Behavior-induced Disposable Cup Automatic Separation X-Bin Study

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Abstract

Purpose: This study seeks to develop behavior-induced automatic separation X-Bin for disposable cup speculators. Some students throw away the contents. **Research design, data and methodology:** Therefore, environmental beautification workers spend a lot of time sorting disposable cups at school garbage collection sites. Disposable cups that have been thrown away like this are bad in terms of appearance and smell. In addition, cleaning inside garbage affects recycling rates and is closely related to environmental problems. **Results:** Clean cleaning reduces the amount of garbage incinerated without being recycled and reduces the cost of recycling. According to Korean Social Trends 2020, COVID-19 began to spread, and recycling of disposable items such as disposable cups increased by about 15 percent from the same period last year. **Conclusions:** These are classified for recycling, and the amount of garbage thrown on the streets is estimated to be larger. In order to prevent COVID-19s, the use of disposable goods is inevitable, but facilities are needed to dispose of them properly.

Keywords : Recycling, nudge, disposable products, environmental pollution, work environment improvement

JEL Classification Code: II0, I10, I18, I19

1. Introduction

1.1. Study of the Necessity and Purposes

The use of disposable products in Korea is so large that it has become enough to regulate its use. Although the government started to regulate and people's use of disposables decreased somewhat, COVID-19 increased

consumption again as most stores offered disposable cups instead of cups. In the summer, as orders for drinks containing ice increase due to the hot weather, a pile of street waste can be seen mixing with the remaining drinks, giving off a bad smell.

In particular, at the university, in front of the library reading room, in the corridor, and in the reading room trash cans, they are filled with disposable cups containing drinks that students drank. Typically, during the student's exam, there are several times more disposable cups piled up in the trash than usual.

Most students throw away drinks and cups without separating them. Some students often discard the contents as they are. In other survey, the reason for not separating was because they were too lazy to do so, and 88% of the students said that the reason for separating discharge was because of environmental reasons (Ahn et al., 2020).

As a result, environmental beautification workers spend a lot of time separating disposable cups in separate collection points in schools. Disposable cups discarded in this way are not good for aesthetics and cause an odor (Ahn et al., 2019).

In addition, internal cleaning of garbage has a profound relationship with environmental issues as it affects the recycling rate. If it is well cleaned, the amount of waste that cannot be recycled is reduced, and the cost of recycling is reduced. In fact, as COVID-19 began to spread, the recycled emissions of disposable items such as disposable cups increased by about 15% from the same period last year (Statistics Korea, 2020).

This is classified as recycling and discharged, and it is estimated that the amount will be higher when the garbage thrown on the street is added. Increasing use of disposable products is inevitable to prevent COVID-19, but facilities that can properly dispose of them are needed.

This study is to develop an action-inducing automatic separation X canister for people who discard disposable cups without permission, and it is said that garbage is treated cleanly and hygienically.

1.2. Research Contents and Method

The purpose of this study was to develop a trash can for convenient and hygienic separation of beverage contents from disposable container.

Therefore, a questionnaire survey was conducted on college students in their early to mid-twenties to find out the reason for not disposing of disposable cups and contents.

Afterwards, based on the structural analysis of the existing trash can and the above survey, we developed a design of a new trash can that can solve the current problems and investigated whether its function is appropriate.

Through this study, we attempt to present a design of a trash bin designed to separate and dispose of the disposable cup and its contents in search of the problem of the trash bin where disposable cups and beverages are thrown together.

2. Research Development

2.1. Design and Research

One of the problems with the current trash can structure is the structure of a single container in which disposable cups and beverages cannot be separated.

Research of Behavior-induced Disposable Cup Automatic Separation X-Bin Study

1. Have you ever seen a disposable cup with leftover contents on the street or in a trash can?
   ◉ Yes(go to question 1-1)
   ◉ No

1-1. How did you feel about the disposable cup with the contents?
   [Select All]
   ☐ The environment is likely to be polluted.
   ☐ It's unsanitary.
   ☐ Unpleasant
   ☐ Have no idea.
   ☐ The others.

2. Where did you see the most disposable cups in your life?
   [Select All]
   ☐ In the school (in front of the library, reading room, lecture room, etc.)
   ☐ Subway
   ☐ Public park
   ☐ Bus stop
   ☐ The others.

3. Have you ever thrown the contents of disposable cups into the trash can without emptying them?
   ◉ Yes(go to question 3-1)
   ◉ No

3-1. If you have experience throwing it away, why?
   [Select All]
   ☐ There's no place to throw away the contents.
   ☐ It's inconvenient to clean.
   ☐ Other people threw it away the same way.
   ☐ I thought someone would clean it up even if I didn't.
   ☐ The others.

4. Which case do you think would be more effective when writing a notice to induce a particular action?
   ◉ Coercive or negative speech
   ◉ Non-forceful or positive speech

[SUBMIT]

Figure 1: Behavior Survey for Disposable Cups

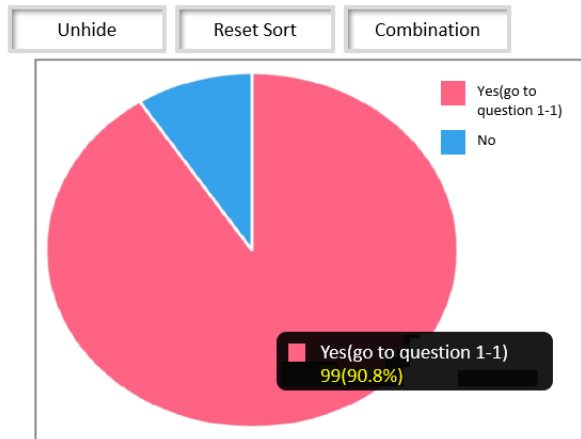**1. Have you ever seen a disposable cup with leftover contents on the street or in a trash can?**

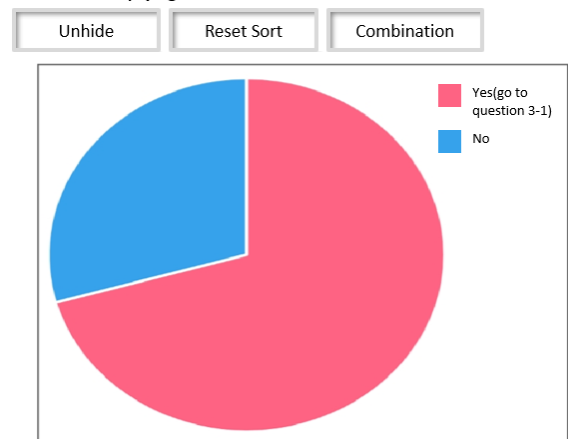| Unhide | Reset Sort | Combination |

Yes(go to question 1-1)

No

Yes(go to question 1-1)
99(90.8%)

Figure 2: Survey Results of Disposable cups with contents

1-1. How did you feel about the disposable cup with the contents?

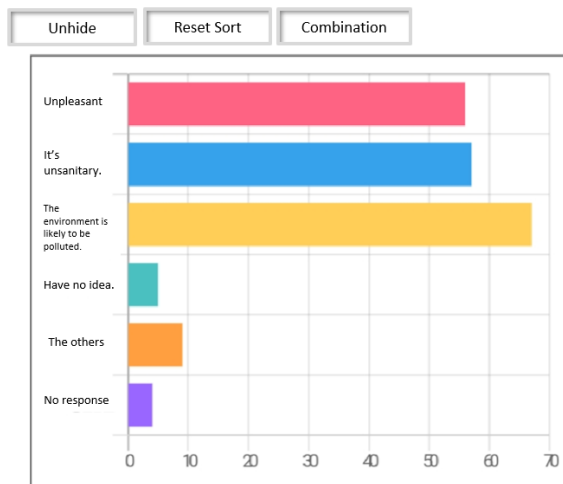| Unhide | Reset Sort | Combination |

Unpleasant

It's unsanitary.

The environment is likely to be polluted.

Have no idea.

The others

No response

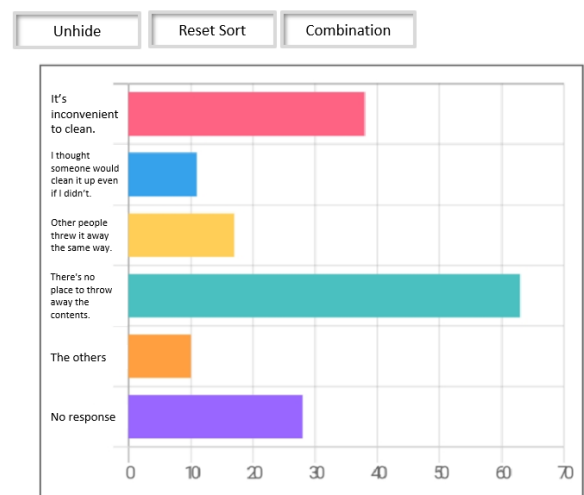**Figure 3:** Survey Results of feeling about disposable cups with contents

Through the survey, 90.8% of people have seen a disposable cup with contents on the street or in a trash can. Many of them think that the environment is likely to be polluted, and they feel unpleasant and unsanitary.

3. Have you ever thrown the contents of disposable cups into the trash can without emptying them?

| Unhide | Reset Sort | Combination |

Yes(go to question 3-1)

No

Figure 4: Survey Results of throwing disposable cups with contents

3-1. If you have experience throwing it away, why?

| Unhide | Reset Sort | Combination |

It's inconvenient to clean.

I thought someone would clean it up even if I didn't.

Other people threw it away the same way.

There's no place to throw away the contents.

The others

No response

Figure 5: Survey Results of the reason of Throwing Disposable Cups with Contents

The main reason people do not separate the disposable cup and the contents was identified as inconvenience and the absence of a place where the contents could be separated and discarded.

Based on the above results, it was intended to improve the structure of the existing trash can, rather than forcing those who dispose of the trash to separate disposable cups and beverages.

Thus, it was decided to develop a trash can that automatically separates discarded disposable cups and beverages from the trash can.
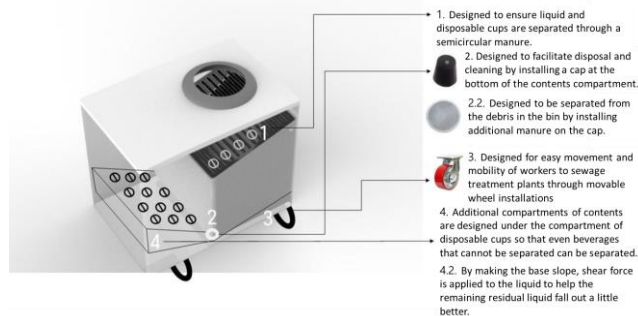
2.2. Steps to Make the Trash Can

Figure 6: Primary Prototype of the Trash Can

Step 1. Compared with the existing trash can, I studied and developed the first prototype.

Step 2. Semi-circular strainer – The upper plate of the separate bin is designed so that the liquid and disposable cups are clearly separated through a semi-circular strainer rather than a straight hole.

Step 3. A stopper was installed in the center of the bottom of the contents compartment to facilitate the operator's disposal and cleaning. In addition, a strainer was installed at the stopper so that the waste and beverages in the barrel could be clearly separated.

Step 4. Wheels-It is designed by installing fixed and movable wheels so that workers can move to the sewage treatment plant without difficulty and have good mobility.

Step 5. An additional content compartment was designed under the disposable cup compartment so that beverages that could not be separated can be separated. Furthermore, by making the bottom inclined, the shear force acts on the liquid, so that the residual liquid can be separated and removed even a little better.

2.2.1. The Meaning of Nudge

Nudge means 'to prick his side.' It refers to a method of inducing choice by intervening flexibly without being forced to do so. This word was introduced and popularized in The Nudge, co-authored by behavioral economist Richard Thaler of the University of Chicago and Professor Cas Sunstein of Harvard University's Law School (Kang, 2016). The essence of the nudge is to induce action without orders or instructions. A fly-shaped sticker on a men's toilet urinal is one of the typical nudge examples.

It is said that the amount of urine that falls out of the urinal after the fly sticker was applied decreased by 80%.

This nudge effect is that the members of the organization are not aware of it and are not very stressed, rather than forcefully applying pressure to make the organizational system work.

It is expected that it will be effective according to the characteristics of human behavior, "coordination behavior" and "cooperation" among the basic forms of social behavior.

● Response	Number of responses	
● coercive or negative language	22	8.8%
● Uncoercive or positive speech	225	89.6%
● No response	4	1.6%

Figure 7: Nudge Survey Results

When trying to induce a specific behavior through the survey results listed above, most people prefer positive speech rather than coercive or negative speech.

Therefore, the content of the text should be written in a positive and gentle nuance.

For the overall standard, refer to the' Safety and Health Signs' of the'Occupational Safety and Health Act', and mark the sign (text) near the entrance of the trash can and make it according to the following conditions.

● Make it in an appropriate size for easy identification.
● The size of figures and symbols should be at least 30% of the overall standard of the label.
● Use a material that is not easily damaged or deformed. (Vinyl film attached or stamped form used)
● Use a contrasting color so that the letters (pictures) on the cover can be distinguished from the background.

2.2.2. Patent Confirmation Inspection

There are no intellectual property rights.

2.3. Design and Development

2.2.1. Design basis

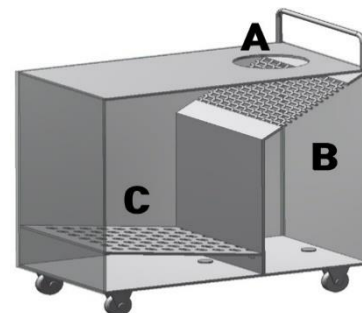There are no intellectual property rights.

Figure 8: Final Prototype (front)

This design is the final prototype by adding more ideas to the first prototype. This design is an idea that the disposable and the contents of the cup are automatically separated when the contents are thrown. When the cup is put upside down in the direction the contents enter, the contents and the cup pass through A, the contents accumulate in B, and the cup accumulates in C along the slope. Therefore, the name of the liquid automatic separation bin is 'X bin'.
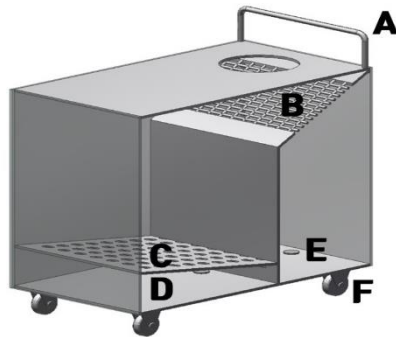

Figure 9: Final Prototype (back)

A-Height-adjustable handle: It is designed by attaching a handle that can adjust the height to make it convenient for cleaning workers to move the trash can and not put a burden on the body.

B-Upper filter plate: Design the filter plate to be inclined by about 35 degrees so that disposable cups are stacked in the left space C. The filter plate is designed so that the liquid phase and the disposable cup are clearly separated through a semicircular filter screen.

C-Lower filter plate: It is designed to be able to separate liquid that could not be separated by installing the semicircular filter screen once more under the disposable cups. The strainer was designed as an assembly type for easy cleaning.

D-It is designed so that the bottom surface is inclined so that shearing force acts on the liquid so that the residual liquid can be separated and removed even a little.

E-A cap was designed to be installed at the bottom of each bin in the direction of the handle A so that the operator can easily clean the trash bin and discard the contents. In addition, it was designed to completely separate the waste and liquid in the barrel by installing an additional strainer at the stopper.

F-Wheels: It is designed so that the operator can move to the sewage treatment plant without difficulty and good mobility through the installation of fixed/movable wheels. This can further lead the worker away from musculo skeletal diseases and back pain.

G-The height of the trash bin was calculated taking into account the proper working height for humans. It is based on

ergonomics. The design based on the average of the human body measurement data is used. The reason for using a design based on the average is that people of various physiques use it.
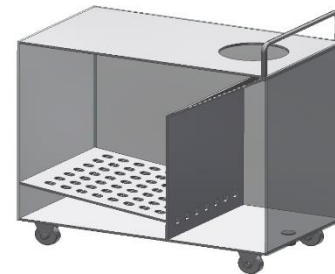

Figure 10: The Shape of B-1

Figure 11: The Shape of E-1
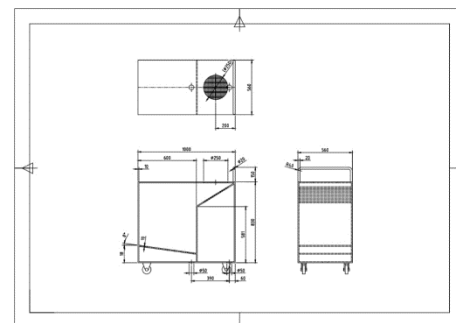
2.3.2. Design Drawing of Trash Can

Figure 12: Design Drawing of Trash Can

3. Comparison with Trash Can

Table 1: Main Contents of the Trash Can Design Drawing

	X-trash can	Trash can on campus	Subway trash can
Can the liquid be thrown away together?	O	X	X
Is it convenient for cleaning workers to move trash cans?	O	X	X
Is it good when emptying and washing the trash can?	O	X	O
Does it trigger user behavior?	O	X	X
Is it hygienic?	O	X	O
Does an odor occur?	△	O	X
Is it economical?	△	△	O

3.1. Comparison with Regular Trash Can

Figure 13: Trash Can in School

The trash cans installed in our school were compared with the X bins. First of all, the trash cans installed in our school are trash cans in which the contents and containers cannot be separated.

When comparing X-pass, first, there is a difference between odor and hygiene problems. Since the contents of the X can be separated, the contents left behind and the disposable cup are not mixed together, so it is superior to the trash can in school in terms of appearance and odor problems. Second, from the perspective of workers who clean the trash bins, the X bins with wheels are more convenient to move than the trash bins in the school that do not have wheels.

Finally, the X can have a space for the contents to be discarded. The nudge design naturally induces the behavior of separate collection, so the X-can is superior to the trash can in the school in terms of recycling and cleaning issues.

3.1. Comparison with Regular Trash Can

Figure 14: Subway Trash Can

The trash cans installed in the subway and X cans were compared. The trash cans installed in the subway are trash cans that can be collected separately, and a collection box for drinking water is installed. In terms of hygiene, subway trash bins are superior to X bins because they have a drink-only container and the entrance is narrow, so it doesn't smell bad.

However, musculoskeletal burden of repeated and intense work by workers is higher than the musculoskeletal burden experienced by manufacturing workers (Kim et al., 2013). In terms of ergonomics, compared to subway trash bins that require heavy collection bins to be lifted in the process of moving and emptying trash bins, X bins have wheels and a valve at the bottom, so workers can be distant from musculo skeletal disorders and low back pain. It also has a differentiation that induces behavior with a nudge design.

4. Conclusions

In this study, in order to propose measures to improve trash cans on campus, a survey was conducted on 20s, the main users of trash cans on campus, and analyzed and studied based on statistical data. The results are as follow.

The main reason people do not separate the disposable cups from the contents is the inconvenience and the absence of a place to discard the contents. Based on this, a trash bin that automatically separates trash was envisioned, and the numerical value was determined by applying ergonomics.

The height of the trash bin was designed to be 83cm, width 100cm, and length 56cm, which is half the average height of 20s. There are two beverage outlets at the bottom with a diameter of 5cm. An additional strainer was installed in the space with the separated disposable cup to allow residual liquid that could not be separated to escape to the bottom. In addition, handles and wheels are attached for convenient movement of the environmental sanitation center. As a design, a nudge that induces separate collection was used.

Unlike the trash bins on campus, the X bin is superior in appearance and odor problems as its contents can be separated, and it is convenient to move with wheels. By presenting the X can, we expect to solve the problem of bad smell and aesthetics in the school and increase the recycling rate through separate collection.

References

Ahn, S. W., Jung, H. S., Kim, J. H., Baek, J. S., & Baek, W. B. (2019). Disposable Cup Automatic Cleaning Device. *The Korean Society of Manufacturing Process Engineers*, 255-255.

Ahn, S. Y., Kim, D. H., Lee, E. J., Moon, Y. B. (2020). School Waste Management at the Middle School and Middle School Students' Awareness and Learning Experiences about School Waste. *The Korean Society for Environmental Education, 33*(2), 157-170.

Asmui, M. U., Zaki, S. M., Wahid, S. N. S., Mokhtar, N. M., & Harith, S. S. (2017). Association between litterers' profile and littering behavior: A chi-square approach. *AIP Conference Proceedings*, 1842(1), 030003.

Choi, J. H., Kim, W. J., Jeong, S. D., Gu, M. S., Lee, J. W., Kim, D. W., & Byun, H. W. (2019). Smart Separation Recycling Bin. *The Korean Institute of Electrical Engineers*, 203-204.

De Kort, Y. A., McCalley, L. T., & Midden, C. J. (2008). Persuasive trash cans: Activation of littering norms by design. *Environment and Behavior, 40*(6), 870-891.

Folianto, F., Low, Y. S., & Yeow, W. L. (2015). Smartbin: Smart waste management system. *IEEE 10th International Conference on Intelligent Sensors, Sensor Networks and Information Processing.* 1-2.

James H. Liu, Chris G. Sibely (2004). Attitudes and behavior in social space: Public good interventions based on shared representations and environmental influences. *Journal of Environmental Psychology*, 24(3), 373-384, doi: https://doi.org/10.1016/j.jenvp.2003.12.003.

Kang, J. M. (2016). A Methodological Classification of `Nudge Communication`: Searching for the Ways of Using Nudge for Public Persuasion. *Korean Society For Journalism And Communication Studies, 60*(6), 7-35.

Kim, H. J., June, K. J., Shin, G. Y., & Choo, J. A. (2013). Associations between Job Stress and Work-related Musculoskeletal Symptoms in Street Sanitation Workers. *J Korean Acad Community Health Nurs*, *24*(3), 314-322. doi: http://dx.doi.org/10.12799/jkachn.2013.24.3.314

Kim, H., & Jung, E. C. (2017). Proposal of Design Concept for Inducing Recycling Behavior through Framing Effect. *Journal of the HCI Society of Korea*, 980-983.

Leeabai, N., Areeprasert, C., Bussa, B., Dilinazi, D., & Takahashi, F. (2020). The color preference and noticeability of trash bins. *Japan Society of Material Cycles and Waste Management*, 443.

Leeabai, N., Suzuki, S., Jiang, Q., Dilixiati, D., & Takahashi, F. (2019). The effects of setting conditions of trash bins on waste collection performance and waste separation behaviors; distance from walking path, separated setting, and arrangements. *Waste Management,* 94, 58-67.

Moon, H. S. (2015). The study on Public facility design for the improvement of street environment -Focused on the Seoul City stronghold pickup Zone Public Trash Cans-. *Society of Korea Illusart, 18*(4), 123-131.

Peng, H., & Zhou, J. (2019). Study on urban domestic waste recycling process and trash can automatic subdivision standard. *In IOP Conference Series: Earth and Environmental Science*, 330(3), 032043.

Rolc, S., Krestan, J., Kratky, J., & Buchar, J. (2017). Design of Blast Resistant Litter Bins. In 30th International Symposium on Ballistics. doi: 10.12783/ballistics2017/17024

Samann, F. E. (2017). The design and implementation of smart trash bin. *Academic Journal of Nawroz University*, *6*(3), 141-148.

Sejera, M., Ibarra, J. B., Canare, A. S., Escano, L., Mapanoo, D. C., & Suaviso, J. P. (2016). Standalone Frequency Based Automated Trash Bin and Segregator of Plastic Bottles and Tin Cans. *IEEE Region 10 Conference TENCON*, 2370-2372.

Soewardi, H., Sari, A. D., & Aktoba, R. (2017). Ergonomic participatory approach for designing the innovative trash bin. *International Journal of Applied Engineering Research,* 12(24), 14510-14513.

Tunggal, T. P., Supriyanto, A., Rochman, N. M. Z., Faishal, I., Pambudi, I., & Iswanto, I. (2016). Pursuit algorithm for robot trash can based on fuzzy-cell decomposition. *International Journal of Electrical and Computer Engineering*, 6(6), 2863-2869.

Wijaya, A. S., Zainuddin, Z., & Niswar, M. (2017). Design a smart waste bin for smart waste management. *5th International Conference on Instrumentation, Control, and Automation,* 62-66.

Yang, S. H., Park, B., Kang, Y. S., Gal, W. M., Choi, J. H., Kim, D. S., Kim, T. G., & Cho, M. S. (2015). *Ergonomics Human Factors*, Paju, Korea, Hyungseul Publishing, 237-262, 323-464, 533-553.