IMPACT OF CUSTOMER-LEVEL TRASH SORTING TECHNOLOGY AT SEATTLE PUBLIC UTILITIES

A Recycling Contamination Reduction Initiative

Submitted to:
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INTRODUCTION

The purpose of this report is to introduce a set of solutions to solve an ongoing problem faced by Seattle Public Utilities (SPU). The problem being addressed deals with poor recycling contamination rates in the households served by SPU. As an R&D Engineer at SPU, I will introduce solutions through a set of self-sorting "smart" trash cans to you, Mr. David Lee, a Manager with the Consumer Projects Department. I will discuss the issue that these products will seek to solve, the underlying technology, the product requirements and points of comparisons, and lastly the final selection which best caters to SPU's requirements.

BACKGROUND

When items that are unrecyclable are incorrectly placed with other actual recyclables, it can harm the recycling integrity of the entire lot. In turn, if the contamination rate is too high, this can lead to the entire batch to be sent to a landfill instead of to a recycling plant [1]. The proportion at which we measure how much dirty recyclables harm the overall recyclable batch is termed the recycling contamination rate [2]. For years, the recyclables that Seattle Public Utilities collects from our customers have been imported by China for proper recycling disposal and reuse. However, that reliance will soon be buckling under new Chinese policies that makes the requirement for importation stricter for American cities and jurisdictions looking to rid of their collected recycled matter. The strict requirement states that the recycling contamination rate of material looking to be exported to China must not exceed 0.5% [3]. This requirement is problematic for SPU in particular, where a 2009 study found a recyclable contamination rate of 6.28% for single family households in the Seattle area [4]-far exceeding the Chinese requirement.

Reducing recycling contamination begins at the consumer. Misinformation via "aspirational recycling" is the top factor contributing to high recycling contamination rates [5]. To help facilitate the proper disposal of recyclables at the most direct level of action, I will propose the idea for SPU to adopt "smart trash can" technological initiatives to roll out to households. This is an automated, self-sorting approach to help to reduce our single-family recycling contamination rate to levels suitable to fit the Chinese standard.

OVERVIEW OF REQUIREMENTS

SPU is a governmental agency; our company's finances are funded by public taxpayers. Therefore, the funding that is obtained is scrutinized and carefully allocated. As such, the most major factor we must consider is cost. The cheaper the product is, the greater number of smart trash cans we are able to roll out to our growing consumers in the Seattle area. The 0.5% Chinese mandate is a governmental regulation, whose burden lies on SPU. Providing these smart trash cans to the consumer is thus a commodity; it is a tool for us to encourage a solution to this problem. However, at the same time, we must not be overly cost-conscious, to the point where we let cost compromise the product's recycling contamination rate. The balance between cost and effectiveness (via low recycling contamination rate) must be configured such that cost is minimized while the overall recyclable contamination rate for single-family household is at within safe levels for the Chinese importation standard.

Another requirement that must be considered must be with customer support. As SPU is the provider, not the manufacturer, of the smart trash cans, the manufacturer must provide ample customer support and contact. This is so that SPU can act as an appropriate, knowledgeable liaison between customer and product.

A final requirement we must consider must be feature-richness. To encourage the use of the smart trash cans, we must engage our consumer base as much as possible. A metric to consider then, is how many additional features come with the smart trash can.

TECHNICAL BACKGROUND

The self-sorting technology of smart trash cans is done through machine learning technology through visual sensing. When an item is placed in the trash can, the item is sent to an intermediary scanning area. Here, a sensor will scan the object and consult its visual database of objects. By using point of comparisons to different visual material makeup profiles, the trash can will then determine the correct classification of the object. At last, the trash can will put the piece of trash in the correct bin. Figure 1 below shows this implementation in a basic smart trash can model.

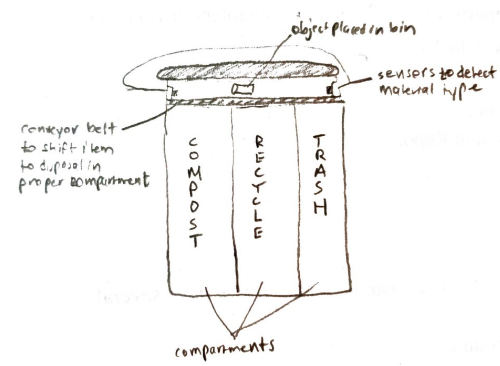

Figure 1: Implementation of standard sensor technology in a basic smart trash can model.

Smart trash cans with lower average recycling contamination rates use additional testing analyses. A prominent example of this is with an additional spectrophotometry test. In a spectrophotometry test, a small sample is extracted from the larger object being tossed. This small sample is then combusted and placed in solution. Light is then passed through the solution. A detector then takes the post-sample light and builds a wavelength profile of the sample. From there, the detector deduces the material of the sample by comparing it to an existing material database [6]. Figure 2 below shows an illustrated diagram to this spectrophotometry process.

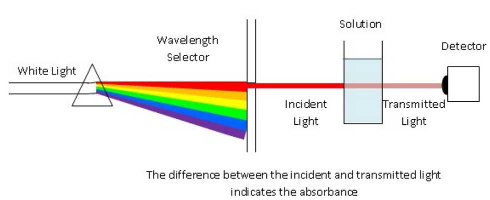

Figure 2: Basic process of spectrophotometry [7].

PRODUCT DESCRIPTION

We will consider three potential products willing to work with SPU for our contamination reduction initiative. All three smart trash cans are, at minimum, capable of the base self-sorting technology as described in the technical background section. However, they will differ in recycling accuracy/precision, cost, feature-richness, and customer supportability.

"NeoTrash" is a smart trash can developed by Philips Technology. A Philips base is located in downtown Seattle, within walking distance of the SPU headquarters. After discussing with Phillips for a bulk commercial discount, we received a rough estimate of $99/can. NeoTrash has, on average, a recycling contamination rate of 0.15%; it uses an additional, extensive spectrophotometry test. NeoTrash comes with three additional features for the consumer: Google Home integration, self-bag replacement, and trash volume-compaction.

"XiaoLaji" is a smart trash can developed by Xiongwei Electronics. Xiongwei is a Chinese manufacturer, based out of Shenzhen, China. Xiongwei has no offices in North America. After speaking with Xiongwei representatives, we were quoted an estimate of $29/can. XiaoLaji has, on average, a recycling contamination rate of 0.50%; it does not use an additional spectrophotometry test. XiaoLaji does not have any other additional features; there is no user interface.

"Can-Can" is a smart trash can developed by Westinghouse Electric. The closest Westinghouse Electric base is in San Francisco. A company representative quoted Seattle Public Utilities $59/can. Can-Can has, on average, a recycling contamination rate of 0.35%; it uses an additional, rudimentary spectrophotometry test. There is one additional feature offered by Can-Can: trash volume-compaction.

POINT-BY-POINT COMPARISONS

In terms of cost, the XiaoLaji smart trash can is by far the cheapest at $29/can, followed by Can-Can's $59/can, and then NeoTrash's $99/can. However, their costs are directly related to how effective the smart trash cans are at recycling. In terms of effectiveness, the most expensive option, NeoTrash, has the lowest recycling contamination rate at 0.15%. This is followed by Can-Can's 0.35% and XiaoLaji's 0.50%. How effective we will want to make our smart trash cans be to keep our overall recycling contamination rate low will come at a directly correlated cost. This is our ultimate opportunity cost. If we wanted to maximize effectiveness, we would choose NeoTrash. If we wanted to minimize cost, we would choose XiaoLaji. However, it is important to note that XiaoLaji's recycling contamination rate teeters right at the Chinese standard.

In terms of customer support, Philips' NeoTrash offers the most localized

and accessible support as their office is within the same downtown district as SPU. If any problems arise with the product, contact with Philips could be done with direct face-to-face contact. A partnership could be more easily established. This is in comparison to Westinghouse Electric's Can-Can, whose nearest office is in San Francisco. Problems that arise here can be done with a same time zone communication call, or via meeting interfaces a short hour flight away. The least supportability offered would be with Xiongwei's Xiaolaji. Their office working times in Shenzhen, China operate on a drastically different time zone. In addition, language barriers might prove to be an issue, as the Xiongwei team has very limited English abilities.
Regarding additional features, the NeoTrash wins out. The NeoTrash offers the most amount of user incentives; however, it comes at its steep price point. For a full modern, smart package, we may consider the NeoTrash. However, for a basic smart package, we may consider the Can-Can, as it comes with one additional feature of trash-volume compaction, which comes at the middle price point out of the three. The XiaoLaji offers no additional features, and thus the minimal user incentive into the product out of the three comparisons.

CONCLUSIONS

As seen in the point-by-point comparisons section, we saw that with the requirements of customer support, effectiveness, and feature-richness, the most superior out of the three is the NeoTrash, followed by the Can-Can, and then finally the XiaoLaji. This neglects the cost factor, which ranks in the reverse of the order stated prior. However, in SPU's situation, we have weighted requirements. And, our most stressed factor for SPU as stated in our requirements section is cost. As a company in the public sector, we do not have the luxury of a lax budget. Thus, in weighing cost first, then attributive factors of customer support, effectiveness, and feature-richness, we conclude that the most optimal smart trash can to combat recycling contamination rates is Westinghouse Electric's Can-Can.
For its standing out of the three as the middle price-point, we are given a regional customer support contact, a decent recycling contamination rate, and an additional feature that appeals to the user's attention. For its cost, the Can-Can offers a substantial product and support team for reducing a household-wide contamination rate, and thus is most preferred for SPU's investment toward our contamination reduction initiative.

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