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Semantic Analysis of Outdoor Waste Bin Design: A Case Study of the ISI Yogyakarta Campus

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ABSTRACT

Outdoor waste bins at Institut Seni Indonesia (ISI) Yogyakarta use a three-color system, yet the intended categories are not always clearly understood and the bins are not consistently noticed in outdoor settings. This study examines how users perceive the form, color, material, size, weight, labeling, placement, and use of the existing bins. A convergent mixed-methods design combined an online survey of 69 campus users with a focus group discussion involving six students and two lecturers. Survey responses were summarized descriptively, while focus group data were coded thematically; the two strands were then compared in a joint display. The survey indicated generally positive perceptions of waste-separation functions and satisfaction, but more moderate evaluations of form, color, size, and weight. Focus group participants reported limited awareness of the color-coded system, less frequent use of outdoor than indoor bins, and concerns about visibility, placement, and maintenance. They preferred simple but distinctive forms, clearer text and icons, accessible locations, and durable or recycled materials. Demographic variables were used only to describe the sample; no age- or gender-based significance testing was conducted. Because the study assessed perceptions rather than observed disposal behavior, the findings identify design opportunities rather than proven behavioral effects. The study offers context-specific guidance for making campus waste bins clearer, more usable, and more educational.

KEYWORDS

Product Semantics
Outdoor Waste Bin
User Perception
Mixed Methods
Campus Waste Management

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INTRODUCTION

Product semantics concerns how people interpret a product through its form, color, material, text, icons, and other design cues. These cues help users recognize what an object is, how it should be used, and what values it communicates (Syarief, 2012). Recent studies show that both formal qualities and explicit cues matter: visual form contributes to product identity and perceived meaning, while shapes, text, and icons can encourage or discourage particular interpretations of use (Sunstrum et al., 2024; Zhong et al., 2022).

For a public waste bin, this communication needs to happen quickly. When category labels, openings, or colors are ambiguous, users may hesitate or sort waste incorrectly. Public participation can help designers identify cues that people understand (Keramitsoglou & Tsagarakis, 2018), but design should not be reduced to appearance alone. In a field study, (Leeabai et al., 2021) found that color preference did not by itself predict waste-collection performance; location and noticeability also mattered. More broadly, littering and disposal are shaped by individual, social, and contextual factors as well as infrastructure (Chaudhary et al., 2021).

A university campus is therefore a useful setting for studying how product meaning meets everyday practice. Bins are encountered repeatedly by students, lecturers, staff, and visitors across routes, gathering spaces, and work areas. ISI Yogyakarta offers a particularly relevant case because its art and design community is accustomed to reading visual language, yet users still rely on clear, immediate cues when disposing of waste. The campus also brings together several faculties with different activities and waste patterns, allowing the same bin system to be considered across varied settings.

The existing outdoor system consists of three colored bins for different waste categories.

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Preliminary inspection and user accounts indicated that the labels were not always clear, some locations were less visible or convenient, and the bins did not consistently communicate the intended sorting system. These issues are important because a zero-waste campus depends not only on infrastructure, but also on education, policy, community participation, and shared responsibility (Baba-Nalikant et al., 2023).

Previous campus studies have examined broad factors influencing zero-waste participation or tested design interventions through observed behavior (Baba-Nalikant et al., 2023; Hung et al., 2024). This study takes a narrower first step by asking: How do campus users perceive the semantic, functional, and contextual qualities of the existing outdoor waste bins at ISI Yogyakarta? It evaluates key design attributes and identifies priorities for a future redesign. Because behavior was not observed before and after an intervention, the study does not claim that the current design causes or changes disposal behavior.



Figure 1. The three colored outdoor waste bins at ISI Yogyakarta (Source: Mutmainah, 2025)

METHOD

This study used a convergent mixed-methods design to develop a contextual account of how campus users perceive existing outdoor waste bins (John W. Creswell & J. David Creswell, 2017). The quantitative strand described broad patterns in survey responses, while the qualitative strand explored how participants explained their experiences and design preferences. The two strands were analyzed separately and integrated during interpretation.

Study Setting

The study was conducted at Institut Seni Indonesia (ISI) Yogyakarta and focused on outdoor waste bins in the Faculty of Visual Arts and Design, Faculty of Performing Arts, Faculty of Recording Media Arts, and administrative areas. These locations include circulation routes and shared spaces used by different groups within the campus community.

Data Collection Techniques and Instruments

Data were collected between February and March 2024 using two techniques. First, an online survey was distributed through Google Forms to students, lecturers, and administrative staff. Its questionnaire, the quantitative instrument, contained closed- and open-ended items and five-point Likert scales covering form, color, material, size, weight, familiarity, satisfaction, perceived hygiene, aesthetics, usability, ease of separation, and clarity of waste categories. Second, a focus group discussion (FGD) was conducted using a semi-structured discussion guide, the qualitative instrument. The guide addressed aesthetics, functionality, symbolic meaning, location, maintenance, and suggestions for improvement (Khan & Abedin, 2022).

Participants and Sampling

The survey was open to current ISI Yogyakarta students, lecturers, and administrative staff familiar with campus facilities. Participation was voluntary, and 69 responses were analyzed. The sample was dominated by undergraduate students from the 2021 and 2022 cohorts, with smaller representation from the 2020 and 2023 cohorts, lecturers, and staff. All faculties were represented, although the Faculty of Visual Arts and Design was the largest group. Respondents were 18-45

years old, and female respondents outnumbered male respondents. These characteristics describe the sample only and were not used to infer differences in perception.

Focus Group Composition

The FGD included eight participants: six students (75%) and two lecturers (25%). Participants were selected purposively from willing campus users to include both frequent student users and lecturers with broader experience of campus spaces. Familiarity with the campus and its waste facilities was the principal inclusion criterion.

Data Analysis

Survey responses were analyzed using frequency distributions, percentages, and the central summary scores reported for each five-point item. No inferential tests were performed; accordingly, the study reports no statistically significant age- or gender-based differences. FGD notes or transcripts, were read closely, coded for recurring ideas, grouped into categories, and interpreted as themes concerning semantic clarity, access and location, design preference, innovation, maintenance, and environmental or educational value.

Data Quality and Integration

The survey and FGD used the same perceptual, experiential, and preferential dimensions. After separate analysis, survey patterns were compared with FGD themes in a joint display (Table 1), with attention to both agreement and tension between the two strands. This alignment and triangulation strengthened the credibility of the interpretation.

The study did not report psychometric reliability testing or formal inter-coder agreement. Its findings should therefore be read as descriptive and context-specific rather than as validated causal evidence.

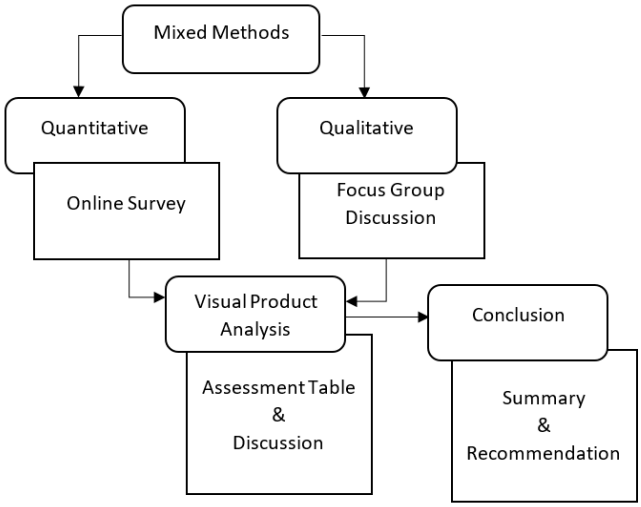

Figure 2. Convergent mixed-methods research framework (Source: Mutmainah, 2025)

RESULTS AND DISCUSSION

Respondent Profile

The online survey generated 69 responses (100% of the survey sample). Most respondents were students from the 2021 and 2022 cohorts, and the Faculty of Visual Arts and Design was the most represented academic unit. Smaller groups of students from other cohorts, lecturers, and administrative staff extended the sample beyond a single year or role.

The FGD included eight people: six students (75%) and two lecturers (25%). Their perspectives provide useful context for interpreting the survey, but the small, purposive group is not statistically representative of the wider campus population.

Respondent age (18-45 years) and gender were recorded only as descriptive characteristics. The larger number of younger and female respondents reflects who participated; it does not demonstrate that either group was more interested in product visuals or held different preferences.

No subgroup comparison or significance test was conducted.

Survey Findings: Visual Product Attributes

The survey examined how respondents perceived form, color, material, size, and weight, alongside experiential and preferential qualities. Results are interpreted descriptively and indicate how the current bins were perceived, not whether those perceptions produced correct disposal behavior.

Form

Form received a largely mid-scale response: 52.7% of participants selected 3, while 18.8% selected 4 and 10.1% selected 5. The result suggests that the bins were recognizable and usable but did not communicate a particularly distinctive identity. This interpretation is consistent with product-semantics research showing that form contributes to perceived character and meaning, while specific shapes can guide interpretations of possible use (Sunstrum et al., 2024; Zhong et al., 2022).

Color

Color received a reported score of 3.0. Although some respondents evaluated the color scheme positively, FGD participants did not consistently understand what the three colors represented. Color liking and semantic clarity should therefore be treated as different issues. Leeabai et al., (2021) similarly found that color preference alone did not predict waste-collection performance; noticeability and setting also mattered. At ISI Yogyakarta, color needs to be reinforced by readable words, icons, and consistent placement.

Material

Material received comparatively positive ratings: 40.6% selected 3 and 34.8% selected 4, while no respondent selected the lowest score. Participants generally regarded the current material as adequate for outdoor use, but the responses did not establish its long-term durability or maintenance performance. Recent research on recycling environments also shows that material and aesthetic quality can affect whether facilities feel welcoming and inclusive (Fagerholm et al., 2026).

Size and Weight

Size and weight each received a reported score of 3.0. The draft records that 21.4% selected 3 for size and 46.4% selected 3 for weight. These values point to moderate evaluations, but the complete response distributions are needed before stronger conclusions can be drawn. In practical terms, the bins need enough capacity and stability for outdoor use without becoming difficult for staff to move and clean.

FGD Findings

Participants reported using indoor bins more often than outdoor bins. They associated this preference with convenient locations, perceived cleanliness, and familiarity. This is a self-reported pattern rather than an observed measure of use.

The meaning of the three-color system was not consistently recognized. Rather than assuming that this was caused by insufficient promotion, the finding indicates that the intended categories were not reliably communicated through the existing combination of color and information.

Location and visibility were recurring themes. Participants mentioned outdoor bins in the Fine Arts plaza and cafeteria, suggesting that bins were more readily recalled when placed near familiar destinations and everyday routes. Other locations were described as less strategic or less visible.

Participants preferred designs that were simple and functional but still distinctive. Suggested possibilities included transparent containers, game-like features, and technology. They also valued durable or recycled materials, ease of maintenance, accessibility, and clear category information. These suggestions represent design ideas to be tested, not established solutions.

Participants also saw educational potential in the bins. Clear visual cues could help make waste categories more visible in everyday campus life, although the present study did not test whether such cues improve sorting accuracy.

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The FGD highlighted three practical considerations. Students preferred waste bins to be placed in crowded and highly visible areas, where they could be found and used more easily. They also explained that colour alone did not allow them to identify the appropriate waste category quickly, particularly when the labels were small or unclear. In addition, participants responded positively to bins that appeared clean, used liners, and had surfaces that could be cleaned easily. Taken together, these responses suggest that visibility, clear labelling, and ease of maintenance were more important to participants than colour as an isolated design feature.

Table 1 brings the survey indicators and FGD themes together. The joint display shows where the two strands reinforce one another and where a positive survey rating is complicated by contextual concerns raised in the discussion.

Table 1. Joint Display of Survey Indicators and FGD Findings by Product-Semantics Dimension

No	Variable	Survey indicator	Mean score*	FGD theme	FGD finding
1	Perceptual	Form	3.0	Aesthetic appeal	Usable but visually ordinary; a simple, distinctive form was preferred.
		Color	3.0	Information clarity	The meaning of the three colors was not consistently understood.
		Material	3.5	Visibility and access	Location and visibility affected whether outdoor bins were noticed.
		Size	3.0	-	-
		Weight	3.0	-	-
2	Experiential	Ease of waste separation	5.0	Awareness of color coding	Participants were not consistently aware of the category-color relationship.
		Perceived cleanliness	3.5	Innovation	Transparent, game-like, and technology-assisted concepts were suggested.
		Clarity of waste category	5.0	Location	Bins near familiar destinations were recalled; other locations seemed less strategic.
		-	-	Environmental value	Durability, recycled materials, and ease of maintenance were valued.
3	Preferential	Aesthetic perception	3.5	Preference for outdoor bins	Outdoor bins were reported as less frequently used than indoor bins.
		Health/hygiene perception	3.5	Overall design assessment	The design was usable but needed clearer cues, placement, and maintenance.
		User satisfaction	5.0	Educational potential	Clear labels and visual cues were viewed as opportunities for campus learning.

Integrated Interpretation

The survey and FGD converge on a distinction between basic usability and communicative clarity. Respondents gave strong reported scores to ease of separation, category clarity, and satisfaction, yet FGD participants described uncertainty about the color-category relationship and used outdoor bins less often. The survey may have captured an evaluation of how the bins appeared in principle, while the FGD exposed difficulties that emerged in context.

This relationship is consistent with recent evidence that semantic cues work in combination. Zhong et al., (2022) found that form, text, and icons can each shape perceptions of possible operations, while Leeabai et al., (2021) showed that color preference alone does not explain waste-collection performance. The current findings therefore support a redundant cue system in which color, words, icons, openings, and placement reinforce the same message.

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Familiarity, Satisfaction, and Use

A total of 79.7% of respondents reported having seen similar bins, while 21.7% reported having used the product directly and 5.8% reported never having seen a similar product. These items indicate that recognition was more common than direct experience. Satisfaction was also reported by 79.7% of respondents. Familiarity and satisfaction should not, however, be interpreted as evidence of correct sorting or regular outdoor-bin use.

Hygiene, Aesthetics, and Ease of Use

Perceived hygiene and aesthetic quality each received a reported score of 3.5. Cleanliness was discussed as a condition shaped by location, exposure, and maintenance rather than by form alone. Similarly, visual appeal can make a facility feel more acceptable, but it does not establish whether users sort waste accurately.

Ease of waste separation and clarity of waste categories received the highest reported scores (5.0), and 36.9% selected the highest response for category clarity. These ratings suggest confidence in the intended function, but their apparent tension with the FGD's color-category confusion needs to be checked against the item wording and raw distributions.

Interpreting the Survey-FGD Relationship

The difference between positive survey ratings and more critical FGD accounts is analytically useful. A questionnaire asks respondents to judge predefined attributes, whereas a group discussion allows them to describe where, when, and why a facility is or is not used. The FGD therefore adds placement, maintenance, familiarity, and education to an evaluation that might otherwise focus too narrowly on the object.

Baba-Nalikant et al., (2023) likewise found that zero-waste behavior on a campus is shaped by education, personal experience, policy, community engagement, social responsibility, leadership, and communication. The present study does not test those mechanisms, but it suggests that bin redesign should be situated within a broader campus system rather than treated as a stand-alone product solution.

This boundary also distinguishes the study from intervention research. Hung et al., (2024) combined a redesigned disposal area with observation and statistical testing, allowing them to assess changes after the intervention. The ISI Yogyakarta study provides requirements for such a next step, but it cannot claim that the existing or proposed design has changed behavior.

Design Implications

First, each waste category should be communicated through several mutually reinforcing cues: a consistent color, concise wording, an easily recognized icon, and, where appropriate, a differentiated opening. Recent semantic-cue research supports this combination (Zhong et al., 2022). Tactile or structural distinctions could also be explored to improve access for users with visual impairments, but such features must be co-tested with the intended users (Srijuntrapun & Sirirungruang, 2025).

Second, placement should be treated as part of the design. Bins need to be visible along ordinary movement routes and close to places where waste is generated, without obstructing circulation. A maintenance plan is equally important because dirty, damaged, or overflowing bins can weaken otherwise clear visual messages.

Third, transparent panels, gamification, sensors, or screens should be treated as concepts for prototyping, not automatic improvements. Low-cost trials can establish whether a feature improves comprehension and use before the campus commits to a more complex system. Basic legibility, access, and maintenance should remain the first priority.

Finally, material selection should balance durability, ease of repair and cleaning, environmental impact, and visual quality. Recycled material may carry educational and symbolic value in an art campus context (Asamoah et al., 2022), but its sourcing, fabrication, and maintenance need to be assessed rather than assumed to be sustainable.

Limitations and Future Research

The study was conducted at one campus with a voluntary survey sample dominated by students and a small, purposive FGD. The analysis was descriptive, several item distributions

require verification against the raw data, and no inferential comparison was made across demographic groups. The findings are therefore not generalizable to all ISI Yogyakarta users or other universities.

The study also measured perceptions and self-reported experience rather than observed disposal behavior. A future phase should develop and test a revised bin system, record sorting accuracy and contamination before and after installation, and examine how placement and maintenance influence outcomes over time. Environmental knowledge and personal norms could also be measured because they are relevant to university waste-management behavior (Wu et al., 2022).

CONCLUSION

The existing outdoor waste bins at ISI Yogyakarta were generally perceived as usable, but their semantic performance was uneven. Survey responses indicated positive perceptions of separation functions, category clarity, and satisfaction, alongside more moderate evaluations of form, color, size, and weight. The FGD added a more contextual picture: participants did not consistently understand the color system, reported using outdoor bins less often than indoor bins, and raised concerns about visibility, placement, and maintenance.

Together, the findings point to four redesign priorities: a simple but distinctive form; redundant category cues using color, words, icons, and possibly differentiated openings; visible and accessible placement; and durable materials that are easy to clean and maintain. Technology or game-like features may be explored, but only after these basic requirements are addressed and tested with users.

This study does not demonstrate behavior change. Its contribution is a set of evidence-informed, context-specific requirements for the next design iteration. A subsequent field study should test whether a redesigned system improves category recognition, sorting accuracy, and contamination rates in everyday campus use.

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