Waste Station Signage Comprehension: An analysis of waste stream contamination in the Irving K. Barber Learning Centre

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Special Thanks

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Project Introduction

This project was intended to analyze the effectiveness of indoor waste station signage improvements. This analysis was attained by performing small-scale waste audits on several waste stations in one of the University of British Columbia's (UBC) busiest buildings, the Irving K. Barber Learning Centre. Aiming to reduce waste stream contamination, this project identified several commonly confused waste items and increased their representation on waste station signage. Following this process two waste audits were performed to record the number of commonly confused items in the four waste streams at four indoor stations, these results were then compared to the recordings from a control group of waste stations. Once the data was gathered it was analyzed to identify any usage trends or changes in waste stream contamination. The results of this analysis were varied; however from the slight trends that are seen recommendations about future steps can be put forth.

Background Information

This project has been conceived through the partnership of UBC's Zero Waste Initiative, the Campus Sustainability Office and UBC's Social Ecological Economic Development Studies (SEEDS) program. The impetus for this analysis stemmed from a previous waste stream contamination study that focussed on the effectiveness of outdoor waste station signage, titled *Waste Station User Experience: A CBSM Approach*. This study, completed by Jessica Devlin, (Devlin 2014), utilized a mixed mode methodology to gauge the effectiveness of outdoor waste station signage based upon user experience and comprehension. Through this project's analysis, there were several conclusions about the effectiveness of waste station signage were made and several commonly confused waste items were identified. Acknowledging that the signage throughout both indoor and outdoor waste stations is relatively similar across the campus, paired with information taken from previous waste audits, conclusions about the effectiveness of indoor waste stations were made from the outdoor waste station signage analysis. Utilizing this knowledge, the project coordinators working within the Campus Sustainability Office, Bud Fraser and Neal Wells, the Zero Waste Coordinator, Ivana Zelenika, and this project's author, Jessica Devlin, were able to develop several stickers that identify the most commonly confused waste items, these stickers were then applied to a select number of indoor waste stations. Due to future plans to overhaul the outdoor waste station signage, indoor waste station signage was chosen as the focus of this project.

The analysis outlined in *Waste Station User Experience: A CBSM Approach* provided several conclusions about waste station signage comprehension; the most pertinent conclusions include (Devlin, 2014):

"When asked if the signage was helpful in assisting with waste sorting, 53.3% of participants stated it was helpful, however 43.3% of participants stated they had difficulty with some items

despite the signage. These items included mixed products such as paper and plastic mix, food waste, the coffee lid, sleeve, and cup, and containers that may not show visible recycling symbols"

"[T]hree of the respondents stated that they found the coffee cup and coffee cup sleeve icon confusing, noting that it is hard to discern between the two icons when in a rush, and that the difference between the two was confusing"

"[F]ive participants expressed their confusion of where to put the coffee cup components, with one participant stating "[t]he dotted line on the coffee cups is confusing, at quick glance it looks like cups can go in both".

In addition to these conclusions, the surveys conducted in the outdoor waste station analysis allowed for respondents to give their suggestions through an open ended question regarding any suggestions for improvements to the waste station signage they may have. Below are comments that contributed to the conception of the indoor waste stream analysis (Devlin, 2014):

"UBC's recycling stations need to, and present a unique opportunity for, becoming a hands-on space for education, but they need to be standardized across all buildings and outdoor locations, and they need to be specific to the items typically disposed of on campus"

"Sometimes having to sort garbage into too many different bins is too time consuming, too confusing …It's way too difficult sorting out all the different types of recyclables and I usually just throw the entire item into one bin (for example, all parts of the paper cup are recyclable...I'm too lazy to sort the plastic lid from the paper and the sleeve)"

Methodology

This research was conducted in the Irving K. Barber Centre for Learning (IKB), situated within the UBC Vancouver Campus, located at 2329 West Mall, Vancouver, BC, 49.2611° N, 123.2531° W.

Unlike the study outlined in *Waste Station User Experience: A CBSM Approach,* this project's analysis took an entirely quantitative approach to examining waste station comprehension. This was attained by evaluating the waste stream contamination through a series of waste audits of select indoor waste bins. Audited waste stations were chosen using a fully systematic selection process. As discussed in the informational paper, *Sampling*, by M. Baker, systematic approach was taken to selecting the waste stations to be audited. Accurate measurement is described as an unbiased approach that ensures data collected is free of systematic bias and errors (Baker 2002) . For the purposes of this project, selecting an accurate approach relatively free bias of involved looking at the number of waste stations within the IKB building and selecting a several waste stations that would represent the placement of all stations within the building; to ensure sampling

specificity all waste streams within the selected stations were audited. Sampling specificity is described as the steps taken to ensure that measurement will represent the information the research question is seeking (Baker 2002). In all, there were seven waste stations chosen throughout the building located in the following areas:

- Ike's Café West
- Ike's Café East
- IKB First Floor West
- IKB First Floor East
- IKB First Floor Bathrooms
- IKB Second Floor East
- IKB Second Floor North East

These stations were chosen due to their disbursed placement within the building, targeting multiple difference building usage areas, including the internal café, Ike's, the main level, primarily used for students and faculty moving throughout the building (Level 2) and the upper level (Level 3), primarily used for quiet study.

Of the selected stations it was determined that four of the seven stations would be utilized to measure the effectiveness of signage additions (the experimental variable) and three stations would remain as control measures to ensure bias was not incurred. Possible bias includes variation in waste collection on auditing days skewing the collection numbers, certain bins being utilized at a greater rate of others at different times, and variations in station signage throughout the building. To test the effectiveness of augmented signage single symbol stickers were created to be placed directly underneath the waste station opening. These stickers were designed to overcome the issues brought forth by the outdoor waste station analysis. These stickers aimed to reduce the comprehension barrier by using clear "yes" and "no" coloured rings and simply designed symbols representing two commonly misplaced items, coffee cups with lids and plastic bags, as seen in Appendix B.

Within the four selected stations two styles of sticker placement were tested, referred to throughout this paper as "Style A" and "Style B". Splitting the test stations into two styles allowed for a comparative analysis of the effectiveness of different combinations of sticker placement. A picture of both Style A and Style B can be seen in Appendix A.

There were three waste audits performed on all seven of the chosen stations. The waste audits were performed by sorting through the waste in each of the four bins- Organics, Containers, Paper, and Garbage- counting out and recording the number of coffee cups, coffee cup sleeves, and coffee cup lids that were found in each stream. The first audit performed was used as a collection of baseline data, there were no stickers placed before carrying out this audit. Upon completion of the audit stickers were placed on the appropriate waste stations. This audit took place on June 24th, 2014 at 4pm. The second waste audit was performed on July 16th, 2014 at

4:15pm, a similar time was selected to ensure consistency in the data collection variables. This waste audit collected information on the effectiveness of the newly placed stickers as well as information from the control stations. The third waste audit was performed on July 28th, 2014 at 3:00pm, again the data collected was used to measure the effectiveness of the stickers as well as data from the control stations.

Once all of this data was collected it was analysed to answer two research questions, and their accompanying hypotheses, as follows:

Q1. Did the stickers have any effect on the waste stream choice?

H_0: The stickers will have no statistically significant difference on the waste stream choice

H_1: The stickers will have a statistically significant difference on the waste stream choice

Q2. Which style of sticker placement was more effective?

H_0: The is no significant difference in effectiveness between Style A and Style B

H_1: There will be a significant difference in effectiveness between Style A and Style B

In order to answer Question 1 the data collected was broken down into signage style (Style A, Style B, and the Control) and into waste stream type (Organics, Containers, Paper, Garbage). From here multiple two sample t-tests were performed. The t-test formula was chosen as it is able to compare a variable against a control to look for any significant differences that occur outside of random chance. As there is a high degree of chance that could be introduced to this data (due to the variant nature of waste disposal) a p-value of $P<0.10$ was selected to accommodate the inherent variablity within the data. These t-tests allowed for the determination of where the stickers made a statistically significant change in the waste stream choice, or whether the variance in numbers between the control data and the samples was the result of random chance.

To answer Question 2 the means of each waste stream were determined and then compared to the control. The data was separated by whether it was collected from a control station, a station with Style A signage, or Style B signage, images of this signage can be seen in Appendix A. In order to eliminate any errors the baseline data from each station was not used as it did not have influence of either style of sticker.

Results

Due to the multipart nature of the data collection, the results from this project are broken down into different components. For ease of understanding the results are laid out by station style, and all results recorded are reported as compared to the control data.

Q1: Style A

The results of the tests of significance performed for the Style A data is displayed in Table 1. Due to the minimal amount of plastic bags found within all of the waste streams only the cup, sleeve, and lid data was analysed.

Table 1: t-test results for Style A experimental variable when compared with the Control

Sticker	**No Cups + No Bags**		**Yes Cups**		**No Sticker**		**Yes Bags**	
Stream	Organics	Reject H0?	Containers	Reject H0?	Paper	Reject H0?	Garbage	Reject H0?
Cup	-0.234	N	-4.371	Y	0.898	N	-0.447	N
Sleeve	-1.028	N	-1.567	Y at 0.10	1.640	Y at 0.10	1.732	Y at 0.10
Lid	0.655	N	0.974	N	2.183	Y at 0.05	1.567	Y at 0.10
T-Critical at p<0.10=1.439			T-Critical at p<0.05=1.943					

Q1: Style B

The results of the tests of significance performed for Style B data is displayed below in Table 2. Due to the minimal amount of plastic bags found within all of the waste streams only the cup, sleeve, and lid data was analysed.

Table 2: t-test results for Style B experimental variable when compared with the control

Sticker	**No Bags**		**Yes Cups**		**No Cups**		**Yes Bags**	
Stream	Organics	Reject H0?	Containers	Reject H0?	Paper	Reject H0?	Garbage	Reject H0?
Cup	-0.655	N	0.293	N	0.243	N	-0.447	N
Sleeve	-0.277	N	-1.000	N	0.100	N	1.732	Y at 0.10
Lid	-0.655	N	1.362	N	2.000	Y at 0.05	1.567	Y at 0.10
T-Critical at p<0.10=1.439			T-Critical at p<0.05=1.943					

Q2: Style A Organics

In the Style A samples the organics bins had two stickers placed at their openings, one sticker that indicated “no cups” and one sticker that indicated “no bags”, examples of these stickers can be seen in Appendix B. A comparison of means between the number of cups, sleeves, and lids

found in the control versus the stations with Style A signage resulted in promising statistics. The number of cups seen in the Style A control organics bins was 1.6 times higher than the number of cups found in the experimental variable with the specific “no cup” sticker. Correspondingly, the number of sleeves decreased by three times in the experimental group, and the number of lids was 50% less in the experimental group. There were no bags found in the Style A organics bins.

Q2: Style B Organics

The experimental variable organics stream in the Style B group had one “no bags” sticker placed at the opening. While there was no explicit reference to coffee cups on this stream, there was a “yes cups” sticker placed on the adjacent containers stream. On average, the experimental variable had 25% less cups than the control stream, with the auditing team finding six cups in the variable and eight cups in the control bin, on average. There was an equal number of sleeves found in the Style B group as there was in the control group, adversely, there were 33% fewer lids in the control bins than in the experimental group. There were no bags found in the Style B organics bins.

Q2: Style A Containers

Upon the containers bins within the Style A experimental variable group a “yes cups” sticker was placed near the opening of the bin, an example of which can be found in Appendix A. This sticker was placed within close proximity to the neighbouring organics “no cups” sticker, creating a clear and decisive message informing users where coffee cups and lids should be placed. The average number of cups in the experimental variable group was 300% higher than the control group which did not have an explicit “yes cups” sign. Contrarily, the average number of sleeves increased by 150% within the experimental variable stream, and the number of lids decreased by 81% on average in the experimental variable stream. This data shows that there is an unequal number of lids, sleeves, and cups entering the different streams.

Q2: Style B Containers

Similar to Style A, the Style B containers group had a “yes cups” sticker placed nest to its opening. In contrast to the Style A results, the average number of cups found in this waste stream was 40% higher in the control stream than it was in the experimental variable stream. Comparable to the Style A containers stream, the number of sleeves increased slightly in the experimental variable stream, and the number of lids was dramatically lower in the experimental group than in the control group, with the average number of lids in the experimental group sitting at 3 pieces, and the average number of lids in the control group sitting at 13.5 pieces.

Q2: Style A Paper

The paper containers in the Style A group did not have a sticker placed near their opening, they were left blank in order to emphasize the adjacent waste stream stickers. In the experimental variable Style A paper stream the average number of cups was 63% lower than in the control paper bins. The average number of paper sleeves in the control waste stream was much higher

than the average number of sleeves found in the experimental variable stream, with the averages sitting at 23 pieces in the control bins and 6 pieces in the experimental variable bins, a difference of 74%. The average number of lids found in the Style A containers was higher in the control bins, with zero lids found in the experimental variable bins and an average of 6 lids found in the control bins.

Q2: Style B Paper

At the Style B stations the paper stream had a "no cups" sticker placed at the opening, as seen in Appendix A. In these bins the average number of cups found in the control bins was 1.3 times higher than in the experimental bins. Similar to Style A, the number of sleeves found in the control paper bins was 43% higher than in the experimental bins, with an average 23.5 of sleeves found in the control bins versus an average of 13.5 sleeves found in the experimental bins. The number of lids found in the control bins was six times higher than the number of lids found in the experimental bins.

Q2: Style A Garbage

The Style A garbage bins did not have a sticker pertaining to cup placement, rather there was a "yes bags" sticker placed at the opening. Within the Style A stations the average number of bags found in the garbage bins was one bag, compared to the control average of one bag. It is worth nothing however that only one Style A garbage bin contained a bag, whereas two of the control bins contained one bag each. The average number of cups found in the garbage bins was 4 pieces in the control bins and 3.5 pieces in the experimental variable bins, a decrease of 12% with sticker placement. There were no sleeves found in the variable garbage streams and an average of 1.5 sleeves found in the control bins. There was decrease in the number of lids found in the Style A experimental variable bins of 83% after sticker placement.

Q2: Style B Garbage

The Style B garbage bins had a "yes bags" sticker placed upon the existing signage; there were two bags found in the Style B garbage bins, compared to the average of one bag found in the control bins. The number of coffee cups found in the Style B bins was 37% lower than the number of cups found in the control bins. On average, the number of sleeves found in the experimental variable Style B garbage bins was 33% lower than in the control bins and the average number of lids in the variable bins was 67% lower than the number of lids found in the control bins

Discussion of Results

As seen in the tables 1 and 2 above, the majority of the waste streams do not show a statistically significant reduction in waste stream conversion. Nine of the twenty four variables showed a statistically significant change in waste placement after the augmentation of the existing station signage at a probability of $P<0.10$. Despite these unimpressive results lessons can be taken from

the differences that were seen. In the Style A combination the number of placed in the correct containers stream was increased dramatically with the placement of the “yes cups” sticker; however the number of cups in the Style B containers bins was unchanged by the placement of the same sticker. To be able to analyze why this is seen the placement of the adjacent sticker must be examined. The Style A stations had a positively reinforcing cup placement sticker on the containers stream paired with a negatively reinforcing “no cups” sticker placed on the organics bins. Conversely, the Style B paper bins had a negatively reinforcing “no cups’ sticker placed at the opening, paired with the positively reinforcing “yes cups” sticker placed on the containers bins. Overwhelmingly, in the baseline study cups were more often found in the organics bins over the containers and paper bins, with an average of 16.3 cups seen in the organics stream over an average of 7.3 cups counted in each of the containers and the paper streams. The combination of an explicit “no cups” over the organics stream, as seen in Style A of the experimental variable, appears to have strongly influenced the correct placement of coffee cups into the containers stream, whereas the placement of a “no cups” sticker on the paper stream appeared to have no influence. As seen in figure 1 the signage in the IKB building specifically identifies the organics stream as being able to take compostable paper, this could be the source of the high levels of cups recorded in the organics stream as many people may not know if their coffee cups are compostable or not, the majority of cups sold at the UBC campus are not compostable.

Figure 1

With the increase in the number of cups found in the containers stream there was a statistically significant change in the number of sleeves found as well, as seen in Table 1. This is supported by the comparison of means, as the average number of sleeves found in the containers stream in

Style A containers bins was 150% higher than in the control bins and 67% higher in the Style B containers bins than in the control bins. This suggests that there are still a proportion of users that are not taking the time to separate the sleeves from the cups; however the number of sleeves found in the paper streams (the correct stream) was high across all variables, suggesting that user comprehension is high with the style of signage used on the IKB paper stream bins, as seen in figure 2.

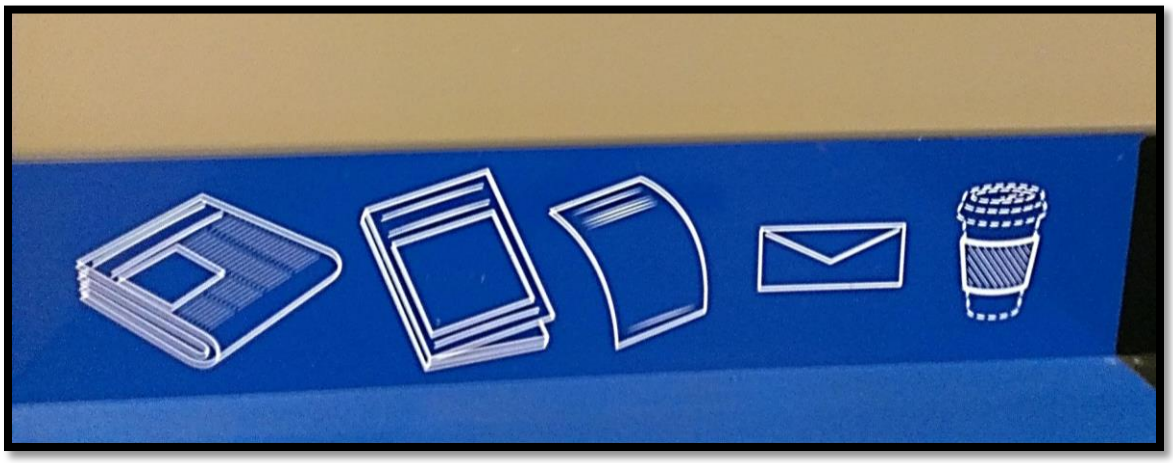


Figure 2

In the Style B station signage there were no statistically significant positive changes in the placement of cups, sleeves, and lids, suggesting that this combination of sticker placement was not effective at reducing waste stream contamination. When comparing the means of cup, sleeve, and lid placement there were positive changes, as seen in the results section, however these changes were not statistically significant enough at a P-value of $P<0.10$, suggesting that the changes seen are most likely the result of chance placement.

When looking to answer the research questions the null hypothesis for question one has to be accepted on 15 of the variables, and can be rejected in nine variables, stating that the sticker placement had no statistically significant effect on waste stream placement for the majority of variables. In research question two the evidence suggests that the combination of stickers placed in Style A was more effective in more variables than Style B; therefore the null hypothesis can be rejected and the experimental hypothesis can be accepted.

Limitations

Given the scope and scale of this project the rigour of the statistical evidence found is low. Due to timing and man power the number of bins audited, and the number of times they were audited, was limited. For a more scientifically rigorous examination of the waste station signage effectiveness more bins would have to be audited, and the number of audits held would be increased. Given the resources available to this project the type of auditing that took place

allowed for human error due to the researchers not being able to fully dump the bins to sort through the items. This could have led to the under reporting of items within the bins, especially bins that were more full. In addition to this a timing bias could have been introduced due to the variable bin emptying schedule. Currently bins are emptied on an as needed basis, therefore due to placement and frequency of usage the bins audited had varying levels of waste within them, this could have contributed to the overall variable results. There were two bins with different signage than the other five bins, and all bins indicated that compostable paper could be placed in the organics waste stream, represented by a symbol of either a coffee cup or a soup bowl. This signage may have led to confusion in the users as the added signage contradicted these symbols. Future studies should take place when the bins have updated signage, or alternately cover up the current compostable paper symbols.

Conclusions

This project gives insight into the user comprehension of commonly confused items, due to limitations however, most the changes seen cannot be labelled as statistically significant. Further research would positively contribute to the conclusions seen through this paper. From this data no overarching conclusions can be made about all waste station signage effectiveness, however when the information is broken down, lessons can be learned from individual components of this project. Clear positively reinforcing messaging is more effective when paired with negatively reinforcing messaging, as seen in the Style A cup placement. This project has also shown that user comprehension of coffee cup sleeve placement is high, yet there is still a percentage of users that do not have the desire to separate their sleeves.

Works Cited

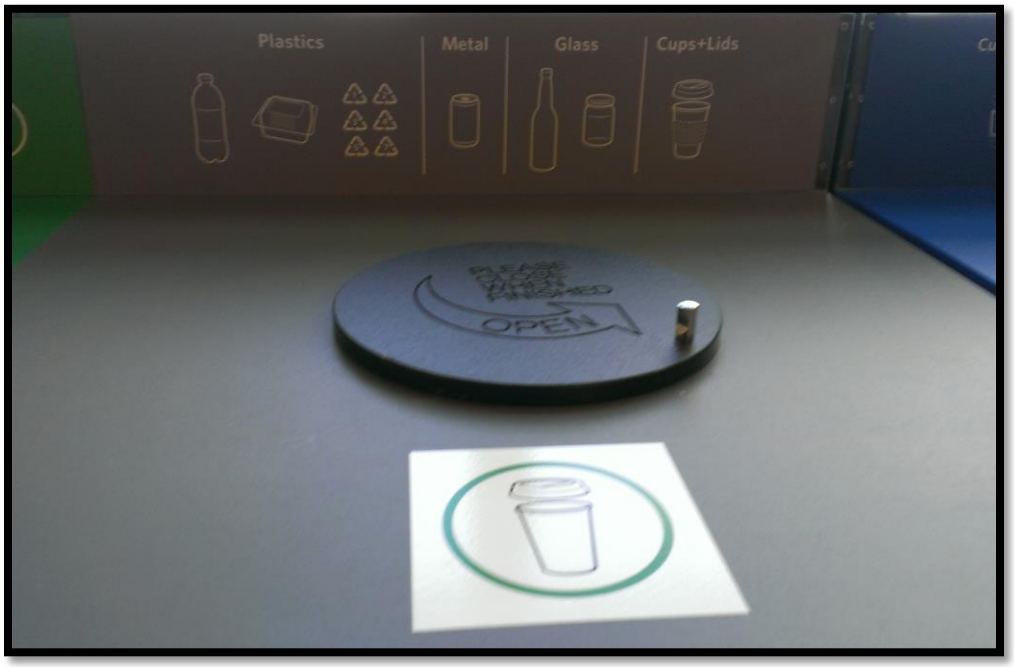
Baker, Michael J. 2002. “Sampling.” *Marketing Review. Autumn 2002* 3(1).

Devlin, Jessica. 2014. " *Waste Station User Experience: A CBSM Approach" Unpublished.*

Appendix A

Style A Organics Signage

Style A and B Containers Signage



Style A and B Garbage Signage

Style B Organics Signage

Style B Paper Signage

Appendix B

Added Signage Stickers