Improving Waste Diversion on St. George Campus:

A Study of Recycling and Composting Behaviours

University of Toronto

Prepared for: UofT Sustainability Office

December 2016

Table of Contents

Executive Summary

The waste diversion rate at the University of Toronto's (U of T) St. George campus is good, great even. In fact, U of T has the highest waste diversion rate among Canadian universities (U of T Facilities & Services, 2016). However, at 70% diversion, there is more work to be done, and future improvements to the waste diversion rate will likely be more difficult and require more focused attention, as the "low-hanging fruit" have already been picked.

In order to make well-informed decisions about waste diversion on campus, and move well-beyond the 70% diversion rate, U of T's Sustainability Office retained the services of the Recycling Research Group to access the current state of recycling and composting (RC) on St. George Campus. The study focused on two areas: assessing the existing RC infrastructure; and assessing RC behaviour (i.e. how well students, staff, and faculty sort their waste). Special attention was paid to potential barriers, such as infrastructure variability, behavioural patterns, and attitudes, which may be preventing proper RC and impeding waste diversion.

Three findings are particularly important for the Sustainability Office to consider when introducing programs and policies that address waste diversion:

1. There is a high degree of variability in the RC bins and signage. The inventory revealed 20 different types of bins in 3 locations.
2. 55% of materials going in waste stream could be recycled or composted. The waste stream is the default.
3. RC accuracy during the game was not affected by participants' expressed attitude toward RC. We observed no causal link between expressed attitudes and behaviour.

This report makes a series of recommendations for the Sustainability Office primarily based on these key findings. Of particular interest is the third finding, which shows that positive attitudes towards RC do not correspond to proper RC behaviour, therefore, social practice recommendations should be taken very seriously. Three such recommendations are offered to the Sustainability Office:

1. Revise Procurement Policy by prohibiting the purchase of black plastic and "compostable" plastic materials, which end up contaminating the containers stream.
2. Reduce bin inconsistency by removing outliers and old infrastructure, replacing old signage, and making the compost bin level with rest of bins.
3. Remove streamed bins from cafeterias and set up area for users to stack trays with mixed materials. Have staff members sort the material.

Overall, this research study has identified potential barriers to correct RC behaviour. By addressing these barriers, the Sustainability Office can reduce contamination and improper sorting, thereby increasing U of T's waste diversion rate.

1.0 Introduction

1.1 Project Description

Recycling and composting (RC) are essential parts of a sustainable lifestyle; they save considerable amounts of energy and water, as well as reduce greenhouse gas emissions and pollutants (Weitz et al., 2002). To capture these benefits, the client- the University of Toronto Sustainability Office, represented by Dione Dias, the project coordinator- retained the Research Recycling Group to conduct a study of RC behaviour by campus users (students, faculty, visitors), with the ultimate goal of increasing waste diversion on the St. George Campus. In particular the client seeks to identify barriers to RC, including those that contribute to incorrect RC and contamination of RC streams and / or excess garbage, which may come in the form of signage, infrastructure or user attitudes, and resolve them through appropriate interventions.

1.2 Scope

Due to time and resource constraints, this study focused exclusively on RC infrastructure and behaviour in three high traffic locations, Sid Smith, Robarts Library and Medical Sciences Building. These buildings were studied over a four week period between October and November, 2016. These locations were chosen at the recommendation of the client, and because they are used by a diverse student population, and have cafeterias. The study is not intended to be exhaustive, rather it offers a snapshot of common RC behaviours and some barriers users face in sorting materials. It offers a starting point for future research, which will be discussed at length in the discussion portion of this paper.

In addition to time and resource constraints, this study was limited by how waste diversion was conceptualized. Increasing RC on campus, and thus diverting more waste from the landfill, is one way to increase the waste diversion rate. Another way to improve waste diversion

on campus is to focus on the "reduce, reuse" components of the three R's (the third, of course, being "recycling"). Although the former is the focus of our study and report, the latter is important to consider when reading this study's findings, as reducing waste more broadly is very important. The research question, objectives, and project design were based on the assumption that improving RC on campus is the best way to increase the waste diversion rate. However, decreasing the amount of materials consumed overall would also improve U of T's waste diversion rate.

1.3 Research Question, Goal and Objectives

The client's goal is to increase recycling diversion on St. George Campus, which prompted the research question: "What are the main factors that contribute to incorrect RC on St. George Campus?" To answer this question and recommend suitable interventions to the client, this study set out to achieve the following objectives:

1. Identify barriers preventing accurate RC;
2. Offer insights into the connection between expressed attitudes and observed behaviours.

1.4 Deliverables

In considering the needs of the client and key audiences, including the office of Sustainability personnel and University of Toronto staff, and campus users (students, faculty, staff, guests), study findings were delivered as follows:

1. Research Report: presents: i) observed behaviour of 231 users and expressed attitudes of 40 users at 3 high traffic locations; ii) data collection methods and; iii) recommended interventions, intended to be used for summary briefs and internal communications (See Appendix V & VI).

2. RC Bin & Signage Inventory & Assessment: contains photos and details of RC bins and signage in 3 buildings, demonstrating the RC opportunities and barriers that exist on campus, and helping to inform recommended interventions (See Appendix I).
3. Infographics (2): both infographics (See Appendix V and VI) present research findings in visually compelling ways. One is intended for the Office for Sustainability and its internal communications, while the other is designed to inform a broad audience comprised of campus users. Both are appended to this report.

2.0 Literature Review

2.1 Overview

Given the study's focus on RC behaviour, two key literatures were reviewed; behaviour change and social practice. Scholars who study behaviour change, examine factors that motivate or influence individuals to behave in a certain manner, and related interventions aim to change individuals' behaviour. Scholars who advocate a social practice approach look at collective behaviour and social norms, and as such offer systemic interventions. While the behaviour change literature informed the early design of the study and some of the methods chosen (e.g. surveying users to capture their expressed attitudes), both literatures were instrumental in analysing study results and offering recommendations. See 6.0 Recommendations section for more detail.

2.2 Behaviour Change

Two behaviour change frameworks were considered in developing this study: Theory of Reasoned Action and Theory of Planned Behaviour. Theory of Reasoned Action, one of the earliest frameworks developed for predicting variables that influence behaviour, states that "behaviour is behavioural intention" (Montano & Kasprzyk, 2015) (p.99). This framework poses

that attitudes towards an attitude object, determined by beliefs about outcomes from performing that behaviour, combined with normative beliefs, form behavioural intention, which directly predicts behaviour. Later studies showed that this framework was much more successful once the variable of perceived control over the action was added, as it included external factors that could impact perception and intention to form certain behaviours, thus forming the Theory of Planned Behaviour (Ajzen, 1991). Other studies testing the Theory of Planned Behaviour show that, depending on context, certain variables may carry more weight for forming behavioural intention (Albarracín et al., 2003; Albarracín et al., 2004; Albarracín et al., 2005).

In relation to predicting pro-environmental behaviour, the Theory of Planned Behaviour framework can help explain the observed 'environmental values-behaviour gap,' which describes the incompatibility between "pro-environmental values and environmentally-supportive behaviour" (Kennedy, Beckley, McFarlane, & Nadeau, 2009) (p.151). Although an individual can express pro-environmental attitudes, other variables such as normative beliefs and perceived control can deter such behaviour if context permits it.

This framework was selected to aid in the development of an observation tool and survey questions, and manage certain variables that are encompassed under the Theory of Planned Behaviour. These include attitudes towards recycling, and observed and self reported barriers that could influence perceived control and normative beliefs.

2.3 Social Practice

The work of Giddens (1986) and Bourdieu (Bourdieu and Nice 1984; 1977) was foundational in the development of social practice theory, which details the patterns of everyday routines and actions that emerge from social, cultural, and material interactions (Shove and Pantzar 2005; Shove and Walker 2010; Hargreaves 2011; Warde 2005 as described in O'Shea

2004). A practice "is a routinized (sic) type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge" (Reckwitz 2002:249).

Social Practice Theory informed the recommended interventions targeting systemic change. See 6.0 Recommendations section for more detail.

3.0 Methodology

As directed by the behaviour change literature and Theory of Planned Behaviour, this study aimed to answer the research question through the application of the following three research methods: 1) a RC infrastructure assessment; 2) observation of RC behaviour, and; 3) a materials sorting game followed by a survey. An interview was also conducted with Reno Strano, the University of Toronto Waste Manager to supplement the research.

3.1 RC Infrastructure Assessment

A RC infrastructure assessment was conducted to identify, map and assess different types of bins and signage. This was done to ascertain the consistency of RC bins and signage, and to identify obvious RC barriers. The locations chosen were Sidney Smith, Robarts' Library and the Medical Science Building. Areas included in the assessment were hallways, classrooms, lecture halls, study areas, cafeterias. Areas excluded were washrooms and outdoor bins.

Blueprints of each floor were used to map the location of all bins encountered, which were further assigned to a category. Notes on the types and condition of bins and signage were also recorded. Details and photos of all bin types were compiled into the RC Infrastructure guide appended to this report (see Appendix I).

To analyze the data collected, the bin types were grouped into three bin categories: 1) assorted waste bins; 2) recycling only bins, and; 3) garbage only bins. Compost bins were analyzed separately. The proportion of each bin was calculated for each individual building, and then aggregated together. The signage for each bin category was also sorted and analyzed to identify inconsistencies.

3.2 Observation of RC Behaviours

An observation study (observing without interfering or influencing behavior) was conducted to observe how users interact with RC infrastructure and to determine which streams have the highest incidence of incorrect RC and / or contamination. This method also helped to corroborate inventory findings regarding RC barriers.

The locations for our observations were chosen based on our observations from the site assessment. To ensure consistency across the comparison, standard assorted waste bins (Appendix I) located in a cafeteria next to a green bin were selected for observation. Guidelines for observing RC behaviour consisted of a procedure to evaluate waste sorting, ensuring researcher had an unobstructed view of the bin, and that there was a table close enough to sit at to record observed behaviour without being intrusive. This was created to ensure consistency between group members observations. See Appendix II for complete observation guide.

Observations were recorded in a chart that captured behaviour for each materials stream (garbage, containers, paper, and coffee cup, plus the compost stream available via the separate compost bin). Sorting accuracy and hesitation prior to disposal of items were recorded for each stream, with hesitation acting as a proxy for engagement with signage and / or conscious material sorting. Observations at each location were conducted twice and completed over one week for 1

hour at a time during the high traffic period of 12pm to 1pm between October 31 and November 4, 2016.

The accuracy of material sorting for each stream was calculated by adding up the number of correct disposals for each stream and creating an average. Hesitation was calculated in the same way. This was aggregated across the three locations. Each stream was ranked for accuracy. A chi-square test of independence, which is "used to determine if there is a significant relationship between two nominal (categorical) variables" (Statistical Solutions, n.d.), was performed to examine the relationship between hesitation and accuracy of waste disposal (See Appendix IV).

3.3 Game Design

A materials sorting game was created to observe the way students sort specific waste items. A replica of the standard waste bin (including shape and size of the receptacle holes and stickers) was created and a prize draw was used to incentivize playing the game, which was advertised through signage at the game site. Students who volunteered to play the game were given twelve materials to sort. The items included a plastic cup, plastic fork, a clam shell package consisting of a clear (recyclable) lid and black (non-recyclable) bottom, "compostable" plastic cup, paper coffee cup with plastic lid and cardboard sleeve, a compostable coffee cup, a paper bag, clean napkins, and a styrofoam plate.

Game participants then answered a 9-question survey that attempted to glean user awareness and attitudes towards RC on campus. Interview transcripts were coded for how strongly an opinion or idea was expressed, revealing factors that contribute to inaccurate materials sorting (See Appendix III).

The rationale behind combining the game and survey into a single interaction was to observe RC behaviors in a controlled setting, and to use the game to capture participants' interest and motivate them to fill out the survey. The findings from this method were cross-compared with results from the earlier observations.

This method was employed over 2 days in the Sidney Smith lobby for a total of 6 hours and resulted in data collection from a total of 40 game participants / survey respondents. An opportunity (convenience) sampling approach was taken as only people close to or passing by the game site were asked to participate in the game and survey.

3.4 Surveys

As previously mentioned, the purpose of the surveys was to capture user awareness and attitudes towards RC on campus. The questions were divided into 3 categories to determine the attitudes, barriers, and behaviours of participants. A mix of close-ended and open-ended questions were used. Coding was used to analyze the quantitative and qualitative data collected. Beliefs and values of the participants were then compared and correlated to their sorting accuracy from the game.

3.5 Interview with the Waste Management Supervisor and Recycling Coordinator

Additional clarity on behind the scenes sorting practices (undertaken by custodial staff), as well as, requirements and practices of the University of Toronto's recycling contractor was sought from Reno Strano, the Waste Management Supervisor and Recycling Coordinator at University of Toronto.

According to Reno, contamination of RC streams is not a significant factor affecting waste diversion, as up to 20% contamination of an item is still considered acceptable from the

contractor's point of view. The exception is "compostable" items like compostable plastic and coffee cups, which have high potential to contaminate a plastics stream and do not compost as advertised since the appropriate technology to process those items is lacking (consequently they belong in the waste stream). Reno identified black plastic, an item used by many vendors across campus, as another problematic material, since it is most often attached to a recyclable clear plastic lid forming a clamshell, but is not actually recyclable. This information was used to inform our observations of RC behaviour from the 3 locations, and for the game.

3.6 Limitations

Although this study provided useful information, the methods contained several limitations. First, the site assessment only included three campus buildings so the results cannot be generalized. Also, some of the classrooms could not be accessed, so classroom bins were not included in the sample. This could skew the proportion of each bin type and potentially omit additional bins and/or signage types. Secondly, the observations of RC behaviour were only conducted on the standard assorted waste bin. This study did not compare behaviours at different bin types. For the game design, the compostable plastic cup and the black plastic container bottom were discarded from the analysis due to complex distinctions on the correct/accurate sorting. Therefore, no composting items were included in the game. In addition, attracting participants with a recycling game may have unintentionally selected for people who care more about recycling. Furthermore, exposing them to a recycling and sorting exercise before taking a survey on their recycling habits, may have preconditioned their responses. Lastly, the survey questions created did not address bin consistency as a barrier to RC behaviour. This should have been included so that it can be compared with the interpretation that inconsistency of bins may contribute to why users have difficulty forming correct and consistent RC behaviour.

4.0 Results

4.1 Recycling Infrastructure Inventory

A total of 223 bins were recorded in the RC infrastructure assessment. The most significant finding from this part of the study was the high degree of bin inconsistency that exists in the locations studied: 20 bin types (of different sizes, colours, and shapes, with varying materials streams and signage variations) were identified and the most common of these, the standard waste bin (comprised of four streams; waste, containers, mixed paper and coffee cups) represented only 35% of all the bins recorded. See Figure 1.

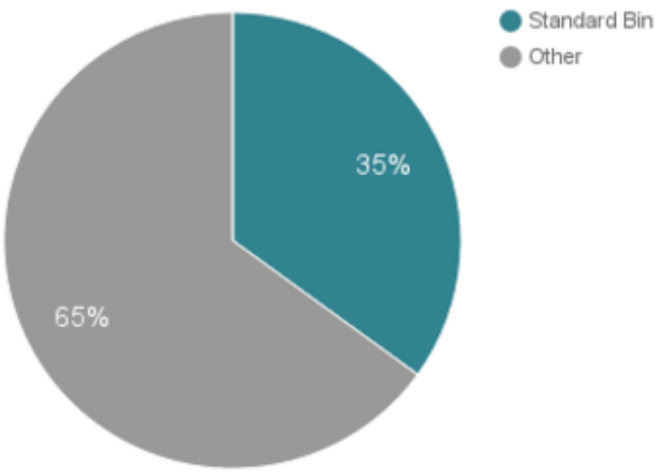


Figure 1. Consistency of the standard assorted bin

Another important finding is the lack of visibility of the green compost bins. There are significantly fewer of these bins (12 total between the 3 locations) and due to being smaller and separated from rest of bins are consequently overlooked by users. These results indicate that there are very few green bins, limiting opportunities for students to compost their organic waste.

The RC infrastructure assessment also found many variations in the colours, wording and placement of signage. In a few instances, signage was damaged (faded or soiled). Placement of signage on front face of bins was difficult to see. Some "solitary" recycling bins, did not have signage, and some had signage that indicated materials that were not consistent with each other. None of the "solitary" garbage bins have signage.

4.2 Observation of RC Behaviour

The key finding of observing RC behavior was that 55% of the interactions with the waste stream were not accurate. In other words, items disposed of during those interactions could've been recycled or composted. This was discovered through the following analysis:

Data from observations was broken into 3 different areas: 1) the relationship between hesitation and accuracy; 2) total within stream accuracy, and; 3) insight into default streams. As per the relationship between hesitation and accuracy, a chi-square test of independence was performed with an alpha level set to 0.05. The most significant finding from this portion of the study was the fact the results revealed no significant relationship between these variables, χ^2 (1, N = 235) = 0.348, p = 0.555. People were no more likely to accurately dispose of their trash when they hesitated versus when they did not (See Appendix III).

With respect to total stream accuracy, data analysis shows that users sorted materials in the paper stream the most accurately, at a rate of 81% accuracy. The stream with the least accuracy was the waste stream, at just 42% accuracy. On this note, the waste stream also had the highest default rate, meaning that it was the most used stream, at 63% of total items disposed. These results indicate that the stream with the highest potential for intervention is the waste stream, as it is both the most used stream and the stream subject to the least amount of material sorting accuracy.

4.3 Survey Results

A total of 40 participants were surveyed. The response rate for each question was very high and can be seen in Appendix III. The most significant finding from this portion of the study is the fact that expressed attitudes are not good indicators of recycling behaviour.

4.3.1 Attitudes.

The survey shows that most respondents express a positive attitude towards recycling. This finding suggests that attitudes may not be a major obstacle for recycling. However, the attitudes towards composting were considerably different. The highest responses were split between a very negative and a very positive attitude towards composting. This indicates that there is discrepancy between recycling and composting attitudes.

4.3.2 Barriers

From the survey and as anticipated, it was found that the top 3 reasons that prevent people from recycling and composting when on campus are: 1) confusing signage; 2) lack of conveniently located bins, and; 3) lack of time. This indicates that there may be issues with the number and location of bins, convenience, and whether recycling and composting are easy or user-friendly.

It is also interesting to note the additional comments recorded in the "other" section of this question. For recycling, the comments included: "not enough garbage bins", "food in containers", "I take it home to recycle", and "uneducated". This shows that there may be constraints with food and contamination of recycling because people may not know what to do or feel like they must take it home to recycle correctly. The "uneducated" response may indicate knowledge barriers. For composting, the comments included: "not enough garbage bins", "I take it home to compost", and "was not aware of composting bins". These comments reflect the same

barriers as recycling. They also reflect the results from the RC infrastructure assessment, where green bins only accounted for a small fraction of the bin types recorded

4.3.3 Behaviours

Respondents indicated that the most difficult items to sort were food items, followed by batteries and containers. The top reasons for this was the lack of compost bins nearby, "clarity of recycling rules on campus", followed by "clarity of bin signage". This finding also shows how the lack of green bins is a barrier to correct RC behaviour, and that signage may be inadequate.

The study also indicates that half of the respondents always put their waste into the garbage stream when they don't know where it is supposed to go. This is a good result because it shows that there may be less contamination of the recycling streams. However, 10% of respondents answered that they put their waste "in the closest bin no matter what it is". This may indicate a lack of concern for recycling. However, two out of the thirteen participants who answered that recycling is "extremely important to them" in question 1, also answered that they would put their waste in the closest bin to them if they do not know where it should go.

These are important findings as they indicate that factors other than attitudes impact behaviour. These survey responses support the earlier finding from the observation study that users default to the waste stream and that expressed attitudes do not align with behavior.

4.4 Game Data Results

The sorting game was designed to provide data on sorting accuracy of RC users in a controlled setting. The game participants were given twelve RC items, and as much time as they needed to sort the items into a standard bin with a compost bin situated beside it, replicating the set-up found in Sidney Smith, Robarts Library, and Medical Science buildings. In contrast to the sorting accuracy data collected during observations, real-life distractions and indifference were

more or less removed. Essentially, the materials sorting game offered insight into the question: "Given ample time, few distractions, a situation where full attention could be dedicated to sorting, and some pressure to do well, could RC users sort properly?". If RC sorting was straightforward, and the signs offered good directions, most of the game participants should get perfect or near perfect scores with these circumstantial elements working in their favour. This was not the case. The mean, median and mode for sorting accuracy was 8 out of 12 items correct, or a 67% sort accuracy, even with so many factors working in the participants' favour.

There are some sorting results to note. Firstly, most participants failed to notice the composting bin situated beside the standard bin set-up. In both real-life, and the game there is a height difference between the top of the standard bin and the compost bin. The game results showed that it is very easy for the compost bin to get "lost" beside the recycling and waste set-up. Secondly, there are two items that almost every participant sorted incorrectly: the black plastic bottom of a food container, and a compostable plastic cup. These items are very difficult to sort as revealed in conversation with Reno (see Section 3.5). This information is not readily available to students to learn about proper RC sorting. Lastly, even with the instructions on how to properly recycling coffee cups, their lids, and their sleeves written on the bin, half the participants sorted these items incorrectly. The game data demonstrates that even when paying close attention, and given the tools to sort perfectly, RC users still only sort 3 of out 4 items correctly.

4.5 Game & Survey Capturing Expressed Attitudes

After completing the sorting game, participants were given a survey, designed to gauge their attitudes towards RC, their perceived barriers to RC on campus, and their RC habits (outlined

above). The sorting accuracy for each participant was cross-compared to their answers on two of the survey questions:

- On a scale of 1-5 how important is it for you to recycle while on campus?
- When you are on campus, how often do you recycle and / or compost?

For the first question, a chi-square test of independence was performed to examine the relationship between self-reported importance of recycling and accuracy of waste disposal during the game. The alpha level was set to 0.05. Results revealed no significant relationship between these variables, χ^2 (15, N = 41) = .13.047, p = .599. People were no more likely to accurately dispose of their trash when they self-reported importance of recycling versus when they did not.

Even when participants wanted to recycle properly, (i.e. recycling was extremely important to them), they still recycled improperly. This shows that attitudes do not correspond to RC behaviour in a significant way; this suggests that social practice interventions would be more effective than interventions that attempt to change attitudes towards RC.

Cross-comparing the second question garnered similar results. A chi-square test of independence was performed to examine the relationship between self-reported frequency of recycling and accuracy of waste disposal during the game. Results revealed no significant relationship between these variables, χ^2 (15, N = 41) = 11.383, p = .725. People were no more likely to accurately dispose of their trash when they self-reported a higher frequency of recycling versus when they did not. This suggests that RC behaviours do not improve with greater use, or over time. One limitation to using this question to compare was that it combined the frequency of recycling and composting behaviour. This may have confused participants when answering because they may recycle more or less often than composting. (See Appendix IV)

5.0 Discussion

5.1 Main Findings

Using the data results, three main conclusions were made. These were that there is a high inconsistency in waste management infrastructure, a high degree of incorrect waste sorting, and that there is no relationship between expressed attitudes and waste sorting accuracy.

5.1.1 Inconsistency in RC infrastructure.

The findings from the RC infrastructure assessment indicate that there is a high degree of inconsistency between bins. This includes the type of bins, signage and the number of green bins. This indicates that inconsistency may be a reason why users may have difficulty forming correct and consistent RC behaviour. The results from the survey also support this, specifically in terms of the reported difficulty to sort food waste and the lack of compost bins.

The findings from the site assessment can be compared to the recommendations from the UofT annual waste audits and practices from other universities to identify where UofT can improve. According to each waste audit report conducted at UofT since 2004, recommendations have been put forward to make use of multi-compartment (assorted) bins and eliminate the use of "solitary waste bins" (Envirovision Inc., 2006; .SDK Environmental Consulting & Services, 2015). However, about 50% of the bins recorded in this report consisted of multi-compartment bins, when including all the variations of multi-compartment bins (Appendix I). These bins had different signage and placement of signage, which contributes to the inconsistency. The UofT 2015 waste audit report also recommends having signage with pictograms (SDK Environmental Consulting & Services, 2015), however, our assessment finds that 27% of the assorted bins had signage with only plain black text. This indicates multi-use compartment bins and signage still need to be improved. To address the gaps in collection systems and increase the convenience of recycling and food waste collection, the University of British Columbia has implemented

homogeneous multi-stream waste-sorting and collection infrastructure across the entire campus, with compost bins at all significant generation areas (UBC, 2014). This is an action UofT should also investigate and consider.

5.1.2 High degree of inaccuracy in materials sorting.

Findings from the observation, survey, and the game suggest that people sort their materials incorrectly when on campus, and that materials are defaulted to the garbage stream. The observations reveal that 55% of interactions with waste stream are not accurate, meaning materials disposed of during those interactions could have been composted or recycled. The surveys also reveal that most respondents put their waste into the garbage when they do not know where to put it. Furthermore, the game findings reveal that materials are sorted incorrectly even when participants are paying attention. This indicates that there may be issues with the bins and the signage.

In addition to this study's results, the 2015 UofT waste audit found that 5.8% (or 110 tonnes) of material in the waste stream consisted of mixed containers (SDK Environmental Consulting & Services, 2015). One logical explanation for this is that the hole for the container stream is too small for many containers, so users select the adjacent garbage receptacle, which has a larger hole.

5.1.3 No detected relationship between sorting accuracy and expressed attitudes.

Although, this project's design was largely informed by the behaviour change literature, this finding demonstrates that expressed attitudes do not translate into correct RC behaviour, which in this case is operationalized as materials sorting accuracy. Consequently, even when participants wanted to recycle properly, i.e. recycling was extremely important to them, they still recycled improperly. This shows that attitudes do not correspond to RC behaviour in a

significant way. This is also seen in the survey results where a few participants who expressed very positive attitudes towards recycling also indicated they would put their waste in the closest bin to them if they do not know where it should go. Therefore, social practice interventions would be more effective than interventions that attempt to change attitudes towards RC.

These results also demonstrate that sorting RC materials correctly is very difficult. There are many different types of disposable materials, a number of plastic variations, rules about soiled versus clean materials, five streams, and possibly misleading signage. It is not entirely surprising that game participants did not score well. In order to account for particularly challenging materials, the black plastic and “compostable” plastic were removed from the data set before comparing sorting accuracy to expressed attitude. As mentioned earlier, there is a possibility that participating in the recycling game influenced the participant's’ survey responses, such that the sorting game caused participants to self-report placing a greater importance on recycling.

5.2 Recommendations for Future Research

This study was a modest attempt to better understand the issue of waste diversion on St. George Campus, and there are many possibilities for further research. Expanding the scope and scale of the investigation, to include additional campus locations and more users over a longer timeframe would help corroborate results. While this study found no causal link between expressed attitudes and behaviours (RC accuracy), more work is needed to clearly define the relationship between these factors toward choosing appropriate interventions. Research aimed at gaining a deeper understanding of users’ perceptions of signage, and the impact of different signage design on behaviour would also be valuable. Changing signage might be tempting, but it can be an expensive option so should be grounded in good data as to what will be most effective

prior to proceeding. If possible, the interventions recommended here should be piloted first. A cost-benefit analysis of the larger scale interventions recommended (e.g. switching to a single stream and staffing high traffic areas; phasing out older bins) should also be undertaken prior to proceeding. Finally, seeing as how our observations only accounted for one type of bin, more research studying RC behaviours at different bin types is recommended in order to compare whether or not the bin type affects the student's RC behaviour.

6.0 Recommendations for the Sustainability Office

A suite of recommended interventions follow, which are based on the aforementioned study findings. These are grouped into two categories, the first target individual behaviour change, while the second align with social practice theory and target systemic changes to shift collective user behaviour.

6.1 Community-Based Social Marketing Interventions

6.1.1 Switch Stickers on Bins between Container and Coffee Streams.

- Description: switch container and coffee stream stickers to create better alignment between materials to be disposed of and the size and shape of the hole receptacle.
- Rationale: an inexpensive solution that will clear up confusion generated by ill-matched materials and holes (e.g. Containers are too large for current container hole, but would fit in coffee receptacle hole, and coffee cups fit and are the same shape as the container hole).
- Tradeoffs: may add confusion if people are in the habit of throwing a regularly used item in the same bin each time. Relies on people reading and following sticker cues.
- Possible Indicators:

- Decrease (tonnes) of containers in waste stream / increase (tonnes) of containers in container stream (measure by waste audit each semester)
- Increase (tonnes) of coffee cups in coffee cup stream (measure by waste audit each semester)
- Increase (# students) of post–intervention survey respondents indicating signage is easier to follow.

6.1.2 Recycling Composting Days.

- Description: Designate a day early in each semester as Recycling Composting Day. Volunteers or paid staff stand at recycling bins and show users where items go and answer questions.
- Rationale: teaching users how to properly sort materials will help them create accurate RC habits.
- Tradeoffs: teaching moments may be insufficient to form long-lasting behavior, especially if they are not reinforced by ongoing prompts, incentives, commitments or enforcement. Different behavior is needed at different locations and / or based on kind of infrastructure and materials, which may not be consistent with what is taught during RC Day. Users won't learn how to sort every kind of material during a RC Day.
- Possible Indicators:
    - Decrease (%) of waste / Increase (%) of RC materials (for each stream) (measure by waste audit each semester)

6.1.3 Offer Incentives.

- Description: Increase the discount for bringing personal coffee mug, or food container. Supported by an information campaign about cost savings and other values of reducing waste.
- Rationale: many users are motivated by financial rewards. Survey respondents identified time and convenience as factors affecting their RC practices. A case can be made that "time equals money;" however, for some users discount would need to be substantial for it to seem worthwhile.
- Tradeoffs: reusable coffee mugs and other reusable containers have more embodied energy than disposable ones, so this intervention may create a perversive incentive to treat such materials as disposable (e.g. if a reusable mug gets misplaced and user purchases another to replace it, the effect may be less environmentally sound than if they had always used disposable cups).
- Possible Indicators:
    - Decrease (%) of coffee cups in all streams (measure by waste audit each semester)/ % decrease of containers in all streams (measure by waste audit each semester)
    - Increase ($) in incentives (measure by reviewing annual budget allocation)

6.2 Social Practice Interventions

6.2.1 Revise Procurement Policy & Responsible Purchasing.

- Description: Approach all campus venders and food trucks and regulate containers and packaging. Prohibit use of black plastics, straws and compostable materials, which end up contaminating the containers stream.

- Rationale: reduce availability of materials that cannot be recycled or often contaminate a recycling stream
- Tradeoffs: more effort involved and requires policy and enforcement.
- Suggested Indicator:
    - Decrease (tonnes) of targeted materials (e.g. containers) in all streams (measure by waste audit and / or vendors' packaging invoices annually)

6.2.2 Reduce bin & signage inconsistency

- Description: Remove old infrastructure and replace with standard recycling bins. Replace old stickers and / or signage. Make compost bin level and visible with rest of bins.
- Rationale: consistent infrastructure will contribute to consistent patterns of behaviour and increase RC accuracy.
- Tradeoffs: an expensive solution. Retiring bins might be detrimental to waste diversion rate. Making compost bin level and visible with rest of bins might result in higher degree of contamination
- Suggested Indicators:
    - Increase (#) of installed standard bin / Decrease (#) of other types of bins
    - Decrease (%) of waste / Increase (%) of RC materials (for each stream) (measure by waste audit each semester)

6.2.3 Switch to a Food Tray-Collection System.

- Description: Remove streamed bins from cafeterias and set up area for people to stack trays with mixed materials. Have staff members do the sorting.

- Rationale: Allow for correct sorting of waste into correct stream and reduce contamination.
- Tradeoffs: Requires more staff to do sorting, more time involved. Need to know value proposition of this approach, which may require an investment into a cost-benefit analysis.
- Suggested Indicators:
    - Decrease (%) of waste / Increase (%) of RC materials (for each stream) (measure by waste audit each semester)
    - Increase ($) in cost savings (annual accounting measure)

7.0 Conclusion

Overall, this study reveals three key findings: 1) There is a high degree of variability in the RC bins and signage. Our inventory revealed 20 different types of bins in 3 locations; 2) 55% of materials going in waste stream could be recycled or composted, and; 3) expressed attitudes are not good indicators of behavior and do not predict RC accuracy. These represent areas that should be addressed by the client to achieve its recycling diversion goal. Targeting these areas are two groups of recommended interventions, representing behavior change and social practice theories respective. These are likely to be cost effective, easy to implement on the behavior change side and broadly effective on the social practice side. Further research is needed to determine the potential for signage to impact behavior since this might offer a promising suite of interventions.

8.0 References

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes, 50,* 179-211.

Albarracín, D., Gillette, J. C., Earl, A. N., Glasman, L. R., Durantini, M. R., & Ho, M. (2005). A test of major assumptions about behavior change: A comprehensive look at the effects of passive and active HIV-prevention interventions since the beginning of the epidemic. *Psychological Bulletin, 131*(6), 856-897. doi:10.1037/0033-2909.131.6.856

Albarracín, D., McNatt, P. S., Klein, C. T. F., Ho, R. M., Mitchell, A. L., & Kumkale, G. T. (2003). Persuasive communications to change actions: An analysis of behavioral and cognitive impact in HIV prevention. *Health Psychology, 22*(2), 166-177. doi:10.1037//0278-6133.22.2.166

Albarracín, D., Kumkale, G. T., & Johnson, B. T. (2004). Influences of social power and normative support on condom use decisions: A research synthesis. *AIDS Care, 16*(6), 700-723. doi:10.1080/09540120412331269558

Bourdieu, P., & Nice, R. (1984). *Distinction: A social critique of the judgement of taste.* Cambridge, MA: Harvard University Press.

Envirovision Inc. (2006). *Solid non-hazardous waste audit.* Retrieved from http://www.fs.utoronto.ca/wp-content/uploads/2015/06/Waste-Audit-04_05.pdf?method=

Giddens, A. (1986). *The constitution of society: outline of the theory of structuration.* Oakland, CA: University of California Press.

Kennedy, E. M., Beckleym T. M., McFarlane, B. L., & Nadeau, S. (2009). Why we don't "walk the talk": Understanding the environmental values/behaviour gap in Canada. *Human Ecology Review, 16*(2), 151-160.

Montano, D.E., & Kasprzyk, D. (2015). Theory of Reasoned Action, Theory of Planned Behavior, and the Integrated Behavioral Model. In K. Glanz, B. Rimer, & K. Viswanath (Eds.), *Health Behavior* (pp. 95-124). San Francisco, CA: Jossey-Bass.

O'Shea, M. (2012). *Embodying and Performing Sustainability*. University of British Columbia. Retrieved from https://open.library.ubc.ca/cIRcle/collections/ubctheses/24/items/1.0073124

Reckwitz, A. (2002). Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory, 5*(2), 243–263.

Statistical Solutions. (n.d.). Chi-Square Test of Independence. Statistical Solutions. Retrieved from www.statisticssolutions.com/non-parametric-analysis-chi-square/

SDK Environmental Consulting & Services. (2015). *University of toronto 2015 solid non-hazardous waste audit.* Retrieved from www.fs.utoronto.ca/wp-content/uploads/2015/12/p0481-uoft-spring-2015-waste-audit-final.pdf

Shove, E., & Pantzar, M. (2005). Consumers, producers and practices. *Journal of Consumer Culture, 5*(1), 43–64.

UBC. (2014). *UBC Vancouver Campus Zero Waste Action Plan.* Retrieved from https://sustain.ubc.ca/sites/sustain.ubc.ca/files/uploads/CampusSustainability/CS_PDFs/RecyclingWaste/Zero_Waste_Action_Plan%202014%2010%2003%20final.pdf

U of T Facilities & Services. (2016). Reduce, Reuse, Recycle, Rethink. *University of Toronto*. Retrieved from www.fs.utoronto.ca/building-services-trades/recycling-services/reduce-reuse-recycle-rethink/

Appendices:

Appendix I. RC Infrastructure Inventory

These inventories include images of bins located at three high-traffic location- Sidney Smith, Medical Science Building, and Robarts' Library. Any indication of damage to a bin or alternative to a common or standard U of T bin was noted during the study's observations.

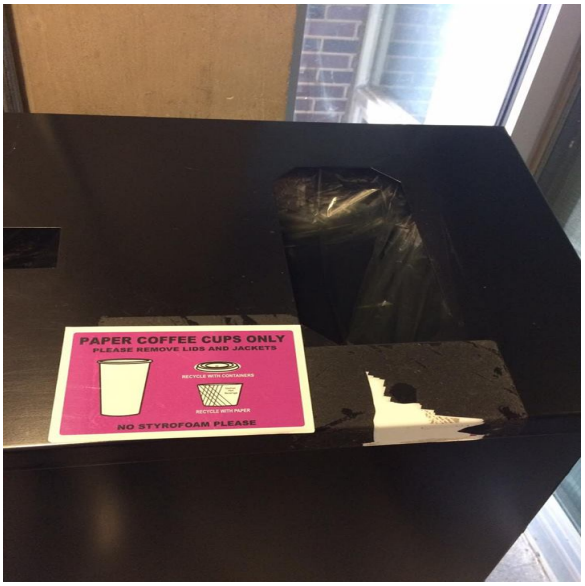
1. RC Infrastructure Data

Total bin consistency at Sidney Smith, Medical Science Building, and Robarts			
Bin Category	Bin Type	Count	Percent (%)
Assorted Waste Bin	Standard assorted waste bin	79	71
	white standard bin	5	4
	white- no colour picture labels	15	13
	white 3 stream- no paper	13	12

Total bin consistency at Sidney Smith, Medical Science Building, and Robarts			
Bin Category	Bin Type	Count	Percent (%)
Recycling Only	Mixed Paper	25	34.7
	Secured Shredded paper	1	1.4
	Batteries	3	4.2
	Paper Towel only	1	1.4
	Blue circle recycling	10	13.9
	Blue square recycling	22	30.6
	coffee cups only	1	1.4
	mini blue recycling	5	6.9
	CD/V.A.T	1	3.7
	bottles and cans brown	3	4.2

Total bin consistency at Sidney Smith, Medical Science Building, and Robarts Library			
Bin Category	Bin Type	Count	Percent (%)
Garbage only	Grey garbage	5	18.5
	unlabelled multiple garbage	2	7.4
	unlabelled standard brown garbage	4	14.8
	starbucks garbage	2	7.4
	mini brown unlabelled	13	48.1
	semi circle garbage bin	1	3.7

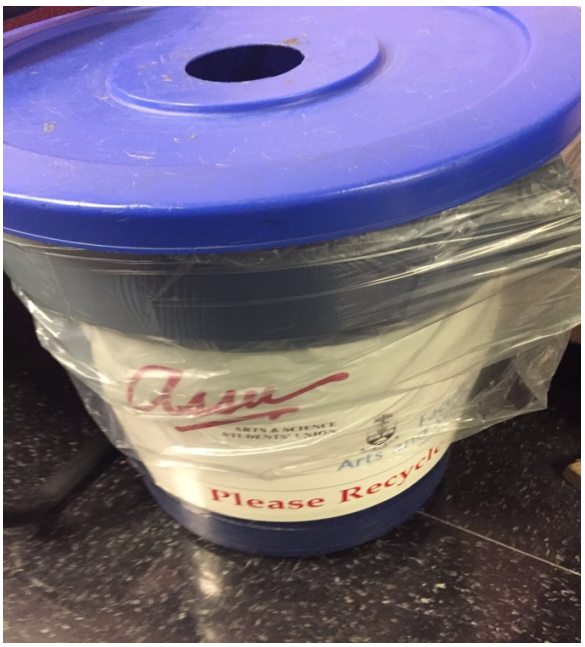
2. Bin Guide for Sidney Smith

Bin # and Variation	Image
1. Standard Bin • Standard U of T Waste system bin that includes all four streams- garbage, recycling, paper, and coffee cups (left to right).	
1.1 Standard bin alternative • Standard waste system bin, but black coloured bin and reverse order of streams- coffee cups, paper, recycling and garbage (left to right). • This bin's holes were placed backwards in comparison to the other standard bin. • These bins have less space for the coffee cup sticker.	
1.2 Black Standard Bin bin with damaged coffee cup sign • Original Coffee cup sign was damaged, but reattached a new sign.	

2. Large bins only for mixed paper • Large standing blue bin for mixed paper only. • Some were coloured all grey and this was noted during observation.	
3.Tim Horton's bins • Alternative standard garbage and recycling bins for Tim Horton's in Sid Cafe. • No paper labels (garbage disposal image), just images or words directly on bin (recycling).	

4. Large bin specifically for shredded documents • shredded paper only	
5. Battery recycling bin • Battery disposal bins.	

6. Generic grey garbage bin • Some bins had lids on with “Caretaker U of T” stickers, and were noted in the observation notes.	
6.1 Generic grey waste bin with lid • Standard grey garbage bin with a lid. • Includes two signs indicating “Caretaking U of T”	

6.2 Bin with "ASSU" sign • No indication of what recyclable materials are allowed to be placed inside.	
6.3 Blue bin without lid • Circular recycling bin • No indication of what specific materials are allowed to be placed inside.	

7. Paper Towel only bin. • Washroom paper towel recycling bin	
8. **Blue Circular Recycling bin** • Classroom "Cans and Bottles" recycling bin. • Some bins had a different lid, and some had no lid, and this was noted.	
9. Square shaped blue recycling bin • Generic paper recycling bin. • No labels.	

10. Standard Green Compost bin • Short, standing green bin. • Standard organic waste bin, usually located right by the Standard waste bin. • Includes label on top of bin lid indicating appropriate items for bin.	
10.1 Organic waste, grey-colored bin • An anomaly of organic waste bin. • Bin located only in Sidney Smith.	

11. Alternate Bin System • This is what a standard bin distribution in classes in Sidney Smith looked like	

2. Bin Guide for the Medical Science Building

Bin # and Variation	Picture
1. Standard Bin • Standard U of T Waste system bin that includes all four streams- garbage, recycling, paper, and coffee cups (left to right).	

1.1 Standard Bin, Alternate order • Includes standard compartments. • Alternate order of signage- garbage, recycling, coffee cups, and paper (left to right).	
2. Large Bins for Mixed Paper • Large standing blue bin for mixed paper only.	

3. Tims/starbucks garbage bin • Small circular hole found in Starbucks of Medical Science cafeteria. • No label.	
4. Battery Drive • Labelled for batteries • Lid slightly placed off	

5. Generic Grey Garbage Bin • Standard grey garbage bin. • Includes "Caretaking U of T" label on front of bin.	
6. Paper Towel Bin • Blue bin for paper towels found in the Women's bathroom. • Sign found above bin fixated on wall.	

7. Blue Circular Recycling Bin (no lid)	
8. Blue Circular Recycle (lid) • Labelled with "bottles, cans, cartoons, tubs" • Small circular hole.	

9. Standard Green Compost Bin • Short, standing green bin. • Standard organic waste bin, usually located right by the Standard waste bin. • Includes label on top of bin lid indicating appropriate items for bin.	
10. White Four-Stream Bin • Waste component streams include garbage, recycling, paper, and coffee cups (left to right). • Slightly damaged- writing, so not as visible to read.	

11. Cream three-streamed Bin Similar to white four-stream bin. • No option available for paper recycling like the white four pack bin	
12. Semi-circular Garbage Waste Bin • Garbage waste bin. • Small, short bin near elevators on ground floor	

13.Standard outdoor • Includes standard compartments, but is grey in colour, located outsides MS building and not slated top.	

3. Bin Guide for Robarts' Library

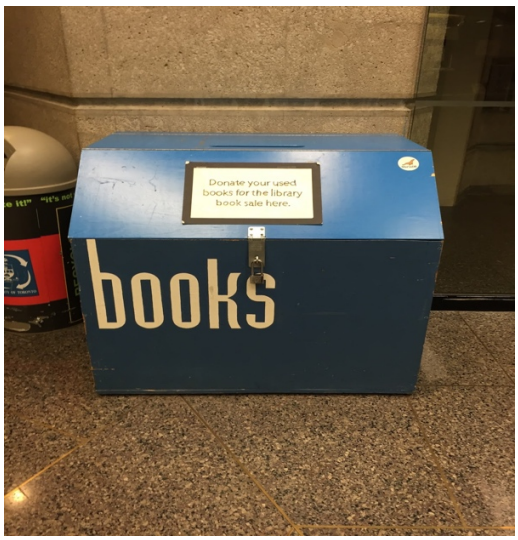
Bin # and variation	Picture
1. Standard Bin • Some were coloured all black and were noted. Of the black bins, several had poorly placed coffee cup recycle signs and were noted.	
2. Large bins only for mixed paper • Some were coloured all grey and were noted.	

Unlabelled multiple stream Bin • Alternate waste stream bin system found in Robarts' cafe. • Does not include any labels, but assume components are garbage and recycling.	
4. Large bin specifically for shredded document • shredded paper only	
5. Battery recycling bin • bin for recycling batteries. • Alternative appearance.	

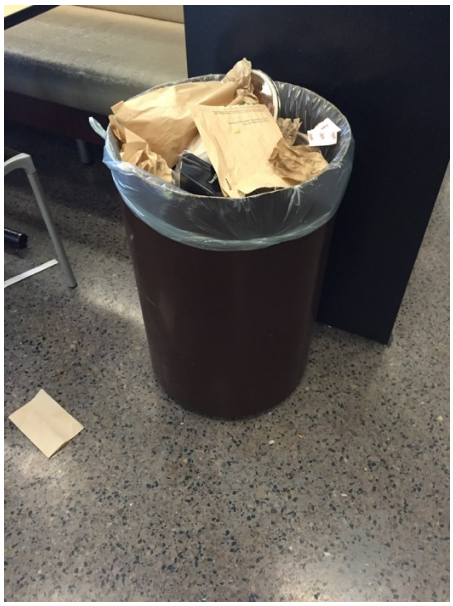
6. Generic grey garbage bin • Some had lids on with "Caretaker U of T" stickers, and this was noted.	
7. Paper Towel Recycling Bin only • Washroom paper towel recycling bin.	

8. Blue Circular Recycling Bin • Classroom "cans and bottles" recycling bin. • Some bins had a different lid, and some had no lid, and were noted.	
9. Square Blue Recycling Bin • Generic paper recycling bin. • No labels.	
9.1 Mini Blue Recycling Bin • Generic small paper recycling bin.	

ROBARTS (Continuation of Medsci guide)

10. Book Donation Bin (First variation) • Bin for donating unwanted books.	
10.1 Book Donation Bin (Second Variation) • Alternate bin for donating unwanted books.	
11. CD/ Video/ Audio/ Tape Wastebin • Bin for old electronic media to be recycled.	 

12. White Four-Stream Bin • Stand white four-stream bin • Labels for Standard bin included on front of bin components.	
12.1 White Four-Streams Bin • Standard white 4-stream bin, but no coloured labels.	
13. Coffee Cups only Bin • Circular blue bin only for coffee cups. • Labels located at the front of the bin.	 

14. Organic Waste Bin • Short, standing green bin. • Standard organic waste bin, usually located right by the Standard waste bin. • Includes label on top of bin lid indicating appropriate items for bin.	
15. Unlabelled Standard Brown Garbage Bin • Circular brown garbage bin.	

16. Starbucks Multiple Unlabelled Bin. • Circular garbage bins holes found in Starbucks. • No labels.	
17. Cans and Bottles ONLY Bin • Brown rectangular prism bin for cans and bottles only. • Label located at front of bin.	

18. Mini Blue Recycling Bin • Small, blue bin for recycling. • No indication of items appropriate to recycle.	
19. Mini Brown Bin • No indication of type of bin. • No labels.	

Appendix II. Observation Guidelines

Make a note on the side describing what you saw (what materials were disposed of, what the users were doing)

1. What is considered "INCORRECT" sorting:

a. Bag of unknown material put in *recycling*
b. Coffee cup put into coffee cup bin WITH lid and jacket sleeve +**make a note**
c. *Styrofoam* cup into the coffee cup stream
d. Wax paper in paper recycling

2. What to do if you see waste thrown out in the right bin, but with lots of food contamination

. Make a note and label it correct

3. Hesitation guidelines:

. If they read the signs
a. If they scan the bin signs

Appendix III. Coded Survey Responses
Sample Size: 40

Question 1 and 2 target Attitudes
Question 1: On a scale of 1-5 how important is it for you to recycle while on campus?

Response Options	**Count**	**Percent (%)**
not important	0	0
slightly important	5	12.5
important	8	20
very important	14	35
extremely important	13	32.5
Total Response	40	100

Question 2: On a scale of 1-5 how important is it for you to compost while on campus?

Response Options	Count	Percent (%)
not important	10	25
slightly important	3	7.5
important	9	22.5
very important	8	20
extremely important	10	25
Total Response	40	100

Question 3 and 4 target Barriers
Question 3: In order of importance what are up to 3 things preventing you from recycling 100% of the time?

Response Options	Count	Percent (%)
lack of time	17	17.9
confusing signage	27	28.4
lack of conveniently located bins	27	28.4
don't think it makes a difference	5	5.3

just forgot	15	15.8
other	4	4.2
Total Response	95	79.1%

Other:
-not enough garbage bins (1 response)
-food in containers (1 response)
-I take it home to recycle (1 response)
-uneducated (1 response)

Question 4: In order of importance what are the 3 things preventing you from composting 100% of the time?

Response Options	Count	Percent (%)
lack of time	19	18.6
confusing signage	21	20.6
lack of conveniently located bins	33	32.4
don't think it makes a difference	4	3.9
just forget	13	12.7
I don't know	8	7.8
other	4	3.9
Total Response	102	85%

Other:
-not enough garbage bins (1 response)
-I take it home to compost (1 response)
-don’t care much (1 response)-
-was not aware of composting bins (1 response)

Q 5-9 target Behaviours

Question 5: What materials are the most difficult to dispose of or recycle when you’re on campus?

Response Options	Count	Percent (%)
paper	4	5.9
cardboard	6	8.8
food	24	35.3

containers	12	17.6
coffee cups	5	7.4
batteries	13	19.1
other	4	5.9
Total Response	68	100

Other:
–don't know we had composting (1 response)

Question 6: Of the materials you chose, what are some reasons why they are difficult to dispose of?

Response Options	Count	Percent (%)
size of waste	3	5.4
different materials	2	3.6
lack of knowledge	3	5.4
lack of clarity of bin options	3	5.4
bin stream hole sizes	5	8.9
different recycling practices for different materials	3	5.4
no compost bins nearby	9	16.1
blank response	2	3.6
bin location	4	7.1
clarity of bin signage	6	10.7
separating components	2	3.6
no bins	2	3.6
clarity of recycling rules on campus	8	14.3
lack of available bins nearby	4	7.1

Total Response	38 (by counting # of respondents, not responses)	95 (by counting # of respondents, not responses)

Question 7: What do you do when you don't know where to put your waste?

Response Options	Count	Percent (%)
always put in garbage	21	52.5
sometimes garbage or recycling	14	35
always put in recycling	1	2.5
closest bin (no matter what it is)	4	10
Total Response	40	100

Question 8: Do you read/look at bin signage carefully?

Response Options	Count	Percent (%)
yes b/c I need to remind myself where my items go	29	72.5
no b/c I already know where waste goes	4	10
no b/c I do not bother to	5	12.5
other	2	5
Total Response	40	100

Other:
-sometimes (1 response)

Question 9: When you are on campus, how often do you recycle and / or compost?

Response Options	Count	Percent (%)
all the time	8	21.1
most of the time	19	50.0
sometimes	8	21.1
rarely	2	5.3
never	1	2.6
Total Response	38	95

Appendix IV. Chi-Square Test:

Accuracy and Importance

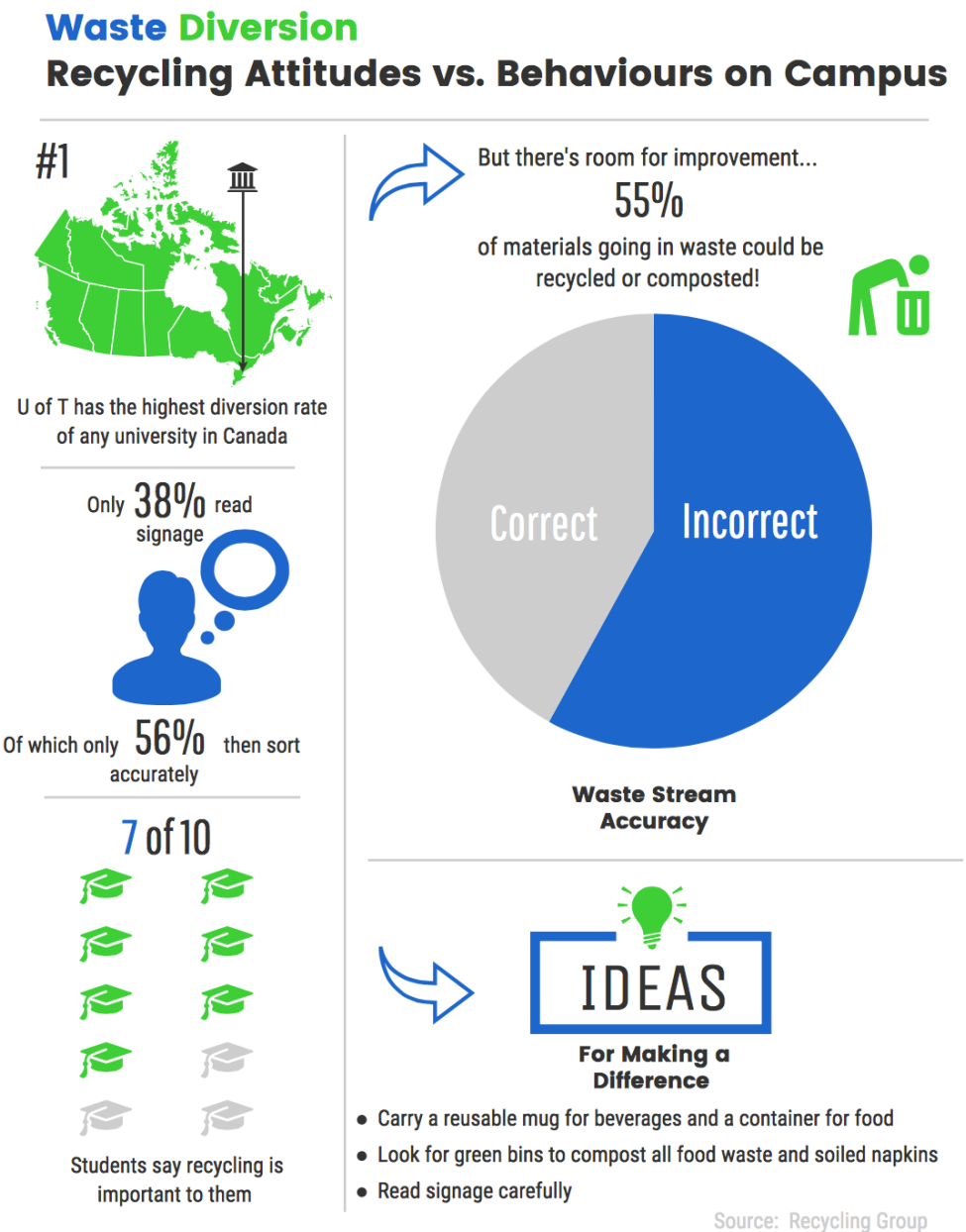
With an alpha level set to 0.05, a chi-square test of independence was performed to examine the relationship between self-reported importance of recycling and accuracy of waste disposal during the game. Results revealed no significant relationship between these variables, χ^2 **(15, *N* = 41) = .13.047, *p* = .599**. People were no more likely to accurately dispose of their trash when they self-reported importance of recycling versus when they did not.

Accuracy and Frequency

With an alpha level set to 0.05, a chi-square test of independence was performed to examine the relationship between self-reported frequency of recycling and accuracy of waste disposal during the game. Results revealed no significant relationship between these variables, χ^2 **(15, *N* = 41) = 11.383, *p* = .725**. People were no more likely to accurately dispose of their trash when they self-reported a higher frequency of recycling versus when they did not.

Appendix V. Public Facing Infographic

This infographic is meant to inform RC users of the University of Toronto's diversion rate and ways in which they could modify their behavior to potentially improve waste stream accuracy on campus.



Appendix VI. Infographic for Office of Sustainability

This infographic is meant to inform the University of Toronto's Office for Sustainability of key findings in our report, a summarized list of recommendations regarding further research, as well as intervention methods that could improve the University's waste diversion rate.