W37339

TOWARD ZERO WASTE: RECYCLERIGHT AT THE NATIONAL UNIVERSITY OF SINGAPORE

Hong Ming Tan, Karl Ann Too, Diyang Lin, and Joel Goh wrote this case solely to provide material for class discussion. The authors do not intend to illustrate either effective or ineffective handling of a managerial situation. The authors may have disguised certain names and other identifying information to protect confidentiality.

A light breeze brought a refreshing coolness to the alfresco cafe table along the busy Singapore street where Grace Gan, executive manager of behavioural insights at the National Environmental Agency (NEA), sat across from Mindy Ong, manager of the Sustainability Strategy Unit at the National University of Singapore (NUS). They were discussing the NUS RecycleRight study, which had been conducted half a year ago on the NUS campus in 2020. This study investigated how NUS students' recycling habits had changed in response to a novel recycling bin design. The study focused particularly on the purity—i.e., the proportion of correctly recycled items—within the new recycling bins.

Gan was excited at the results from this study showing that the new recycling bin design increased the purity rate for plastic bottles from 40 to 73 per cent. However, tempering Gan's optimism was the fact that this study was conducted in a unique setting: on a university campus and among the community of students, faculty, and staff of the university. Noting that a university community tended to be more educated, and more conscious about environmental issues compared to the general public, Gan was keen to pursue a follow-up study in a more public setting to see if the newly designed bins would similarly lead to improved recycling behaviours among the general population.

Stirring her tea thoughtfully, Gan mused, "Shopping malls in Singapore could be good partners for such a field study. We know that they have expressed more interest in sustainability after NEA's push for mandatory waste reporting. We can potentially replace some, or all, of the existing recycling bins in these malls with the new ones from NUS and observe whether people are recycling correctly."

Ong was similarly excited at the prospect of a field study in a selection of shopping malls. She felt that this could be a great opportunity to highlight the value of thoughtful, human, and behavioural-centred design. Ong was aware that testing the bins in the shopping malls Gan had in mind would introduce a set of new challenges, because the bins would now have to function effectively in a wider, more diverse range of settings compared to the study conducted within the NUS community. Nonetheless, Ong was confident in the design and eager to see how it would perform in the wider community.

Both managers left their meeting feeling optimistic about the prospects of setting up and running the new shopping mall study. Nevertheless, as practising professionals in behavioural science, they both knew that the devil was in the details. For the study to yield reliable conclusions, they both knew that it had to be designed thoughtfully. They would have to understand the operational constraints of the setting, possible risks to the study, and how to avoid statistical bias.

BACKGROUND

Ong, who graduated with a degree in environmental engineering from NUS in 2015, had been passionate about sustainability and the environment since her youth. She joined the Sustainability Strategy Unit at NUS in 2021. Prior to working at NUS, she was Gan's colleague at NEA, where she was exposed to behavioural science and the role it could play in promoting sustainable behaviours.

She had decided to join NUS to gain a more in-depth understanding of sustainability and how to promote behavioural change for sustainability in a campus setting. In this role, Ong had been involved in several projects, including the university's Campus Sustainability Roadmap and its Zero Waste Taskforce, which aimed to enhance sustainability through both infrastructure improvements and behavioural nudges. Ong was particularly passionate about one aspect of her work at NUS: working with students to develop innovative behavioural solutions to sustainability challenges. She believed that students' interdisciplinary knowledge and fresh perspectives could be harnessed to create meaningful and lasting change.

Tommy Cheong was one of the students with whom the Zero Waste Taskforce and Ong had worked. In 2020, Cheong was a fourth-year undergraduate student in the NUS Division of Industrial Design. At the time, he was working on his final year project, which was a year-long industrial design project that every student in the program had to complete prior to graduation.

As a key focus for his final year project, Cheong wanted to investigate whether a carefully designed recycling bin (the RecycleRight bin) could facilitate proper waste sorting and make recycling a more conscious and mindful activity. As impurity in the recycling streams was a perennial problem, his aim was to nudge people to recycle right and analyze how much of an impact his intervention (the newly designed bins) would have on the university's goals to not only achieve a high of rate of recycling, but also ensure that people were recycling the correct items in these bins. Additionally, he hoped to demonstrate that it was possible to establish a stronger waste recycling norm at NUS and subsequently influence change in the wider community through its students, faculty, and staff.

Although Cheong had skills in industrial design, he soon realized that he needed to partner with Ong's Sustainability Strategy Unit to experimentally test his designs among the NUS community. Reaching out to Ong and her colleagues, he explained his project and idea to them and found that they were receptive and willing to embark on this partnership. Ong recalled:

> Although our unit receives many proposals for partnership from students, many of these proposals lack implementation feasibility. Tommy's proposal and positive attitude made an impression on us. It was apparent that he had thought through various operational aspects of the design carefully and had a good understanding of why previous attempts to redesign recycling bins had not successfully tackled the impurity problem. Tommy's passion and dedication for the project was apparent, and we felt a strong sense that he wasn't just doing this to check off a graduation requirement, but that he wanted to see this through and design something that could be used in the field one day.

PURITY AND CONTAMINATION IN PUBLIC RECYCLING

“40% of what goes into recycling bins cannot be recycled. This is because some people throw in items which are unsuitable for recycling.”[1]

Recycling was an essential practice to help conserve natural resources, reduce energy consumption, and mitigate environmental pollution. It involved the collection, processing, and reuse of materials that would otherwise be discarded as waste. Proper recycling could help reduce the demand for new materials, which required energy and resources to extract, manufacture, and transport. It could also reduce the amount of waste that ended up in landfills, which could emit greenhouse gases and contribute to climate change.

However, the effectiveness of recycling programs critically depended on the purity of the recycled materials, which referred to the degree to which they were free from contaminants.[2] Contamination occurred when the wrong items (e.g., food waste, liquids, non-recyclables) were put into the recycling bin. Such contaminants, which could not be recycled, reduced the overall quality and value of the recycled materials.

When contaminants were present, effort had to be expended to separate them from the actual recyclables prior to any recycling activity. Certain forms of contamination could not be separated from the recyclable items; in such instances, the recyclables had to be discarded as general waste. A single contaminated item could also run the risk of contaminating other items placed in the same recycling bin.

SINGAPORE’S DOMESTIC WASTE MANAGEMENT SYSTEM

In 2021, Singapore households generated a total of 1.82 million tonnes of solid waste (i.e., non-recycled general waste), comprising approximately 25 per cent of the total solid waste in Singapore.[3] Most Singaporean residents who lived in high-rise public apartment blocks (approximately 80 per cent of the population) would typically dispose of general waste through in-house or common central chutes located on each floor. For recyclables, residents would have to dispose of them in recycling bins located at the bottom of their blocks for older apartments. For newer apartments, both recycling and waste chutes were located on each floor. Public recycling bins had a contamination rate of around 40 per cent, and the domestic recycling rate in Singapore had declined from around 20 per cent in recent years to 13 per cent in 2020.[4]

In Singapore, government-contracted public waste collectors managed the process of collecting solid waste from public apartment blocks. These operations were funded through small fees charged to households, amounting to roughly the cost of a Starbucks grande-size coffee each month.[5]

After collection, solid waste would be sent to one of three incineration plants, two of which were built under the NEA’s Public-Private-Partnership Initiative.[6,7] These incineration plants were waste-to-energy

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[1] “Recycle Right,” Ministry of Sustainability and the Environment, accessed July 19, 2023, https://www.towardszerowaste.gov.sg/recycle-right/.
[2] Contamination and purity rates are related as follows: Contamination Rate (%) = 100% – Purity Rate (%).
[3] Yasmin Begum, “18% Increase in Waste Generated in Singapore Last Year as Economic Activity Picked Up,” CNA, November 29, 2022, https://www.channelnewsasia.com/singapore/waste-generated-2021-recycling-nea-blue-bin-2631336.
[4] Begum, “18% Increase in Waste Generated in Singapore Last Year.”
[5] “Waste Collection Systems,” National Environment Agency, accessed July 19, 2023, https://www.nea.gov.sg/our-services/waste-management/waste-collection-systems.
[6] “Keppel Seghers Tuas Waste-to-Energy Plant," Keppel Infrastructure Trust, accessed July 19, 2023, https://www.kepinfratrust.com/portfolio/environmental-services/keppel-seghers-tuas-waste-to-energy-plant/.
[7] Mitsubishi Heavy Industries Ltd., “Waste-to-Energy Company in Singapore Made a Wholly-Owned Subsidiary: MHI Group to Independently Provide Operations and Maintenance for a 25-Year Period,” news release, August 8, 2022, https://www.mhi.com/news/22080801.html.

facilities, which meant that the incineration process also generated useful electricity. The newest plant, called TuasOne, had an incineration capacity of 3,600 tonnes of waste and could generate 120 megawatts of energy each day, enough power for approximately 240,000 mid-sized apartment buildings.[8]

The resulting ash from incineration would be shipped to a sanitary landfill at Semakau Island, which was located south of the main island of Singapore. As Singapore's only landfill, it was expected to reach full capacity by 2035.[9] The process of incineration reduced the volume of waste by approximately 90 per cent, thereby reducing the amount of space needed for landfilling, an important consideration in land-scarce Singapore.[10]

Faced with the mounting challenges of a low recycling rate, high contamination rate, and rapidly diminishing capacity at its landfill, the government launched the Zero Waste Masterplan in 2019 that aimed for a 30 per cent reduction in the amount of waste sent to landfills by 2030 and a 30 per cent increase in the domestic recycling rate.[11] The goals of the masterplan were subsequently included under the SG Green Plan,[12] an initiative with ambitious goals for sustainability in areas such as increasing greenery coverage, expanding public transportation networks, promoting clean energy, and preparing infrastructure for climate change resilience.

DESIGNING THE RECYCLERIGHT BINS

To design the RecycleRight bins, Cheong used a design thinking process in which he iteratively diverged and converged on design ideas through a series of small experiments in regular consultations with the Zero Waste Taskforce. Diverging involved prototyping new concepts or solutions that he had yet to explore, whereas converging involved refining existing elements of the design or synthesizing existing design concepts together into a particular feature. Throughout this process of repeated divergence and convergence, Cheong had to continually engage users by actively seeking their feedback about the bin design and by passively observing how they used his prototypes to understand if his assumptions were valid and whether users were engaging with his design concepts as he had intended. Exhibit 1 illustrates some of Cheong's early scaled-down prototypes of bin designs, with different shapes and features.

Some of the key design concepts that Cheong investigated included the following:

- *Information banner*. Cheong wanted to investigate the effect of making information more *salient* to patrons. To do so, an early concept that he explored was the display of a large informational banner above the recycling bins to inform patrons of what should or should not be thrown into the bins.

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[8] National Environment Agency, "Tuasone—the Latest and Most Land Efficient Waste-to-Energy Plant in Singapore," news release, July 27, 2022, https://www.nea.gov.sg/media/news/news/index/tuasone---the-latest-and-most-land-efficient-waste-to-energy-plant-in-singapore.
[9] National Environment Agency, "Semakau Landfill 20th Anniversary," *Envision Lite*, June-July 2020, https://www.nea.gov.sg/corporate-functions/resources/publications/books-journals-and-magazines/envision-lite/june-july-2020/semakau-landfill-20th-anniversary.
[10] "Solid Waste Management Infrastructure," National Environment Agency, accessed July 19, 2023, https://www.nea.gov.sg/our-services/waste-management/waste-management-infrastructure/solid-waste-management-infrastructure.
[11] Ministry of the Environment and Water Resources, Zero Waste Masterplan Singapore, (Singapore: Ministry of the Environment and Water Resources and The National Environment Agency, 2019), 2, https://www.mse.gov.sg/resources/zero-waste-masterplan.pdf.
[12] Ang Hwee Min and Matthew Mohan, "Singapore Unveils Green Plan 2030, Outlines Green Targets for Next 10 Years," CNA, February 10, 2021, https://www.channelnewsasia.com/singapore/singapore-green-plan-2030-targets-10-years-1883021.

- *Bin openings.* Cheong investigated two different concepts for bin openings. First, he investigated the application of defensive mechanisms, also known as "Eco-Steers" in the eco-design community,[13] which would slow patrons down from their automatic disposal behaviour. An example of this was a flap that the patron had to lift or shift before disposing of their item. The main idea behind this concept was to create barriers for patrons and slow them down so that they would be more intentional about what they were putting into the bin. Second, he tested the use of openings with customized shapes to prevent incorrect items from being put into the bins. For instance, bins for plastic bottles or metal cans would have circular openings; conversely, bin openings for paper products would be long and narrow. Exhibit 2 illustrates a cardboard prototype of a flap for plastic bottle or metal can recycling.

- *Informative signage.* Recycling bins typically had signs or labels indicating the correct recyclables that could be disposed of in each bin. However, Cheong realized that even here there were many different design choices. How large should these signs be? Would it be better to have smaller signs so that people would have to come closer to the bins (and to their act of recycling) to interact with the signs? Or should the signs be visible from afar? Another category of choices pertained to whether the signs should have messages on the correct actions (i.e., providing examples of *appropriate* items to be disposed of in that bin), incorrect actions (i.e., providing examples of *inappropriate* items that should *not* be thrown into that bin), or contain a mix of both types of messaging. Independent of the tone of messaging, Cheong was also considering its visual design: how should this information be displayed? He could use either graphical icons or actual photographs to depict appropriate/inappropriate items, both of which were reasonably common features of other recycling bin designs. Cheong was also considering a new approach where actual *physical* items would be displayed; however, he was concerned that this could lead to complications with manufacturing and of the bin design.

- *Bin materials.* Cheong noted that many recycling bins in use tended to look old, gaudy, and unappealing. Understanding that aesthetics could play an important part in design, he sought to use materials and colours that could make recycling bins eye-catching. Bright primary colours were selected, and sheet metal was used as the primary material to ensure the colours would be long-lasting. Importantly, Cheong had to ruminate about the opacity of the bin's front: should it be opaque or transparent? While a transparent bin front could nudge people into disposing visually similar items, it also posed a risk to recycling efforts if just one item was wrongly disposed. For example, one spilled drink in the recycling bin for paper would ruin the day's collection and discourage others from recycling properly.

- *Bin placement.* The co-location of recycling and rubbish bins was also a key factor in reducing contamination. To ensure that people could easily put non-recyclables into rubbish bins, the rubbish bin opening was designed to be bigger compared to the recycling bins with defensive mechanisms. Another consideration was whether more people would be deterred from recycling by the defensive mechanisms on the bins and more recyclables would end up in the waste stream instead.

Even as he weighed the pros and cons of each of his various design choices, Cheong knew that he would soon have to move beyond the drawing board and start testing his ideas and building physical prototypes. With the partnership of Ong and the taskforce, he would be able to place these prototypes in common spaces at NUS and observe how the student community responded to his prototypes. As he started fabricating his first physical prototype, Cheong recognized that he would have to consider the feasibility of implementing his solutions at scale and incorporate ease of maintenance in his design.

[13] Tracy Bhamra, Debra Lilley, and Tang Tang, "Design for Sustainable Behaviour: Using Products to Change Consumer Behaviour," *The Design Journal* 14, no. 4 (2011): 427–55. https://doi.org/10.2752/175630611X13091688930453.

THE FIRST TRIAL: "SPEED BUMPS" AND INFORMATIONAL BANNERS

Cheong's first trial was designed to better understand the recycling behaviours of the university community. It was conducted across two areas of the NUS campus. The first was called University Town, which encompassed student housing, sports facilities, and dining outlets. There were nine recycling bin sites within this area. The second was the Faculty of Engineering, which encompassed classrooms, student social areas, and dining outlets, and which had a total of seven recycling bin sites. This first trial proceeded in three distinct phases. Across all three phases, Cheong only implemented design changes to the nine sites in University Town; the recycling bins at the Faculty of Engineering were unchanged from the existing designs, serving as a control group.

The first phase was called the baseline phase and ran for a total of 20 days, from January 13, 2020, to February 10, 2020. In the first phase, Cheong did not make any major changes to the designs of the existing recycling bins. In this phase, Cheong and a team of volunteers concentrated solely on data collection, which was done through a process of "dumpster diving." Each weekday, at approximately 3 p.m., at least two team members would go to the central refuse collection centre, where all the day's recyclables for University Town would be gathered. The team members would then sort through recyclables, measuring how much of each type of recyclable (plastics, cans, and paper) was improperly recycled (i.e., contaminated).

In the second phase, which ran from February 11, 2020, to February 22, 2020, the team fabricated and installed "speed bumps" at the nine sites in University Town on existing recycling bins designed by previous batches of industrial design students (see Exhibit 3). These designs were intended to create friction for people when they recycled, slowing people down in their acts of recycling, so they would become more deliberate in their actions and recycle correctly.

The third and final phase of this trial ran from March 4, 2020, to March 17, 2020. In this phase, the team removed the "speed bumps" from the recycling bins. However, at each bin location, above each set of bins, the team added a large informational banner that displayed examples of incorrect recycling. The banner was approximately 1.5 by 0.5 metres in size and placed approximately 1.5 metres above the bins. Exhibit 4 shows the banner and its placement in this phase of the trial. In both the second and third phases of the trial, the procedures to measure and collect data were the same as in the baseline phase.

LEARNINGS FROM THE FIRST TRIAL

Cheong took the results from this first trial to Ong. Key results from this trial are displayed in Exhibit 5**.** Together, they studied both the quantitative and qualitative data and distilled their findings from the first trial into a number of key observations.

First, Cheong had expected that the installation of a large display banner would be a salient trigger for students to disrupt their existing throwing routine and promote mindful sorting at the bins. However, both from the quantitative data obtained during the trial and from his interviews with students, it quickly became apparent to him that the banners, despite their large size, did not catch so much as a passing glance from the nearly 300 students who walked by each banner every day. The "speed bumps" in the design of the bins seemed to work marginally better at reducing the contamination rates only in the paper and metal can bins. Old habits seemed to be quite sticky.

Through the trial, Cheong also made other qualitative observations. He observed that cleaners frequently struggled with lifting trash bags out of the rubbish bins, which could only be done by lifting vertically. This was especially difficult for cleaners who were older or had shorter physiques.

Guided by the new observations uncovered in this trial, Cheong and Ong further refined the design of the recycling bin. A large physical banner and “speed bumps” would not be effective, as patrons were likely absorbed in their routines to dispose of items before noticing the interventions. Anything that did not disrupt existing routines had the potential for bin contamination. To help cleaners easily clear and maintain the bins, they resolved to explore bin designs that featured a door in the front of the rubbish bin to remove the need for the lifting action. This would help the cleaners of smaller stature to access the bins more easily. Bit by bit, Cheong and Ong adapted and incorporated tweaks through many iterations and modified the bin design for a more significant intervention.

THE SECOND TRIAL: THE RECYCLERIGHT PROTOTYPE

Cheong was determined to use the learnings from his first trial to refine his prototype. After many long hours of drawing, building, reworking, and iterating, he finally arrived at a design that was the culmination of his design concepts. The bin, which he named RecycleRight, featured a contactless guiding tray that encouraged mindful recycling behaviour, a horizontal pull-out compartment for cleaners to easily change trash bags, and a display case to show patrons the actual items that should not be recycled. Exhibit 6 showcases the RecycleRight bins and their various features described here.

As Ong reviewed Cheong’s refined prototype, she felt confident that it could be effective in this next trial. They engaged the services of an established bin manufacturer, OTTO Waste Systems Singapore, to produce two sets of RecycleRight bins. Building off their first trial, they adopted a similar set-up. They decided to perform this trial at total of six separate sites within University Town. At three of those sites, the team used the bin designs with “speed bumps” that worked marginally well during their first trial; at the remaining three sites, the team used Cheong’s RecycleRight bins, the culmination of his design process.

Cheong’s RecycleRight bins were made operational on October 7, 2020. Data was then collected across all six sites for about three months, ceasing in January 2021. Across all six sites, the team used the data that had already been collected in the first phase of the first trial (January 13, 2020–March 17, 2020) as baseline data for the present trial.

From this second trial, the team found that the introduction of the redesigned RecycleRight bins accounted for slightly lower contamination rates of paper and metal cans, but a large decrease in the contamination rates for plastic bottles (from 60 to 27 per cent). These findings gave the team confidence that the final RecycleRight bin designs were effective and could be operationalized.

THE PROPOSED SHOPPING MALL TRIAL

Armed with the positive results from the second trial at the NUS campus, Ong was confident that partnering with Gan at NEA for an expanded trial at three shopping malls would help to validate the efficacy of Cheong’s RecycleRight bin design among the general population. The three malls that Gan had identified—Jurong East Mall, International Merchandising Mart Mall, and Westgate Mall—were large shopping complexes in the western part of the island, all within a 10-minute walk from the same subway station. Their management teams were generally supportive of sustainability efforts, so when Gan contacted them about this potential trial, they were keen to participate.

A key design consideration facing Gan and Ong was how to design the trial during the ongoing COVID-19 pandemic. Two clear options emerged:

- *Option 1*. Randomly switch half of the bins at each shopping mall to the new RecycleRight bins throughout the trial. Such a design would be similar to that of medical trials. One advantage of this design was that it would allow the team to compare the performance (recycling rates, purity levels) of the new bins with the old bins throughout the entire trial duration.

- *Option 2*. Switch all of the bins at each shopping mall to the new bins at a single point in time, halfway through the trial. Doing so would allow the team to measure the purity of each bin before and after the change. One advantage of this design was that it would allow them to see how the new bins performed over time relative to the old bin designs.

The team also considered variants of these options. For instance, instead of randomly switching out individual bins, the team considered switching all bins at one or two shopping malls to the RecycleRight bins, leaving the other malls with the old bin designs. Another example included gradually switching the bins in shopping malls over time.

Gan and Ong knew that the choice of trial design entailed challenges and trade-offs that they had to make. On the one hand, Option 1 would allow a controlled comparison between the two types of bins. This option could potentially result in more precise estimates of the bins' effectiveness, but it might not fully capture the impact of the intervention on the overall recycling behaviour of the mall patrons. Furthermore, the shopping malls have different demographics and customer profiles, which could potentially have impacts on the effectiveness of the bin design.

On the other hand, Option 2 would allow for a more comprehensive evaluation of the intervention's impact over time. However, in this option, it could be difficult to isolate the impact of the effect of the new bin design from other factors that could influence contamination rates, such as the availability of other waste disposal options, changes in the composition of the waste stream, and the awareness and attitudes of the mall patrons toward recycling.

Apart from the analytical factors above, the team knew that they had to consider operational factors as they planned the trial, which created new challenges for them to surmount. For instance, the new RecycleRight bins were larger in size than those used at the three malls; there might not be enough space to place the new bins at the same locations as the original bins. Furthermore, even though NEA would fund the costs of manufacturing the bins and NUS for engaging student surveyors for the trial, the mall operators would be responsible for the daily operations of the bins. Namely, their janitorial staff would have to collect the items in the bins each day, clean the interior and exterior of the bins, and replace the linings of each bin. The team felt that it was important to ensure that operating these new bins would not result in additional work or costs for the mall operators and their janitorial crew.

The trial would likely garner media interest, and Gan and Ong knew that the stakes were higher than with the trials conducted at NUS. If it was successful, it would be a shining example of how academia and public agencies could work together to tackle an intractable real-world problem. More importantly, they had an opportunity to nudge people to make positive behaviour changes and have an impact on the environment. If the trial failed because of a bad design choice or because of a foreseeable error in experimental details, it would be a pity, given that so much effort was put in through the iterative trials.

Feeling the weight of responsibility on their shoulders, Gan and Ong put their heads together as they started sketching out the final design of the trial.

EXHIBIT 1: EARLY-STAGE SCALED-DOWN PROTOTYPES OF DIFFFERENT BIN SHAPES AND DESIGNS

Source: Tommy Cheong (@tommycheong), “RecycleRight Bins,” Behance post, August 12, 2021, https://www.behance.net/gallery/125251793/Recycle-Right-Bins.

EXHIBIT 2: FULL-SCALE CARDBOARD PROTOTYPE OF A BIN DESIGN FEATURING A DEFENSIVE LID

Source: Tommy Cheong (@tommycheong), “RecycleRight Bins,” Behance post, August 12, 2021, https://www.behance.net/gallery/125251793/Recycle-Right-Bins.

EXHIBIT 3: PLACEMENT OF "SPEED BUMP" BINS IN FIRST TRIAL, SECOND PHASE (TOP); CLOSE-UP OF SPEED BUMP DESIGN (BOTTOM)

Source: Case writer, provided by Tommy Cheong.

EXHIBIT 4: PLACEMENT OF INFORMATIONAL BANNER ABOVE BINS IN FIRST TRIAL, THIRD PHASE

Source: Case writer, provided by Tommy Cheong.

EXHIBIT 5: RESULTS FROM THE FIRST TRIAL

Trial phase	Location	Days of data (no.)	Paper Contamination rate (%)		Plastic Contamination rate (%)		Cans Contamination rate (%)	
			Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
1	ENGINE	20	0.81	0.43	45.94	15.66	14.85	9.31
1	UTOWN	20	6.04	3.74	57.28	15.14	36.47	10.19
2	ENGINE	11	1.29	2.04	35.96	9.09	11.67	9.66
2	UTOWN	11	4.00	1.48	46.51	7.23	18.34	10.18
3	ENGINE	12	0.75	1.35	40.88	8.87	7.55	7.95
3	UTOWN	11	4.69	1.77	59.18	3.52	22.31	5.11

Note: ENGINE = Faculty of Engineering, standard recycling bins used throughout all three trial phases; UTOWN = University Town, standard recycling bins used in Phase 1, recycling bins with “speed bumps” used in Phase 2, and recycling bins with informational banner used in Phase 3.

Source: Case writer.

EXHIBIT 6: THE RECYCLERIGHT BINS AND THEIR FEATURES

Source: Tommy Cheong (@tommycheong), "RecycleRight Bins," Behance post, August 12, 2021, https://www.behance.net/gallery/125251793/Recycle-Right-Bins.