Improving Recycling Behavior:
The Influence of Waste Stream Configuration and Labeling

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Abstract

   As overconsumption and low recycling rates are global issues that demand urgent attention, many global regions have been making various efforts to improve their local recycling rates, including various educational institutions in the United States. Understanding the consumer behavior and the status of recycling is crucial for setting up catered interventions and regulations for these areas. Therefore, this study aims to understand the status of University of Illinois at Urbana Champaign's (UIUC) recycling patterns and consumer behaviors regarding recycling accuracy to provide a direction towards an improved recycling system on the university campus. Data was collected through making observations of waste products disposed in 3 different types of waste bins with 1, 2, and 3 waste streams and varying levels of detail and instruction on labels. Overinclusive recycling was observed throughout all streams based on the ratio of misplaced waste products in each stream, but the rate of misplacement significantly varied across different bin types. The study suggests that an increased number of streams, along with specific graphic labeling, increases the recycling rate and waste segregation accuracy.

Introduction

Less than 20% of recyclable materials are recycled on campus, despite having a dedicated facility for waste management and recycling at University of Illinois at Urbana Champaign (UIUC), based on the fiscal year 2023 analysis by the Waste Transfer Station facility on campus. A successful recycling system highly depends on consumer behavior and knowledge as recycling has two components; the act of recycling, and adhering to the local recycling regulations, which is trickier. People often end up committing "overinclusive recycling," which is a term for a phenomenon when non recyclable materials are put in recycling bins (Catlin 2021). Therefore, simply having more acts of recycling does not necessarily increase the actual recycling rate. If anything, it could lead to reduced recycling rates. Due to these causes, influencing the consumers' recycling behavior that satisfies the local recycling regulations has been a complex task globally. This study aims to understand the status of recycling behaviors of students in response to different labels on waste bins. Understanding whether the provided information and labels are effective is crucial to have a catered innovation for an improved campus recycling system. Therefore, by gathering quantified information on the waste segregation of each waste/recycling bins, the study aims to suggest a solution to providing an accurate and effective recycling system to the students that ensures disposal accuracy.

   According to OECD, only 9% of plastic waste is recycled globally and only 4% is recycled in the United States (OECD 2019). The United States' recycling rate is 14.8%, ranking 105th among 180 countries. (EPI Yale 2022). There is no doubt that increasing recycling rate is a global task.

   Various efforts have been made to improve recycling behaviors of the consumers. Studies have shown small details such as labels and placement of waste bins impact recycling behaviors. For instance, bins that are labeled "landfill" had an approximately 25% higher recycling rate than the bins that were labeled "trash," and labels that had

matching visuals also improved accurate recycling (Catlin et al., 2021). As quality and standardization of labels impact the performance of recycling, many organizations have been making efforts to create the most effective recycling system for their consumers. A study done in Michigan State University aiming to expand their recycling program, discovered the following barriers to recycling: insufficient recycling opportunities, recycling convenience, and lack of information about recycling. The study allowed the University to better understand the recycling attitudes and behaviors of their community.

Behaviors based on one's environmental cognition operate somewhat uniquely from the regular connection between one's attitude and their behavior. One's environmental awareness does not necessarily affect the efficacy of their environmental behavior such as the act of recycling (Borden and Schettino, 2010). Therefore, various efforts have been made locally to identify a mechanism for manipulating consumers toward more environmentally responsible behaviors.

Therefore, this study aims to gather information on the status of UIUC recycling patterns and behaviors to identify the successes and pitfalls, and provide a direction towards an improved recycling system on the university campus. Understanding the constraints of the UIUC community is essential in redesigning the recycling system. The goal of the study is to understand the effectiveness of labels and waste bin format on disposal accuracy on campus.

Methodology

The methodology for this research involved a quantitative observational research design. The study focused on fourteen distinct locations across the UIUC campus, including six within the Illini Union, six in an academic building (Lincoln Hall), and two outdoor locations. These locations were selected to capture a diverse range of waste disposal scenarios commonly encountered by students.

There were three different kinds of bin setups included in the study. The first kind being single bins or 1 stream bins (3 in the Illini Union and 3 in the Lincoln Hall) which are unlabeled and all waste in it goes to landfill. The second being 2 stream bin sets (2 outdoor locations) which have 2 bins side-by-side, labeled as 'Landfill' and 'Recycling' without any other color, symbol, or text specifications.

Figure 1. 1 Stream Waste Bin (Left) and 2 Stream Recycling Bins (Right)

And the third kind being the 3 stream bin sets (3 in the Illini Union and 3 in the Lincoln Hall) which have 3 bins side-by-side, labeled as 'Landfill,' 'Paper,' and 'Bottles and Cans' with illustrations and specifications of what kinds of waste items fall into each category. These 3 stream bins also have different shapes of openings, according to the kind of trash intended for each bin, as shown in Figure 2.

Figure 2. 3 Stream Recycling Pod in UIUC Campus

Data collection occurred over a period of nine days across three weeks, between 10th of October and 1st of November 2023, during which all selected locations were surveyed. Researchers equipped with optimal safety gear systematically examined each waste bin to record the number of recyclable and non-recyclable trash items present. Data collection took place at consistent time intervals each day to minimize potential variations.

The primary variables of interest were the presence of labels/infographics on waste bins and the segregation of recyclable and non-recyclable items within the bins. Labels/infographics were categorized as either present or absent, while the types and quantities of recyclable and non-recyclable items were recorded numerically for each bin.

For the purposes of this research, the waste items that are accepted by the University's waste transfer station's recycling streams - metal cans, plastic type #1 and #2, cardboard, and paper - were considered recyclable. Any other waste, including food waste, glass, paper cups, plastic types #3 through #7, and contaminated cardboard or paper, was considered non-recyclable.

It is important to acknowledge that despite best efforts, there were some limitations to this research study:

The study was conducted at only 14 locations on the UIUC campus, which might not be fully representative of waste disposal habits across campus. However, these 14 locations were selected from prime campus areas which receive a lot of student traffic from all different departments, which makes the findings representative of the general student body, rather than students of a certain college or major.

Data was collected over a period of 3 weeks, which might not capture long term trends and variations in recycling behavior, but does represent trends in recycling behavior during regular weeks in the middle of a semester.

There is a potential for human errors and bias in the data, since it was reliant on manual observation and some level of estimation. To minimize this, researchers worked in groups, double-checking each other's observations.

The study does not account for external factors like events, celebrations or variation in student traffic based on days of the week. But it was ensured that data was collected on similar working days, with no ongoing events at the time of observation and no weekends.

While the sample size for this study is relatively small, which may limit the generalizability of the findings, the prime locations of the selected bins and the 126 distinct data points of observation do yield meaningful results.

Results

In order to analyze the impact of the number of streams, the collected data of the number of waste disposals have been broken down into ratios of nonrecyclables and recyclables in each bin for better comparison of disposal accuracy.

Total Number of Waste Product Observed	
Landfill	1623
Recycling	2140
Total	3763

Table 1. Total Number of Waste products observed

As mentioned in table 1, a total of 3763 waste products were observed, 1623 from landfill and 2140 from recycling bins (including 2 stream and 3 stream bins).
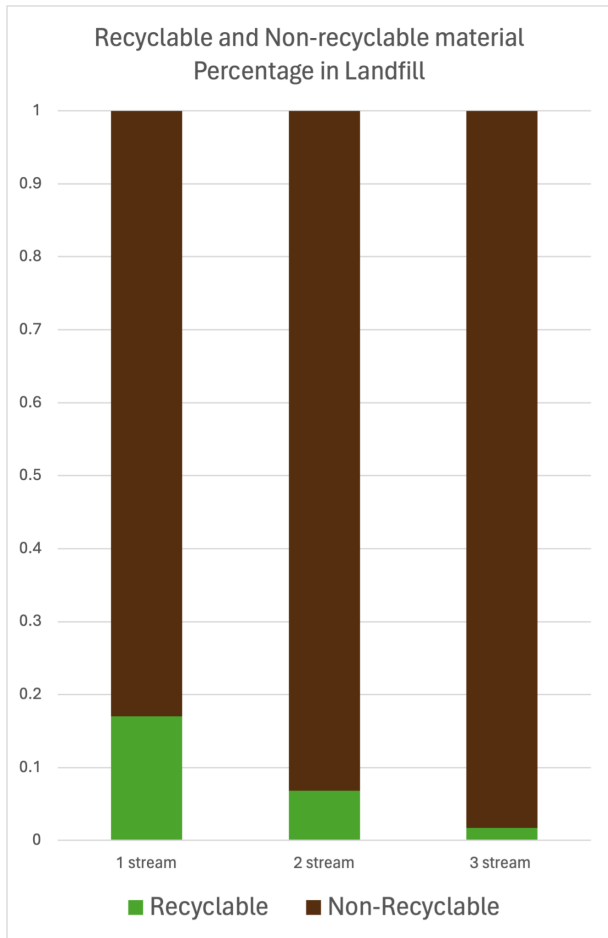

Figure 3. Recyclable and Non-recyclable Material Percentage in Landfill

The average percentage of recyclable materials found in landfills were 17.0% for 1 stream, 6.9% for 2 streams, and 1.8% for 3 streams (Figure 3). This demonstrates a significant decrease in mislocation of recyclable materials in the landfill stream when recycling bins are present. Having more streams, which refers to having more specific indication of the recycled materials for the bin also promotes recycling.
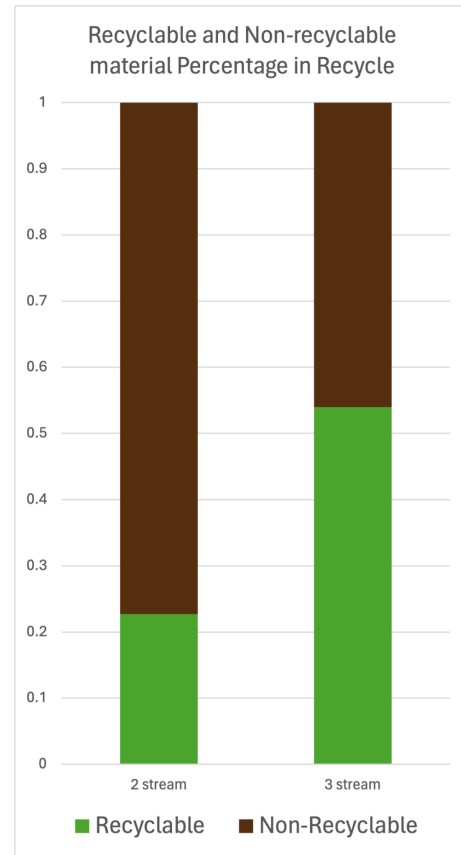

Figure 4. Recyclable and Non-recyclable Material Percentage in Recycle

Next, the average percentage of recyclable materials in recycling bins was 22.7% in 2 streams recycling bins and 54.0% in 3 streams recycling bins. This indicates that specified bins with more recycling instructions promote more accurate recycling behaviors. The results show two characteristics of recycling on UIUC campus. Presence of recycling bins reduces the amount of recyclable materials in landfill. Additionally, the increase in recycling bins, indicating more specific instructions, increases the accuracy of recycling. However, the results also confirm the presence of overinclusive recycling. Even in the recycling bins with the maximum number of streams on campus, nearly half of the content of recycling bins are non recyclable. The results highlight the necessity for policies that encourage accurate disposal.

Additionally, there were some qualitative observations made during the data collection that provides vital information regarding the characteristics of the wastestream on campus. The waste stream tends to depend highly on the waste that is provided at the areas. The student union, where students hold events and eat food, had waste from take out food and drinks. These take out food and drink containers cause recycling contamination as the residue food waste gets into other recyclable materials.

Figure 5. Coffee cups found in the recycling bin for bottles and cans, in a 3 stream bin

Drink containers were often found in the recycling bins. However, these drink containers tend to be plastic type #5, which is not recyclable in UIUC. Much of the overinclusive recycling was plastic type #5, since drink cups, as well as paper cups, are often confused to be recyclable.
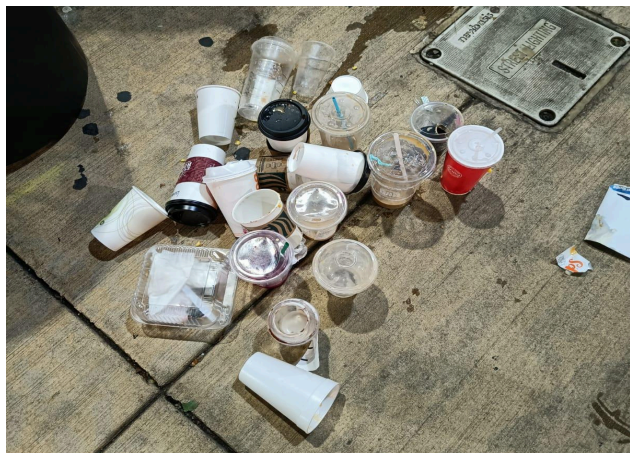

Figure 6. Drink cups found in the 2 stream recycling bin; common example of overinclusive recycling

This overinclusive recycling caused by drink containers reflects consumers' limited knowledge towards recycling contamination and the recycling regulations on campus.
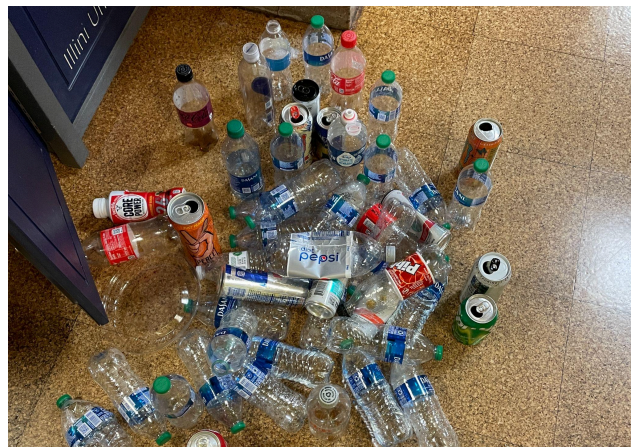

Figure 7. Disposable water bottles found in the 3 stream recycling bin

Disposable water bottles made up the majority of waste in the recycling stream, more than soda bottles or cans. Most of the plastic bottles and aluminum cans were accurately recycled.

Figure 8. A dozen unopened bottles of soda were found in the recycling stream

There were also instances of unopened bottles of soda being found in the recycling stream which indicates tendencies of overconsumption.

Discussion

The findings of this study shed light on the relationship between the labeling of different waste streams and recycling behavior. It is evident that whether or not a recyclable waste product ends up in the recycling stream, and whether or not there is contamination of the recycling stream, depends on

the existence of multiple recycling bins as well as clear labeling on the bins regarding what waste item should go in which stream. The data reveals two main trends in recycling behaviors.

Firstly, the number of recyclable materials ending up in landfill bins progressively reduces with the presence of well-labeled recycling bins alongside. As is clearly visible in figure 3, the 2 stream bins, which have one landfill and one recycling bin, have lesser recyclables being thrown in the landfill side as compared to the 1 stream which only has a landfill option. Further, in 3 stream bins, the landfill bin receives significantly lesser recyclables as compared to the 2 stream alternative, since this set has two recycling bins alongside, labeled as 'paper' and 'bottles and cans,' clearly conveying to the user what item of trash goes where, thus reducing confusion and increasing recycling efficiency.

Secondly, the number of non-recyclable materials contaminating the recyclable materials in the recycling bins drop by almost half, with clearer labeling and increased segregation. This trend can be noticed in Figure 4, as the amount of non recyclable trash contaminating the recycling stream drops by almost half from 2 stream to 3 stream bins. This is because the 2 stream bin sets only label the bin as 'recycling' without specifying what it means or what items are accepted. On the other hand, the 3 stream bins have labels that specify waste types for each bin, making it easier for the user to see that if the waste item at hand is not listed under recycling, then it must go to the landfill bin, thus reducing contamination of the recycling stream, as well as saving recyclables from ending up in the landfill bin.

Overall, the study suggests that increasing the number of recycling bins, divided by the different types of recyclables, makes it easier for users to segregate waste into appropriate bins. Along with the number of streams, clear labeling and illustrations on recycling bins play a huge role. Specific labels of what items go into each bin increase effective segregation of waste and reduce contamination of recyclables caused by non recyclable waste.

Conclusion

This study, despite some limitations of scope and scale, clearly indicates the trends in recycling behaviors with respect to different kinds of bins and different styles of labeling. Recycling behavior improves with clearer labeling and increased categorization of recycling bins. Based on these results, it is our recommendation that on the UIUC campus, 1 stream and 2 stream bins should be reduced from campus buildings and outdoor spaces. These should be replaced with 3 stream bins, and/or possibly increased stream bins, which have distinct categories for the different kinds of recyclables accepted, as well as labels for specific waste items. Based on this study, it can be predicted that this shift will result in increased efficiency of recycling, increased collection of recyclables, reduced contamination of recycling streams, and overall improved recycling behavior.

References

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Appendix

a. Raw Data
    https://uofi.box.com/s/kc8qbu5en6bx6xyeia
    3r302uiv2cnfdg