UBC Social Ecological Economic Development Studies (SEEDS) Sustainability Program

Student Research Report

Researching Green Bin Contaminants at UBC Vancouver Campus

Will Crolla, Carla Frier, Bethany Wat, Pilar Chow

University of British Columbia

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1 Abstract

This research report was executed in collaboration with our UBC SEEDS partner, Bud Fraser, to examine the topic of waste management at The University of British Columbia, particularly to identify problematic food packaging items that are most commonly missorted on campus. This issue is particularly significant when considering the negative consequences of pollution in our environment and detrimental effects to our ecosystems. Our research question is as follows: What food packaging items at UBC are most commonly improperly sorted and what are potential solutions to this issue? Our research design included primary and secondary data analysis based on previous SEEDS reports and audit data obtained by our partner, as well as our own qualitative methodologies in the form of a questionnaire, observation, and a focus group. Major findings reveal that there is prevalent confusion in sorting waste packaging items with both the conforming and non-conforming contaminants. By examining secondary audit data and conducting our own research we found that approximately 80% of contaminants fell into six categories: paper coffee cups, plastic bags, plastic cup lids, plastic cutlery, food waste with packaging, and plastic containers and cups. These statistics revealed that there is still an overwhelming amount of improper sorting that occurs on the UBC campus. We initially focused on researching the psychological motivation or emotions that influenced improper sorting behaviour, however, through our methods we realized that this approach would not provide us with results that can mitigate sorting issues at the waste management level. Therefore, our group pivoted from this starting point and focused our research and methodology on identifying specific food packaging that is most improperly sorted to trace to UBC food retailers that distribute the most problematic packaging. With this information, we suggest further research and actions to identify these food retailers and discuss potential solutions in the form of alternative packaging that can be easily broken down at our waste management facilities. We also discuss potential solutions in the form of mandatory widespread education across campus, specifically targeting entry-level students, as well as a goal of standardization with all UBC food outlets through policy change.

2 Introduction

In this study we attempt to answer the question of what food packaging items at UBC are most commonly improperly sorted, and what are some potential solutions to this issue. Waste audits performed by the Alma Mater Society (AMS) at UBC and a consultant contracted by UBC Waste Management reveals that there is an abundance of contaminants in UBC green bins. These can be sorted into two categories: conforming and non-conforming contaminants. Conforming contaminants are those that could be properly sorted into another bin while non-conforming contaminants are those that may not be properly recycled in another way.

2.1 Research Question

Based on the project expectations discussed with our community partner, we arrived at the following research question: What food packaging items at UBC are most commonly improperly sorted and what are potential solutions to this issue? Through a combination of methodologies and data analysis, we will identify which food packaging items are most problematic at UBC, and propose actions that can be taken in order to mitigate these issues. In this proposal we will review the literature on several issues relevant to our research question, as well as outline the methodology we will be using to address this question.

2.2 Statement of Problem

It is the goal of UBC to achieve 80% waste diversion by 2020. To do this, the majority of items sold on campus should be reusable or recyclable in some way, and users must put their waste into the appropriate bin and refrain from putting recyclable items into the garbage. Currently, there are a series of barriers to the successful realization of this goal, both in the purchasing of inappropriate packaging materials by outlets and the consistent high rates of incorrect sorting, especially into green bins. To fix the problem of inappropriate packaging, UBC has created UBC Food Service Ware Procurement Guidelines (2016) to guide campus food retailers in purchasing packaging that can be reused or recycled. However, this guideline is not enforced and has very little power over franchises with locations on campus, and stores that are run by the AMS rather than the university. In order to increase correct sorting, UBC has implemented a range of campaigns from specific signage on Sort It Out bins to an online game for students to practice waste sorting, with a recent addition of signs specifically discouraging putting plastic in the green bins. The problem is that despite these efforts, there are still high rates of contamination in the green bins. The goal of our research project is to identify items that are especially confusing for users to sort, and specific items and retailers that should be targeted to achieve the largest positive impact on green bin contaminants at UBC. We will achieve this through quantitative analysis of data from a recent waste audit at UBC, as well as gaining further understanding of students' experiences with food packaging and sorting on campus by conducting a survey and focus group and observing behaviour at the Sort It Out bins at selected high-traffic areas.

2.3 Literature Review

Researchers agree on the environmental benefits of composting, as the emissions are less than those from landfills. A study by Lou and Nair (2009; Gunn, Ganz & Keeton, 2012) states that composting reduces greenhouse gas emissions in multiple ways, including the reduction of landfill

use. Lou and Nair admit that though compost releases N_2, CH_4, and CO_2, it is biogenic in origin and therefore does not contribute to greenhouse gas emissions. CH_4 and N_2O are not accounted for in carbon budgeting and landfills emit CH_4, CO_2, and various other gaseous emissions that do contribute to greenhouse gas emissions. Despite this, Lou and Nair (2009) maintain that emissions from composting are lower than those from landfills even after factoring in emissions that come from running such operations. However, despite all efforts, some waste will end up in landfills, but this should not discourage consumers from recycling and composting properly. Unfortunately, Sterman (2011) explains that despite the consensus among the scientific community about climate change, there is still much confusion and complacency pertaining to environmental issues in all strata of society. Sterman argues this is due to the widening gap between science and the public. It is recommended by Sterman that a breadth of simulations and active learning opportunities for both the public and policymakers should be utilized to best inform and instill environmental attitudes. This is because, according to Weber and Stern, as cited in Sterman (2011) the passive transmission of information is not enough to change attitudes and behaviours. Warshawsky (2015) shows through a case study of the American grocery chain, Kroger, that corporate sustainability campaigns are typically designed to improve their public image. This field of research confirms the importance of UBC's waste diversion goals, and highlights the benefits of composting.

Research also shows that the average Canadian consumer, regardless of whether they are environmentally conscious, creates a significant amount of waste and rarely disposes of it all correctly, finding a significant lack of composting behaviours. Consumers from high-income countries such as Canada throw away food because they can afford to plan poorly (Jagau & Vyrastekova, 2017), Gustavson et al. and Secondi et al., as cited in Jagau and Vyrastekova, further claim that the most influential factor of food waste is consumer behaviour. The authors pose that food waste is both an environmental and economic problem (Jagau & Vyrastekova, 2017) and therefore there should be economic incentive to compost for consumers as Warshawsky (2011), claims such compensation is a chief incentive for corporations to compost. As it is, according to Benton (2015), household recycling increased by 578% between 1960 and 2010 in the United States, however the low amount of recycling being done in 1960 would explain the large percentage gain. As of 2013, Americans throw away approximately 7.1 pounds of trash per person per day (Minter, as cited in Benton, 2015), as opposed to 2.68 pounds of trash per person per day in 1960 (EPA, 2012). Thus we can confirm that one would expect the average UBC student to have wasteful habits, and that the problem faced by UBC in diverting waste is faced on a larger scale as well.

Other scholars have undertaken a psychological and behavioural approach to evaluate human pattern behaviors and use psychological evidence to draw conclusions on why improper waste sorting is so prominent. Existing literature deducts that behaviour is influenced by knowledge (Barr & Gilg, 2007), as well as emotion (Hopfensitz & Reuben, 2009) especially when factoring in emotions of guilt and/or shame (Jagau & Vyrastekova 2017; Ferguson & Branscombe, 2010). Barr and Gilg (2007) discuss environmental action in terms of a causal linear model of awareness, information, decision, action; however, they also argue that information alone does not lead to desired behavioural change. Rather, informed environmental behavior lies on situational variables such as knowledge, and psychological variables such as intrinsic motivation (Barr & Gilg, 2007). A variety of researchers have explored the psychology of food waste and determined that emotions have a significant impact on mitigation behaviour (Ferguson & Brandscombe, 2010; Jagau & Vyrastekova, 2017; Hopfensitz & Reuben, 2009). Jagua and Vyrastekova (2010) discuss the emotions of guilt and shame as playing a crucial role in motivating the socially desirable behaviour. This was a conclusion from a study conducted in a university using two types of poster signage, one that encouraged planned decisions of

consumption, and the other associating food waste with negative emotions of loss, based on the Prospect Theory developed by Kahneman and Tversky (1979). Ferguson and Brandscombe (2017) asses these ideas in the larger context of collective guilt-- a negative emotion people experience when their ingroup as a whole is seen as responsible for harm-doing (Wohl, Brandscombe, & Klar, as cited in Ferguson & Brandscombe, 2017). Collective guilt is most effective in influencing behavior when people believe that their group is responsible for wrongs, and when they believe that it is possible to repair the harm. Sussman and Gifford (2011) discover a more positive-based approach drawing on Cialdini et al.'s (1991), Focus Theory of Normative Conduct, studying the effectiveness of signage compared to active models demonstrating correct food composting behavior in public places. Their data reveals that when diners were exposed to models composting appropriately ahead of them they were more likely than unexposed controls to compost. The literature on environmental behaviour, especially in composting, agrees upon the emotional significance of people's actions, but also lacks data in distinguishing whether only socially responsible people experience these emotions or if the campaigns and studies conducted triggers prosocial behaviour. This research provides us with a range of reasons for the improper sorting of waste on campus, although our research will focus on the problems caused by the specific packaging items that are for sale on campus, rather than actions influenced by individual behaviour.

Studies on recycling behaviour have shown that marketing, signage and knowledge about recycling is crucial to improve recycling behaviour. Educating the population about recycling and its consequences are important. Vicente and Reis (2008) found that having knowledge about recycling is the most valid incentive to encourage recycling participation, and individuals feel obliged to recycle because of what they know. Bagozzi & Dabholkar's (1994) research shows that 84% of consumers don't understand the environmental impact of waste, and if they don't know the impact of their waste then they would not be inclined to recycle. Signage and communication needs to be able to appeal to both persuasion and behaviour, as attitudes based on personal consequences of recycling aren't as strong as long term environmental benefits (Lord, 1994). Lord (1994) also finds that positively framed messages have more of an effective impact and favourable attitude towards it. Different elements of signage also contribute to recycling decisions and habits, such as the size of the text or the content on the sign. On average, signs and adverts receive about 1 or 2 seconds of attention, and the first thing that the majority looks at are the graphics. (Van Meurs & Aristoff, 2009) The signage should be eye-catching, as customers are more persuaded by vivid content in comparison to non vivid (Perrine & Heather, 2000). The text should also be easy to read, therefore the effort required is reduced when reading the message (Van Meurs & Aristoff, 2009). Many of these issues have been taken into consideration by UBC Waste, as we can see in the various forms of visual prompts available around campus. Our research took place right after the installation of a new series of signs, which could have influenced the knowledge of the students who were subjects in our research.

Central to our goal of improving waste diversion at UBC through increased accuracy of waste sorting is the potential for increased use of compostable materials and reduction of composite and garbage materials. This issue has led us to explore the literature on the economic viability of composting programs and more compost-friendly food packaging materials. The literature explores the production and collection chains of recyclable materials in great detail (Raheem, 2012; Kan, 2008), as well as a focus on the life cycles of food packaging, although these studies do not focus on materials designed to be compostable (Accorsi et al., 2014). These are useful processes to think about, but compost is the only waste material that is processed on campus in a closed-loop cycle (Cheng, 2016), so it makes sense for our research to focus on the complete product lifecycle for compostable packaging materials. Disposable coffee cups, a product that is a significant problem on campus, have

biodegradable options available, but there is disagreement among retailers about their practicality (Wright et al., 2011). This line of research should be pursued further in helping to convince food retailers to use UBC's preferred food packaging.

Research on economic incentives and the financial practicality of composting programs are enlightening but do not go into detail on contamination outside of household waste disposal (Kan, 2008; Rahmani et al., 1999), which is more easily controlled because of the small number of participants. The location of our research is a public space, which means there are hundreds of people using each Sort It Out station every day, and removes the sense of responsibility for contamination from each individual. Studies focusing on university-specific waste sorting and education programs are somewhat specific to their particular situations (Mason et al., 2003), but do have useful research on the qualities of a successful waste diversion program.There has been no research specifically on waste sorting accuracy on university campuses with concern to compost quality and amelioration through sourcing of more appropriate packaging products. Our research, while not focusing solely on the economics of product sourcing and the removal and recycling process, will take into account how these concerns will affect waste disposal at UBC in our field of concern, the restaurant–to–disposal portion of a product's life cycle.

3 Methodology

In attempting to discover the primary factors contributing to improper sorting of waste at UBC, our research focuses on the behaviours and attitudes behind people's waste sorting actions, specifically seeking to understand motivators in impacting ecological behavior. We use multiple research methods to this end, including a survey to gauge the average student's experience with waste sorting on campus, observing Sort It Out stations to better understand how students interact with the stations, and a focus group to explore knowledge about the proper sorting of individual items. The other half of our research focuses on the physical packaging being improperly sorted on campus and how it moves around campus between being purchased and being thrown away.

3.1 Audit Data

We quantitatively analyze two audit reports of compost contamination in UBC buildings, one for the general campus - the 'Compost Audit' analysis done by TRI Environmental Consulting, and one specifically for the Nest - the Composting Facility audit data. This data was provided by our SEEDS partner, in efforts to supply us with starting resources in our research. We use this data to compare sorting accuracy and waste composition in buildings including the Nest, Irving K Barber Learning Centre, Henry Angus Building, and the Forestry building, which allows us to link sorting behaviours to building-specific conditions like traffic levels and proximity to food outlets, which we present in a map to aid spatial understanding.

3.2 Survey

As a first step in our data collection, we formulated a questionnaire (see appendix E and F for questionnaire sample) to give to students to inquire about their waste sorting habits. This survey helps uncover any correlations between ecological attitudes, emotions, and stated behaviour of participants. This also provides an understanding of the average student's comprehension of correct sorting procedures and the implications of contaminating compost by sorting incorrectly. Collectively, we use

our findings from our research methods to determine how UBC's current system fails to create the desired behaviours and what aspects of signage and education allow for a more efficient system.

3.3 Observation

We attempted to observe behavior at waste sorting stations that were not included in the audit (Buchanan A & D and Central) because while completing our goal of collecting qualitative information revealing people's typical pattern behavior when interacting with on-campus waste sorting units, we can expand the range of buildings and food outlets in the scope of our research. To do this, we sat within view of the Sort It Out bins for 30 minutes at each site and took note of behaviours such as looking at the signage and time spent at the station, as well as what kinds of packaging are being disposed of at that location and whether people are sorting it correctly. This data supplements our quantitative analysis by providing examples of user experiences that we can extrapolate to other sites with comparable traffic and food store proximity.

3.4 Focus Group

To enhance our data, we also led a small focus group to gain more contextual information, where questions can be answered directly with more thought. This method allowed us to get more comprehensive information about where students buy food on campus, what packaging it comes in, and how they dispose of that packaging. We also use this opportunity to measure the average student's knowledge about sorting items that have been identified as common contaminants, by showing them photographs of the items in question. The structured portion of this method were manifested in ten set questions asking participants to sort ten different items into food scraps, recycling, paper, or garbage (see Appendix F). We then proceeded to facilitate a semi-structured format by asking two follow-up questions that invited free flow discussion:

1. Which items did you feel most confused about? Why?
2. Which packaging items do you use commonly?

In asking these questions we hoped to gain more context behind the confusion that led to their chosen sorting behaviours, providing our group with additional qualitative data and face-to-face interaction that the questionnaire and observation methods lacked.

We have developed our methodology in a way that approaches this complex issue from multiple angles. In order to understand compost contamination on campus we first must try to understand if there is any confusion about sorting waste on campus and if so, where this confusion stems from. More specifically, we try to determine which items people are most unsure about sorting. Our survey and focus group help us understand the behaviour and source of students' attitudes and understanding pertaining to waste sorting, their understanding of the issue and its importance, as well as potentially identifying possible problem food service locations. Furthermore, our observations help us fill in knowledge gaps left by the waste audit, both through collecting qualitative data and expanding the range of the study. Some limitations we recognize with our design is that we were only able to obtain data from a specific pool of participants, mainly UBC students. This leads to a gap in information from an older demographic including faculty, staff members, and back of house employees that still play an integral role in affecting improper waste sorting and management. Our quantitative results also relies heavily on the audit data report provided by our SEEDS partner as we

lacked the resources and expertise to conduct our own audit of each Sort It Out bin. Therefore, we were limited in our approach by focusing on the qualitative methods in which we could obtain information about people's behaviours, attitudes, and self-evaluations of proper waste sorting habits.

4 Analysis

4.1 Audit Data

Examining the data provided to us of the compost audit performed by TRI Environmental Consulting for UBC Waste Management revealed the dominance of non-conforming items in UBC green bins as well as the dominance of six categories of contaminants in the green bins. The audit is done annually and in 2017 was performed by the zero waste researcher, Patrick Wilkie, of TRI Environmental Consulting Inc. on November 29th and 30th, 2017. The audit is unpublished and was provided to us directly from UBC Waste Management. In the audit data, non-conforming items accounted for 57.303% of all contaminants, conforming items on the other hand only accounted for 42.697% of all contaminants. The total count of contaminants sampled in the compost audit was 1958, with 1122 contaminants being non-conforming and 836 contaminants being conforming (see Figure 1).

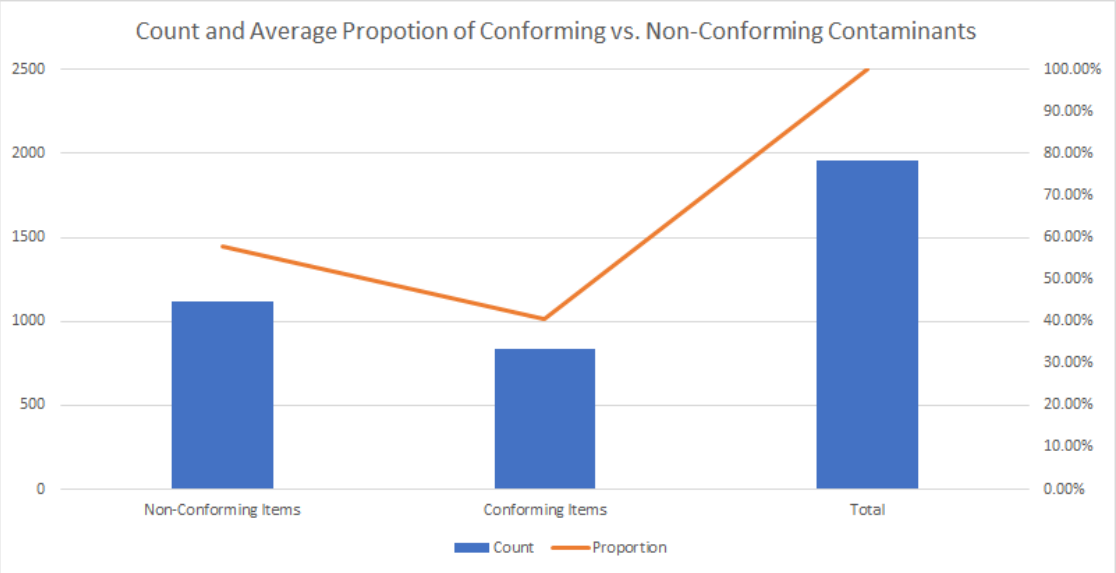

Figure 1

Nearly all the contaminants fell into 6 categories, three of which were conforming categories and the other three were non-conforming. The conforming categories were paper coffee cups, plastic bags, and plastic cup lids, which respectively made up 20.58%, 8.84%, and 4.24% of all contaminants. The non-conforming categories were plastic cutlery, food waste with packaging, and plastic containers and cups, which respectively made up 17.21%, 15.02%, and 15.02% of all contaminants. Collectively, these categories accounted for 1584 or 80.91% of sampled contaminants (see Figure 2).

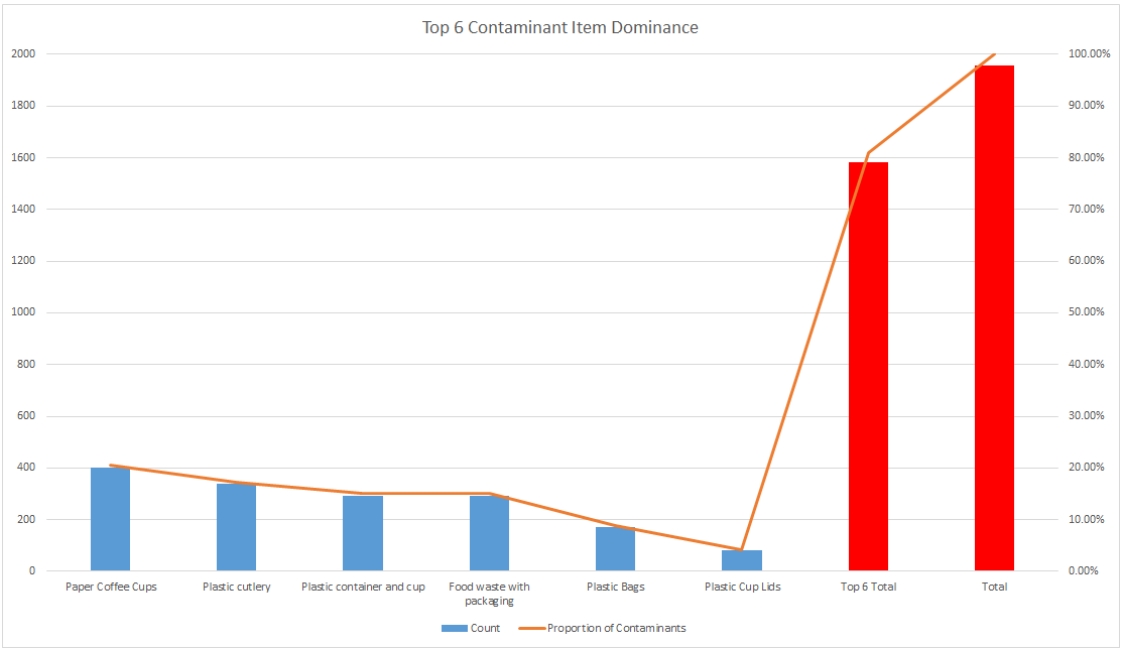

Figure 2

Among each of the buildings analyzed, Regent College had the most conforming contaminants, with 202 of the 221 samples or 91.4% being conforming contaminants. Ponderosa Commons had the most non-conforming contaminants, with 48 of the 49 samples or 97.96% being non-conforming contaminants (see Figure 3 and Figure 4).

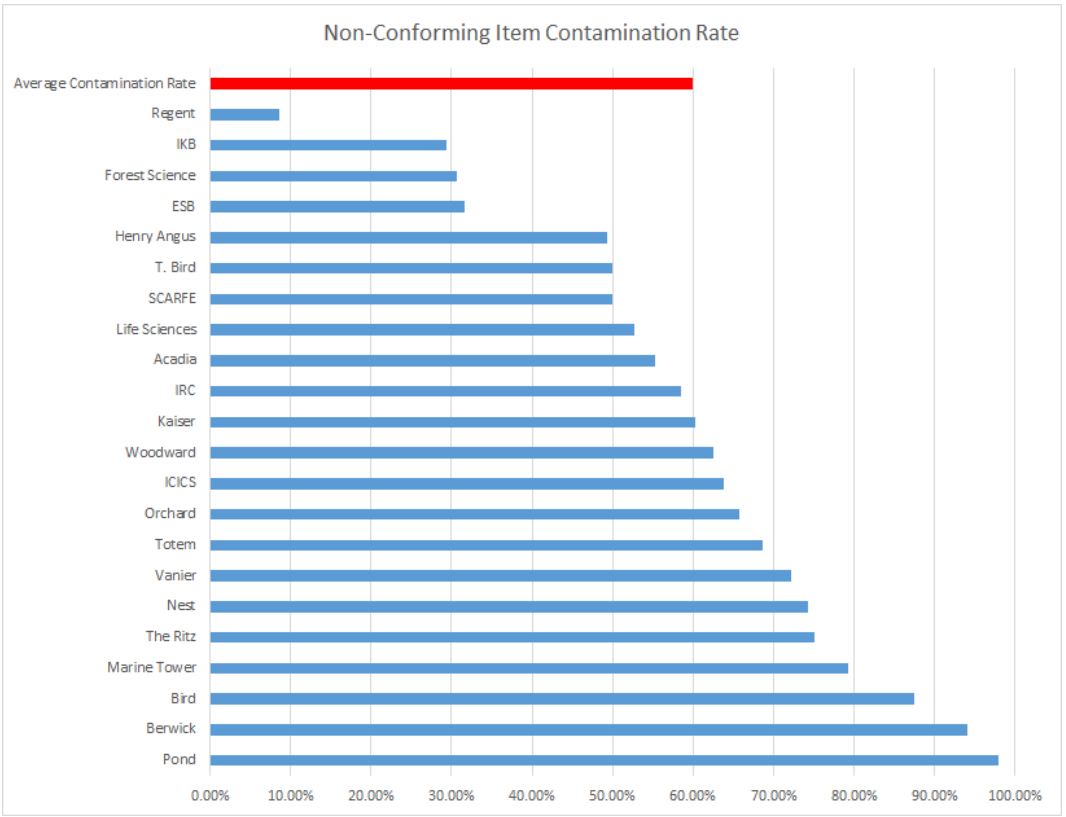

Figure 3

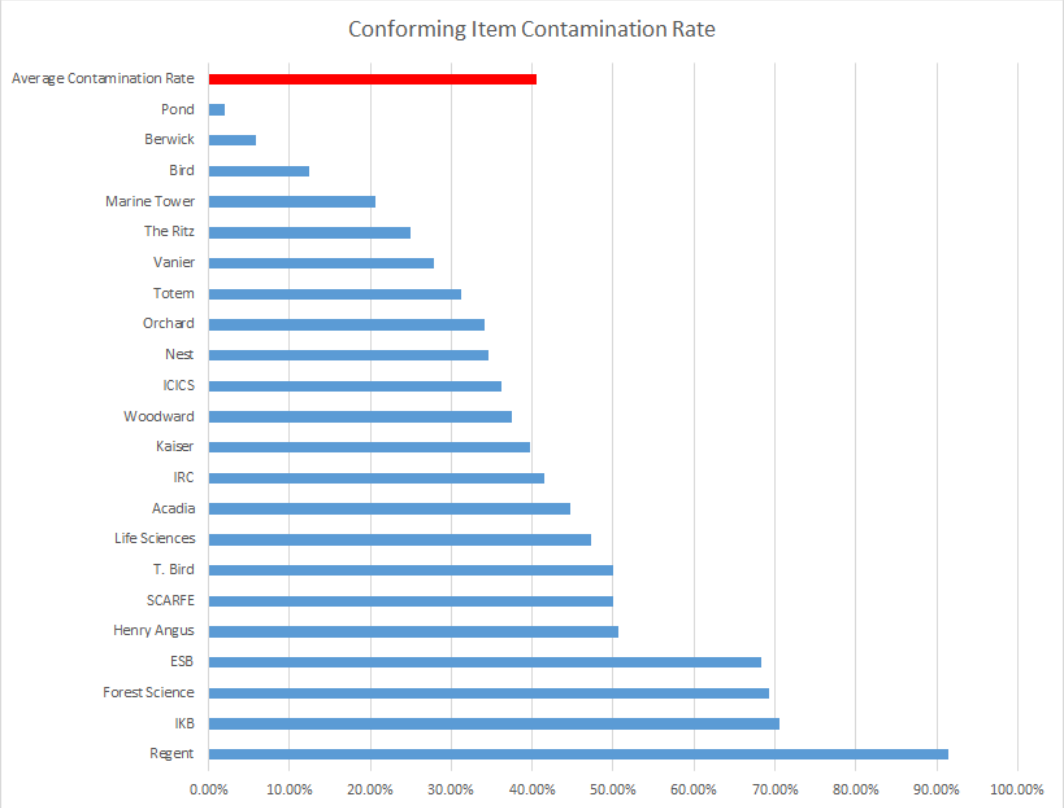

Figure 4

The Earth Science Building had the fourth most conforming contaminants, though it was noted there had been a party or event of some sort that had resulted in much cake and compostable plates being put into the green bin, constituting much of the conforming contaminants. As such, it is possible that there were more non-conforming contaminants sampled, but this is impossible to determine.

This data supports our findings from our observations and focus group that food packaging is among the most problematic categories for people to sort. This highlights the issue also raised through both of the previously mentioned methods of composite items, those composed of two or more different materials that should be sorted into different bins. Food packaging with food still remaining falls into this category and this confusion about composite items can help explain why this is such a problematic type of waste for people to sort. Despite this, our observation showed much higher rates of proper sorting than the audit data showed. There may be a number of reasons for this, including error in our observations, especially accounting for the fact that our observations were only half an hour long and it was not possible to to perfectly observe every piece of waste being discarded. On the other hand, the audit did not include most of the locations that we focused our observations on and therefore the findings we found may be true for the buildings observed - further research would be necessary to determine this.

4.2 Survey

We designed our survey early in our study period, when we were going to focus on behavioural psychology. We added a few questions about food purchasing habits on campus as an afterthought, but overall the content of the survey turned out to be not very useful to our research question, as they were more focused on perceptions of individuals' waste sorting. Further, we directed our survey at UBC students even though they are just a fraction of the people who dispose of waste on campus. When we look at the survey results, we see that our sample size was even more narrow, with

a heavy weight toward upper-year undergraduate students who are 19-21 years old, and the majority were Canadian-born.

From our limited questions on the survey, we learned that the average respondent reported buying food on campus 'often', with the three most popular food retail areas reported as the Nest, University Village, and Central, in order of decreasing popularity. These results are useful because they are a type of information that we did not collect from any of our other methods, and they can inform some of our suggestions for future projects. Our survey also confirms that some students find waste sorting to be tedious, and some are uncertain about where to put their waste. This complements the results of our observation method, where we were unable to tell whether people were hesitating when reading the signs.

4.3 Observation

The goal of our observations was to examine how people interact with the Sort It Out bins. A failure of our experiment was that it was sometimes hard to tell what items people were holding in their hands, so we really only took notes on the easily recognizable items rather than small scraps. One other limitation was that while we chose locations based on high foot traffic, we sometimes saw only a handful of people during our observation period.

In general, we observed much higher rates of correct sorting than we expected, especially of coffee cups, which were a problem item in the survey. We only saw one or two people put their coffee cups in the garbage, and everyone else sorted them according to the signs. A limitation was that we timed our sessions to be near lunch time in order to observe the most disposal of lunch food items possible, but to get a more full idea of coffee cup disposal, we could have gone in the morning when more people have coffee.

We also observed that the items we identified to be miss-sorted (not small scraps that were hard to identify) were similar to the items we identified from the audit as problem items. Things like plastic window bags and compostable soup cups were incorrectly sorted into the compost and garbage, respectively.

Generally, what this method showed us was that our items identified as confusing were indeed confusing to people, but that generally correct sorting rates were much higher than we had anticipated. Further, watching a bin for an hour only tells us about the few items that were thrown away during that time period, while the waste audits were more thorough as they showed the entire contents of a bin. Figures 5 and 6 summarize the quantitative findings of this method.

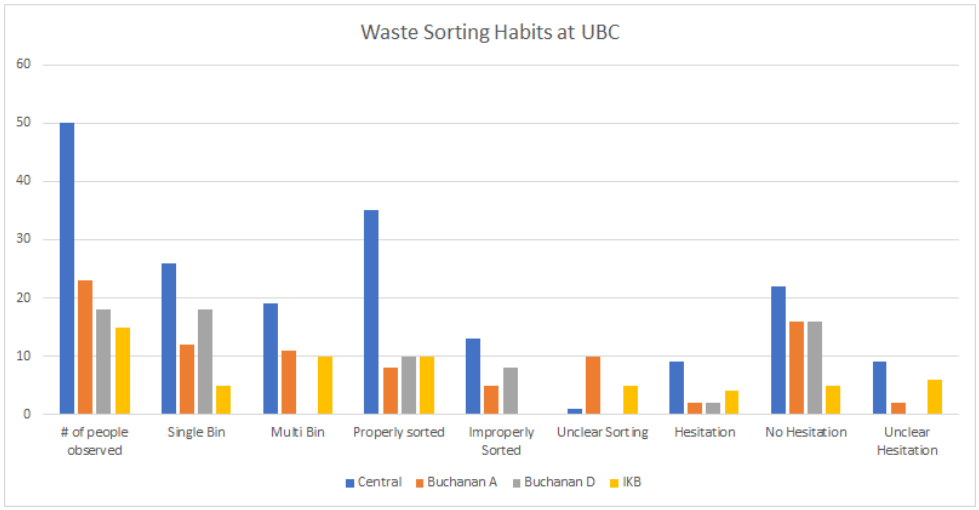

Figure 5

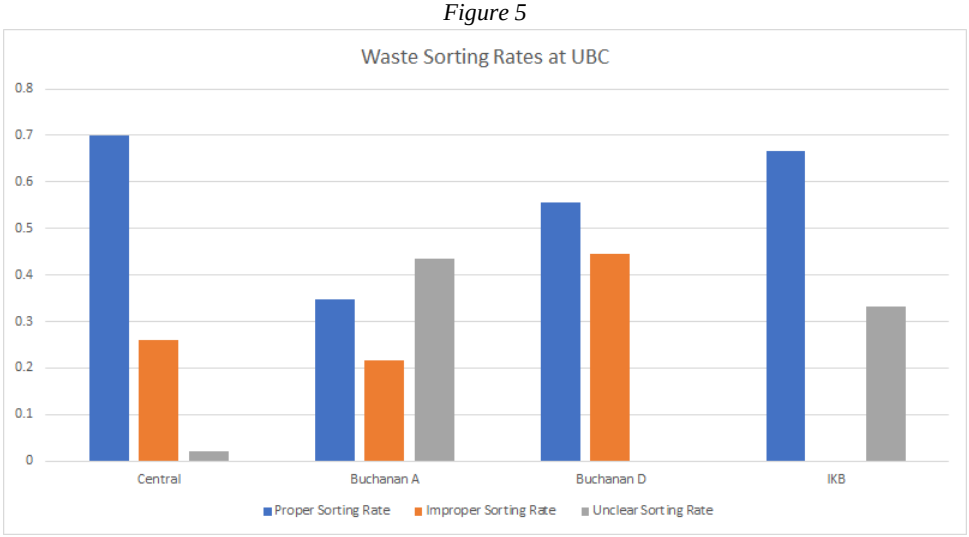

Figure 6

4.4 Focus Group

The focus group yielded insightful results on how students sorted waste items and revealed their confusion towards specific packaging products. We conducted a small focus group of five participants who were gathered from interested groups of friends. We asked them to sort ten different packaging items found at UBC into four categories: food scraps, recyclables, paper, and garbage. A preview of the our data results can be found in Appendix G. The results show that the average score on the questionnaire was 56%, while the lowest score was 40% and the highest score 70%. The data revealed some interesting patterns among the responses of the participants, conveying that the most commonly missorted item consistent among the entire group was plastic cutlery. All five participants sorted plastic cutlery into the 'recyclables' category and in follow-up discussions expressed that they did this because the recyclables signage states that plastic belongs in that bin so they assumed that this was true for all plastics. We found this to be a very problematic and confusing item ourselves, and deduced that the signage might be causing confusion and sorting hesitations for this item.

Other conclusions we gained from our follow-up discussion was that people found composite items very confusing as paper and plastic are two materials that belong in separate bins. Our participants mentioned that items with plastic lining were very deceiving because they are not visible and blatantly obvious. Our second follow-up question asked which packaging items were common with their purchases and the majority three out of five participants said they used coffee cups the most however only three out of five sorted this item correctly. The results we gained from this method

provided us more insight into our research question, disclosing that plastic cutlery is often improperly sorted as well as composite items. We recognize that our focus group was limited in size and age demographic diversity, therefore we suggest conducting further questionnaires asking UBC students, faculty, and staff to practice sorting 'confusing' items to determine whether the improper sorting of common items can be mitigated through targeted signage or further education.

5 Significance of Proposed Research

We started this research project with the aim of identifying social psychological factors including motivators and emotions as well as economic incentives to proper waste sorting in UBC. Our literature review focused mainly on these aspects as we seeked to gain a background on the scholarship of waste sorting, composting, and what influenced sorting habits. Throughout the process of our research as well as in collaborative discussions with our SEEDS partner, we came to the realization that while researching the social psychology of waste contamination was interesting and provided context on human behaviour, this was not a viable research question because most of the areas of confusion we found was not through confusion of signage or lack of motivation, but confusion with the packaging itself. Our results showed that non-conforming contaminants such as plastic cutlery and conforming contaminants such as plastic lined containers were some of the most problematic items expressed by students. This is why our group decided to narrow our research objective to identify packaging items that were most problematic on campus, to propose informed suggestions to our client. With knowledge of problematic packaging, we can suggest our client to further identify and trace food retailers that distribute this packaging.

We have been able to highlight the majority of these food packaging items through our secondary data analysis, and compare these to items that we found through primary research methods to underline the consistencies found. The majority of our participants expressed confusion with composite items as they were unaware that some paper containers had plastic lining, and confusion with plastic cutlery as they found signage for recyclables misleading as it includes the word 'plastic'. A common misconception is that if a food packaging item from one food outlet can be composted or recycled, then it's possible that it can be done throughout all the bins around campus, and with similar items too. Therefore, this highlights the problem that there is a variety of food packaging items and individuals assume that the process of sorting follows a standardized system across all types of food packaging which is untrue at UBC.

This then led to our second part of the research, identifying food retailers that require more attention, as problematic food packaging tends to be distributed from these locations. These areas are highlighted on our buffer map (Figure 7) that highlight the traffic of these items across UBC campus. We identified the five buildings with the highest contamination rates according to the waste audit and observation data and identified food retailers within 100 metres of these buildings, as they are likely the source of the contaminant items. In the cases of the Nest, Central, and University Village, the buildings were listed only by their name due to the large number of retailers in these locations. This has made it easier to identify these food retailers, and other potential outlets that could possibly be contributing to the problem too. With this information, we aim to be able to present to UBC and external food retailers their most problematic items and their environmental effects, and create an open dialogue on how they can implement changes to these problems whether it may be improving signage around campus targeting specific packaging, incentivizing reusable food containers, or overall implementing more waste sorting education amongst students.

This map was made by pairing the observation and audit data to identify areas where green bin contamination is focused on UBC campus. These points are marked using ArcGIS and then had a 100m buffer made within which food service locations were highlighted to identify any potential sources of green bin contamination. This map and its subsequently identified food service locations can be used as a means of beginning a follow-up with the food service locations to identify exact contaminants and their sources.

Figure 7

6 Future Research Directions

Evidently, proper waste management and sorting is a complex and multi-dimensional issue, with many stakeholders involved. But through this study we have come up with a few possible solutions that could help the university achieve it's waste diversion goals and ultimately reduce our ecological footprint as a student body. Firstly, targeting education and making it mandatory for students to understand the impact of their behaviour when it comes to proper waste sorting at UBC is something that can be done immediately and effectively. An example of how this can be implemented is showcasing a short video from UBC Sustainability on Imagine Day, where new students are all gathered in one area and this can teach them proper proper waste sorting habits when entering UBC.

Secondly, there should be further research in identifying which items are most problematic and non-conforming on campus, and approach food outlets that currently use these items. There are currently records of the majority of these items, however because of a growing number of food outlets on UBC, these records need to be updated as new items are being introduced. By conducting further research identifying these items, the data can be presented to UBC and its food outlets to showcase what effects these packaging items can have on waste sorting in UBC, and how we can work to resolve these issues.

Lastly, we'd like to propose to standardize packaging within UBC. Though some food outlets do have compostable items such as compostable plastic lids and cutlery, these aren't the standard

UBC packaging and therefore cannot be properly sorted in the same way, and may have to be sent to landfill instead. Users at UBC may already have preconceived ideas about waste sorting and follow what they've seen before, and therefore don't see small differences between packaging items that could make a difference within our UBC Green Bins. Ideally if all food outlets on campus can adhere to the UBC Food Service Ware Guidelines, then there is a potential that UBC can become a zero-waste campus. Zero-waste, as defined by UBC Sustainability, means that "all unwanted products and materials will be treated as resources that can be used again," ("Waste Action Plan", n.d.) and therefore the aim will result in no garbage generated on campus. This proposal would be emphasised more for non-UBC owned food outlets, such as the food outlets at Central on University Boulevard.

7 References

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8 Appendices

Appendix A: Observation Data

Location	# of people observed	Single Bin	Multi Bin	Properly sorted	Improperly Sorted	Unclear Sorting	Hesitation	No Hesitation	Unclear Hesitation	Proper Sorting Rate	Improper Sorting Rate	Unclear Sorting Rate
Central	50	26	19	35	13	1	9	22	9	0.7	0.26	0.02
Buchanan A	23	12	11	8	5	10	2	16	2	0.347826087	0.217391304	0.434782609
Buchanan D	18	18	0	10	8	0	2	16	0	0.555555556	0.444444444	0
IKB	15	5	10	10	0	5	4	5	6	0.666666667	0	0.333333333

Appendix B: Observation Data Rates

	Location	Proper Sorting Rate	Improper Sorting Rate	Unclear Sorting Rate
	Central	0.7	0.26	0.02
	Buchanan A	0.347826087	0.217391304	0.434782609
	Buchanan D	0.555555556	0.444444444	0
	IKB	0.666666667	0	0.333333333
	Buchanan	0.451690821	0.330917874	0.217391304
	Non-Conforming Items	Conforming Items	Total	
Count	1122	836	1958	
Proportion	57.90%	40.51%	100%	

Appendix C: Audit Data - Conforming and Nonconforming Contamination Rates

	Count	Proportion of Contaminants
Paper Coffee Cups	403	20.58%
Plastic cutlery	337	17.21%
Plastic container and cup	294	15.02%
Food waste with packaging	294	15.02%
Plastic Bags	173	8.84%
Plastic Cup Lids	83	4.24%
Top 6 Total	1584	80.91%
Total	1958	100%
	Location	**NC Contamination Rate**
	Pond	97.96%
	Berwick	94.12%
	Bird	87.50%
	Marine Tower	79.31%
	The Ritz	75%
	Nest	74.29%
	Vanier	72.22%
	Totem	68.70%
	Orchard	65.82%
	ICICS	63.77%
	Woodward	62.50%
	Kaiser	60.32%
	IRC	58.46%
	Acadia	55.32%
	Life Sciences	52.77%
	SCARFE	50%
	T. Bird	50%
	Henry Angus	49.30%
	ESB	31.65%
	Forest Science	30.66%
	IKB	29.41%
	Regent	8.60%
	Average Contamination Rate	59.89%
	Location	**C Contamination Rate**
	Regent	91.40%
	IKB	70.59%
	Forest Science	69.33%
	ESB	68.35%
	Henry Angus	50.70%
	SCARFE	50%
	T. Bird	50%
	Life Sciences	47.22%
	Acadia	44.68%
	IRC	41.54%
	Kaiser	39.68%
	Woodward	37.50%
	ICICS	36.23%
	Nest	34.62%
	Orchard	34.18%
	Totem	31.30%
	Vanier	27.78%
	The Ritz	25%
	Marine Tower	20.69%
	Bird	12.50%
	Berwick	5.88%
	Pond	2.04%
	Average Contamination Rate	0.405095455

Appendix D: Questionnaire Sample 1

Do you think you practice good waste sorting habits?

- ○ Yes
- ○ No
- ○ Sometimes
- ○ Not sure

Do you compost? (select all that apply)

- ☐ At home
- ☐ At school
- ☐ At work

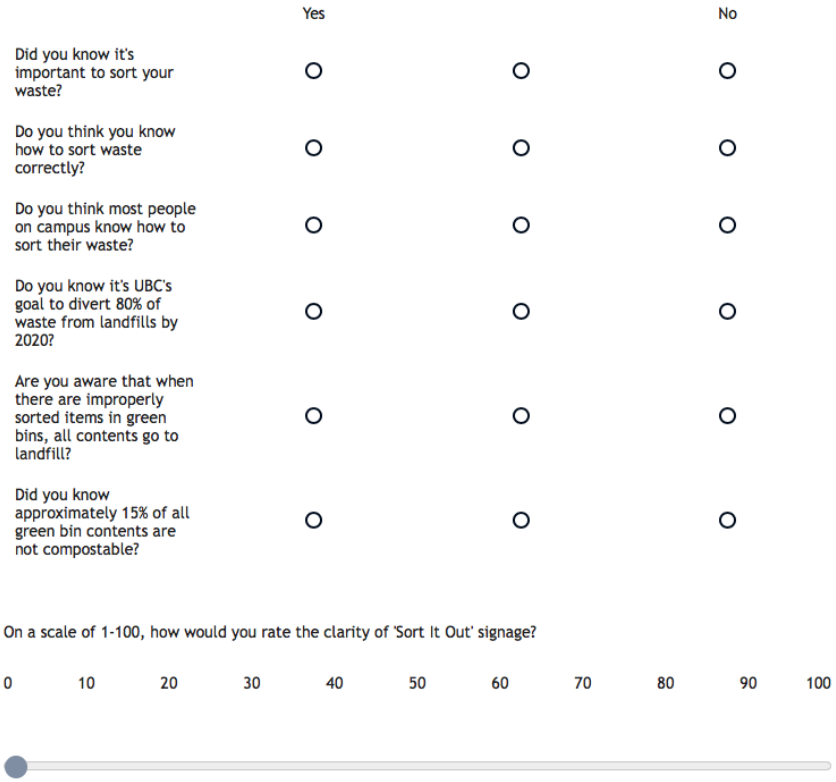
Do you recycle? (select all that apply)

- ☐ At home
- ☐ At school
- ☐ At work

How often do you buy food on campus?

- ○ Every day
- ○ Often
- ○ Rarely
- ○ Never

Appendix E: Questionnaire Sample 2



	Yes		No
Did you know it's important to sort your waste?	○	○	○
Do you think you know how to sort waste correctly?	○	○	○
Do you think most people on campus know how to sort their waste?	○	○	○
Do you know it's UBC's goal to divert 80% of waste from landfills by 2020?	○	○	○
Are you aware that when there are improperly sorted items in green bins, all contents go to landfill?	○	○	○
Did you know approximately 15% of all green bin contents are not compostable?	○	○	○

On a scale of 1-100, how would you rate the clarity of 'Sort It Out' signage?

0 10 20 30 40 50 60 70 80 90 100

Appendix F: Focus Group Sample Questions

CAN YOU SORT IT?

You may select more than one bin.

1. Pastry bag with plastic window

A. Food Scraps
B. Recyclables
C. Paper
D. Garbage

Appendix G: Focus Group Sample Data

Participant	Item	Food Scraps	Recyclables	Paper	Garbage	Q1 Which items did you feel most confused about? Why?	Q2 Which packaging items do you use commonly?
1	1		x			The ones with plastic and paper.	Coffee cups, paper and plastic bags
	2		x			Because it's hard to determine if it is to be recyled or going in	
	3			x		Also, paper cup and bowls didn't know had plastic lining.	
	4				x		
	5		x				
	6	x	x				
	7			x			
	8		x	x			
	9			x			
	10				x		
2	1			x		waxed paper bags, plastic cutlery	coffee cups, plastic cutlery, bag with window
	2		x				
	3			x			
	4			x			
	5		x				
	6				x		
	7			x			
	8				x		
	9			x			
	10		x				
3	1				x	coffee cup because seems like paper, doesn't feel like plastic	coffee cup, sleeve, wax paper bag, jeez what kind of question is -
	2		x				
	3		x				
	4	x					
	5		x				
	6				x		
	7			x			
	8		x				
	9	x					
	10				x		