants (eg: soiled pizza boxes were considered compost waste in Bartlett, as opposed to garbage in Braeburn).

The results may have been hindered by the limited ability of statistical tests to adequately assess meaningful change from non-parametric data. Indeed, the data set was heavily skewed towards zero, therefore large values tended to be discounted as outliers (despite the use of non-parametric tests). Of some relevance, non-parametric tests are less powerful than parametric tests in detecting change between sample sets.

Considering the tendency to discount outliers, a replication of this experiment with a

larger sample size would not resolve but only exacerbate this trend. As an implication, psychological investigations may consider departing from statistical analysis because of this limitation; instead, we suggest that the psychological investigation focus on theoretical principles and small case-study analysis, and reassert the definition of meaningful change.

Recommendations for UBC Client

There are a variety of ways in which the University of British Columbia (UBC) as well as our client can apply these findings. Waste sorting rooms can try to minimize the number of informative posters in order to avoid the information overload effect. In order to measure the true efficacy of using images to convey information, future studies should have the "Sort It" (see appendix D) poster, as well as signage be the only visual intervention used during the observation period. If results find that the absence of overload effect results in an increased correct composting behavior, then UBC may begin to strategically use visual posters and signage to influence sustainability acts across campus. For instance, besides pledging for correct waste sorting behavior, UBC also has initiatives to reduce the overall consumption of energy and water. Perhaps past literature on using images to convey information can be used to address these concerns. Posters can display images or icons reminding the general public to turn off the sink before exiting the bathroom, and turning off the lights before leaving a room, especially in the residential buildings. These interventions should be implemented without the company of any other informative posters in order to yield an effect. Overall, there are many ways that our findings could be applied in order to help UBC reach their sustainability goals.

Appendix

A: Statistical Code

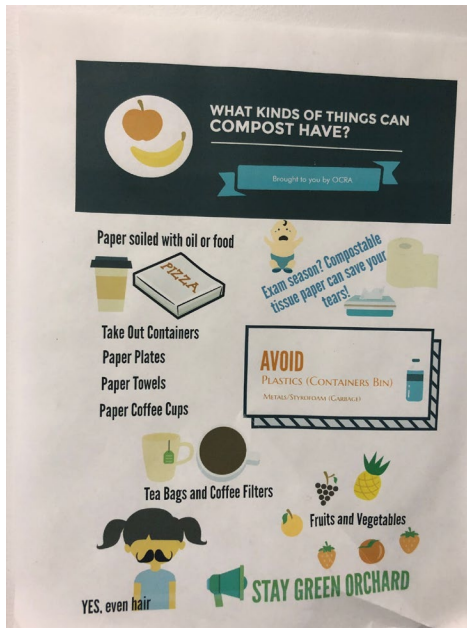If you are interested in running the statistical tests on our date to verify, the python code and repository can be accessed here: https://github.com/shannonjanehogan/ubc-seeds-data-analysis.

B: Legend for Posters and Signage

Posters:

A

B

C
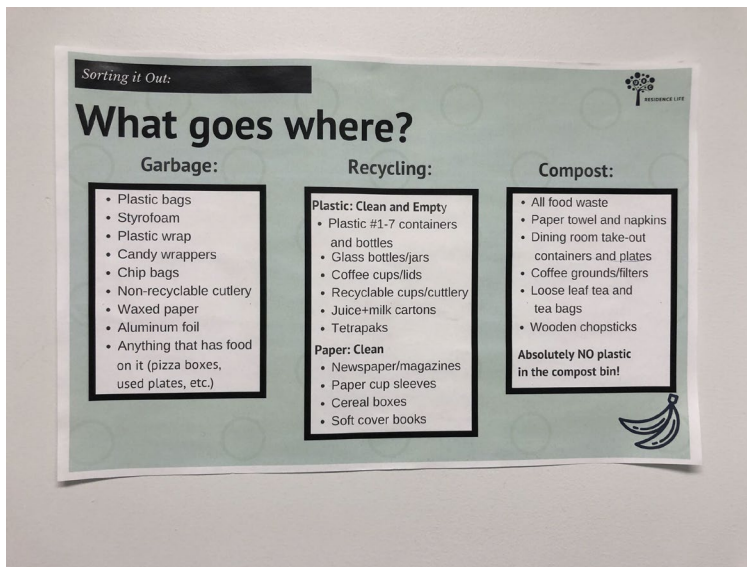
D
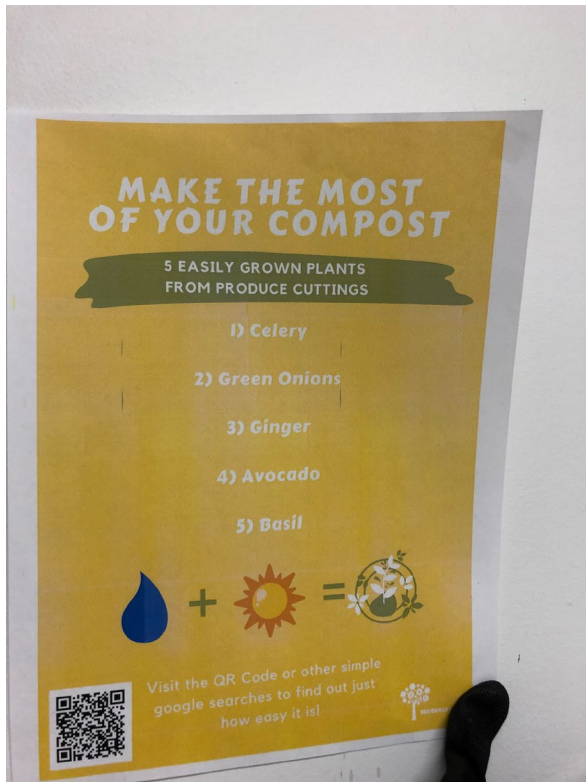
Signage:

1

2

C: Control Poster and Signage Distribution Per Floor

Building	Floor	Poster	Signage
Bartlett	20	A	2
Bartlett	19	A,B	2
Bartlett	18	A	2
Bartlett	17	A	2
Bartlett	16	E	2
Bartlett	15	A	1
Bartlett	14	A	1
Bartlett	13	A	1
Bartlett	12	A	1
Bartlett	11	A	1
Bartlett	10	A	1
Bartlett	9	A	1
Bartlett	8	A	1
Bartlett	7	A	1
Bartlett	6	A	1
Bartlett	5	A	1
Bartlett	4	A	1
Bartlett	3	A	1
Braeburn	19	A	1
Braeburn	18	A	1
Braeburn	17	A	1
Braeburn	16	A,B	1
Braeburn	15	A,B	1
Braeburn	14	A,B	1
Braeburn	13	A,B	1
Braeburn	12	A,B	1
Braeburn	11	A,C	1
Braeburn	10	A,C	1
Braeburn	9	A,C	1
Braeburn	8	A,C,D	1
Braeburn	7	A,B	1

Braeburn	6 A,C	1
Braeburn	5 A,C	1
Braeburn	4 A,C	1
Braeburn	3 A	1

D: Intervention Posters and Signage
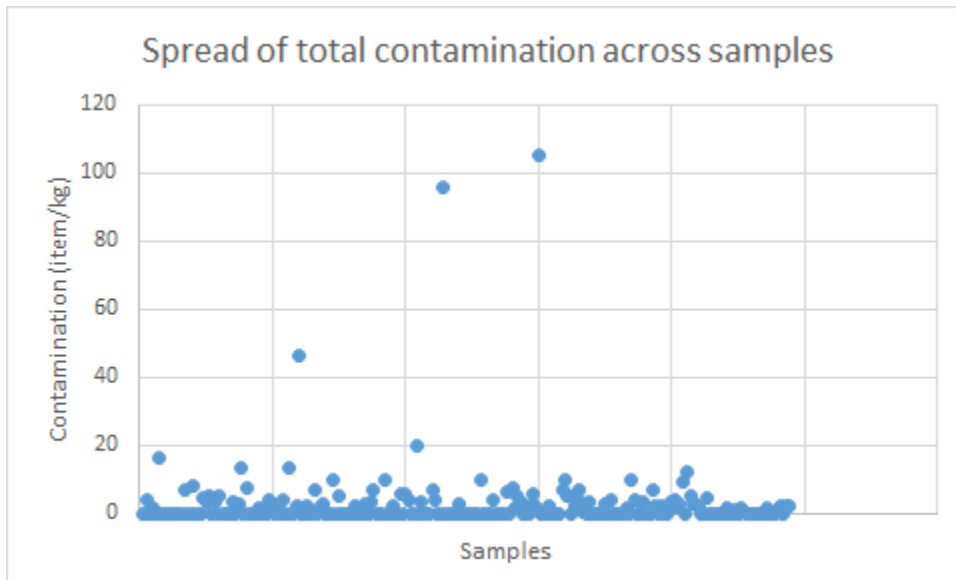
I

II

III

E: Graphs

Figure 1: Scatter plot showing the distribution of contamination rate for all samples (n=244). Data points are clustered around low values of contamination, due to the low average weight of compost waste disposed, and the general high accuracy of composting sorting.
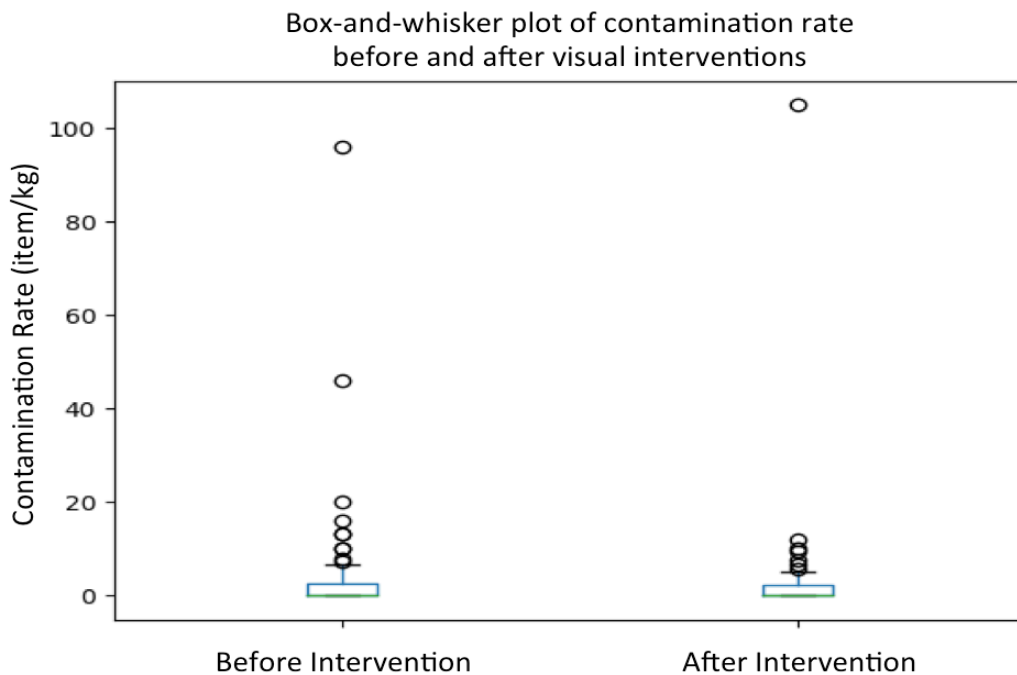

Figure 2: Box-and-whisker plot showing the spread of data, including outliers. The 75th percentile is 2.76 (before intervention) and 2.22 (after intervention), with strong positive skew (skewness = 8.5). The data is not normally distributed.
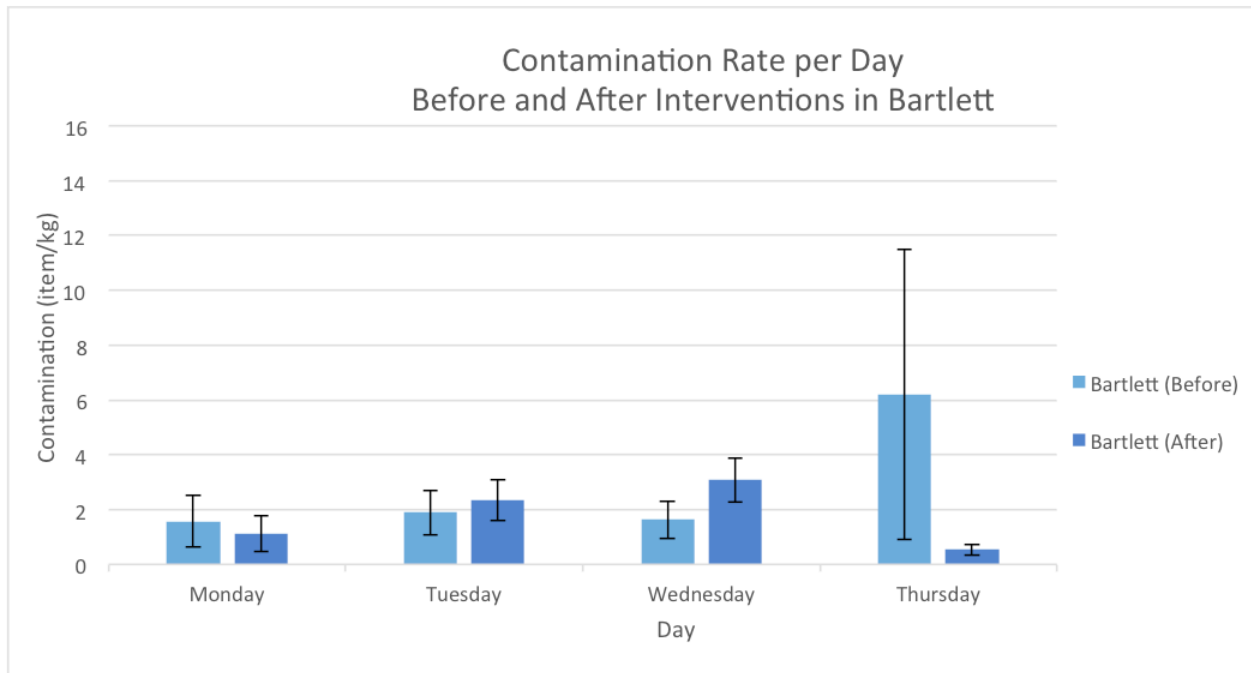
Figure 3a: Bar chart, with error bars, showing with contamination rate per day before and after the visual intervention, in Bartlett building.
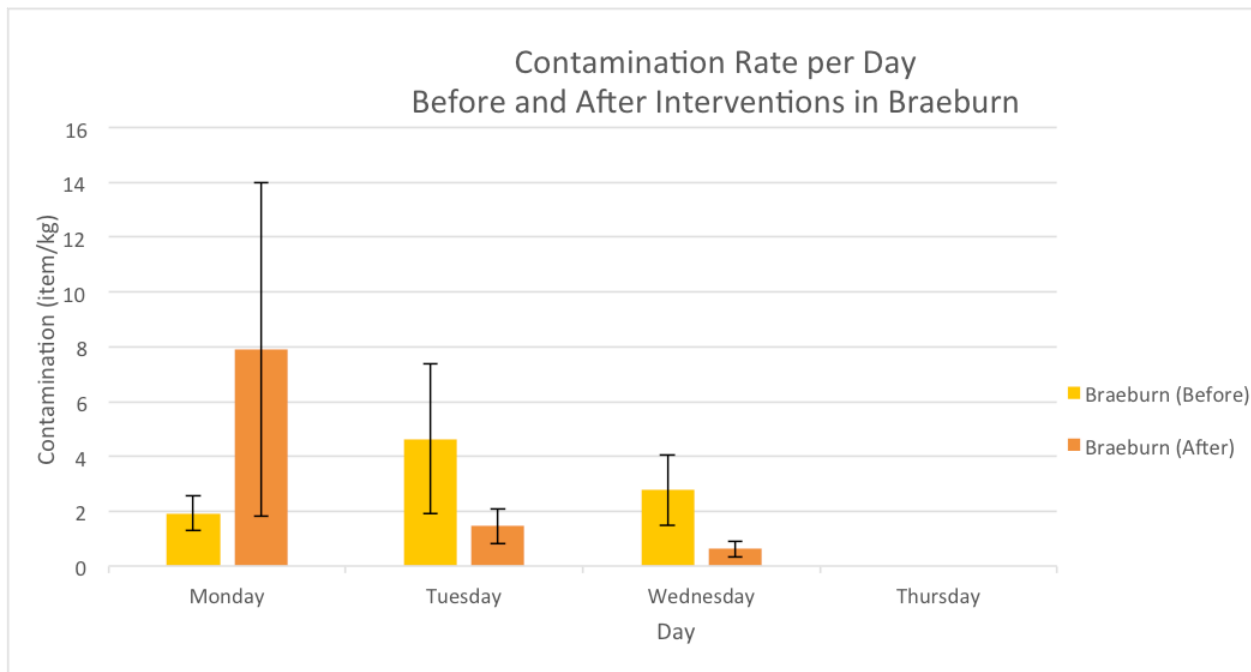

Figure 3b: Bar chart, with error bars, showing with contamination rate per day before and after the visual intervention, in Braeburn building. Due to loss, Thursday data was unpaired and is therefore not presented.

G: References

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