Closing the Loop: Can a Food Delivery Container-Return Reward System Motivate Consumers to Pre-Clean and Segregate Takeaway Packaging?

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Abstract - **The growth of app-based food delivery in Indian cities has generated enormous volumes of single-use takeaway plastic containers. A persistent and underexamined problem is recycling contamination caused by food residue on these containers a challenge that renders recyclable materials unusable and burdens municipal waste management systems. This study proposes and empirically tests a novel closed-loop intervention: a food delivery platform-integrated container-return reward system in which consumers pre-clean their previously used takeaway containers, return them to the delivery agent upon placing a new order, and receive credit points redeemable as discounts on future orders. Grounded in the Theory of Planned Behaviour (TPB) [3], an online survey using a 7-point Likert scale was administered to 112 urban respondents aged 18–35 in India. Instrument reliability was confirmed via Cronbach's alpha, with acceptable consistency for Section C (TPB constructs; α = 0.729) and good reliability for Section D (reward-system motivation; α = 0.854). Spearman's rank-order correlation was used as the primary analytical method. Recycling knowledge was the strongest predictor of recycling intention (C4 × C5: ρ = 0.590, p < .001). All reward-system items (D1–D5) correlated significantly with recycling intention, with identity-based rewards (D4) showing the strongest association (ρ = 0.520, p < .001). Future commitment to consistent pre-cleaning if a reward system is implemented (D5) received the highest mean rating across the questionnaire (M = 5.15). The 26–30 age group reported significantly higher recycling intention than the 22–25 group (Kruskal-Wallis H = 8.021, p = .046). The findings provide empirical evidence that a platform-integrated container-return system has strong consumer acceptance potential and could meaningfully reduce recycling contamination in urban takeaway ecosystems.**

Index Terms- container-return system, food delivery platforms, loyalty rewards, recycling contamination, Spearman correlation, takeaway packaging, Theory of Planned Behaviour, urban consumers

I.AIM

The aim of this study is to empirically investigate whether a food delivery platform-integrated container-return reward system can motivate urban consumers in India to perform the pre-disposal behaviours of rinsing and segregating takeaway plastic packaging, thereby reducing recycling contamination in municipal waste streams.

II.OBJECTIVE

B. Objectives

1. To examine the effect of a food delivery platform-integrated container-return reward system on consumers' intention to rinse and segregate takeaway plastic packaging.
2. To assess the relationship between perceived hassle of pre-disposal behaviours and perceived behavioural control (PBC).

III.INTRODUCTION

The rapid growth of app-based food delivery in Indian cities has made single-use takeaway plastic containers one of the most frequently generated urban waste items. The central environmental challenge they pose is not merely their volume but the manner in which they are disposed. Consumers routinely discard containers that still carry food residue oils, gravies, sauces without rinsing them, and without separating removable components such as lids or labels. This behaviour, repeated at scale, produces recycling contamination: food-soiled plastics degrade the quality of adjacent recyclable materials, and entire batches may be rejected by processing facilities and diverted to landfill.

While the Chintan and NITI Aayog report [17] identifies residue contamination as a primary barrier to India's urban waste management goals, the burden ultimately falls on municipal systems when consumers fail to pre-clean and segregate packaging.

The behavioural science literature identifies two primary barriers: perceived hassle and insufficient motivation [1], [2]. Cleaning a greasy container and separating its components requires effort that consumers, especially those under time pressure, will not expend without a compelling reason.

This study proposes and empirically tests a novel intervention: a food delivery platform-integrated container-return reward system. When a consumer places a new order, they have the option to hand their previously used, pre-cleaned and segregated containers to the delivery agent who arrives with the new order. The platform collects these containers and routes them directly to recycling facilities. The consumer receives credit points redeemable as discounts on future orders. Critically, the loop is closed at the platform level the platform manages logistics and recycling routing without involving the restaurant, avoiding operational complexity for food partners.

The Theory of Planned Behaviour (TPB; Ajzen [3]) provides the theoretical framework for understanding how attitudes, norms, and perceived behavioural control shape consumers' intention to engage in the rinsing and segregation behaviour this system requires. The paper examines these relationships using Spearman's rank-order correlation and compares recycling intention across age and occupation groups using Kruskal-Wallis tests.

IV. LITERATURE REVIEW

A. Recycling Contamination, Rinsing, and Segregation Behaviour

Bernstad [4] demonstrated that the willingness to rinse food-soiled packaging and to separate packaging components before disposal is highly sensitive to perceived effort: when the act of rinsing or removing a lid is inconvenient, contamination rates rise even among environmentally motivated consumers. Oskamp et al. [5] similarly found that situational convenience the proximity and ease of recycling infrastructure is among the strongest predictors of correct recycling behaviour, frequently outweighing attitudinal factors. Ekere et al. [6] documented 'wishful recycling' in which consumers place food-contaminated items into recycling bins out of intention without performing the required preparation steps (rinsing, segregation), highlighting the gap between awareness and action.

Guagnano et al. [7], through a natural experiment on curb side recycling, showed that external conditions and personal attitudes interact multiplicatively: when conditions are favourable, even weakly motivated individuals recycle correctly. The container-return system proposed here is designed precisely to engineer a more favourable condition by embedding the return step into the established routine of placing a food order, and by providing a tangible reward for completing the rinsing and segregation steps correctly.

B. Theory of Planned Behaviour in Recycling Contexts

The TPB has been extensively validated in recycling research. Tonglet et al. [1] found that attitude, subjective norm, and perceived behavioural control (PBC) particularly perceived ease and self-efficacy was a particularly strong predictor in a UK household context. Mak et al. [8] applied TPB to food waste recycling in Hong Kong's commercial sector, confirming that perceived ease and convenience were the dominant TPB drivers. Boerner [9] replicated these findings cross-culturally in Saudi Arabia.

Chu and Chiu [10] specifically identified knowledge of recycling procedures as a key PBC component that predicts actual recycling behaviour, a finding that motivates this study's inclusion of self-reported recycling knowledge (C4) as a central variable.

C. Incentive Systems and Pro-Environmental Behaviour

Steg and Vlek [2] concluded that incentives most effectively promote pro-environmental behaviour when they reduce the perceived cost of the target action and align with intrinsic rather than purely extrinsic motivation. Zhong et al. [11] found in a study of e-waste recycling reward preferences that consumers vary significantly in their sensitivity to economic versus identity-based rewards, with some segments more motivated by environmental image and personal achievement than by monetary value.

Ma et al. [12], using agent-based modelling, found that point-based reward systems produced the most sustained community-level waste disposal behaviour change. Hamari et al. [13] demonstrated that gamification mechanisms points, streaks, achievement badges reliably increase engagement with target behaviours, a finding directly relevant to the proposed system's integration into food delivery platforms that already employ gamified loyalty infrastructure.

D. Research Gap

Despite the extensive literature on recycling incentives, TPB-based recycling behaviour, and gamified environmental systems, no prior study has specifically examined: (i) the contamination problem caused by food residue on takeaway delivery packaging; (ii) a platform-integrated closed-loop return system as the intervention mechanism; or (iii) the pre-disposal behaviour of rinsing and segregation as the target outcome. This study addresses all three dimensions in an integrated empirical framework.

V. THEORETICAL FRAMEWORK AND HYPOTHESES

A. The Theory of Planned Behaviour

TPB posits that behavioural intention is jointly determined by Attitude (positive or negative evaluation of the behaviour), Subjective Norm (perceived social pressure), and Perceived Behavioural Control (perceived ease or difficulty, including self-efficacy). In this study, attitude is captured through contamination awareness (C1) and guilt about incorrect disposal (C2). PBC is operationalised through perceived inconvenience (C3) and recycling knowledge (C4). Behavioural intention is measured directly by C5.

The perceived hassle of rinsing and segregating packaging (B1) is conceptualised as a negative PBC indicator a time-effort barrier that reduces perceived control and suppresses intention. The reward system (Section D) is positioned as an external facilitating condition that modifies the PBC cost-benefit calculation, consistent with Guagnano et al.'s [7] attitude-behaviour-context model.

B. Hypotheses

Two directional hypotheses are proposed:

H1: Perceived hassle of rinsing and segregating takeaway packaging (B1) is positively associated with perceived inconvenience (C3), reflecting a negative PBC effect.

H2: Consumer engagement with a platform-integrated container-return reward system (D1–D5) is positively associated with intention to pre-clean and correctly recycle takeaway packaging (C5).

VI. METHODOLOGY

A. Participants and Procedure

An online survey was distributed via Google Forms through social media and university peer networks in March 2026, targeting urban consumers in India aged 18–35 who regularly purchase takeaway food. In total, 112 valid responses were collected and retained. The sample was predominantly aged 22–25 (52.7%), students (83.0%), and urban residents (95.5%). The most common disposal locations were at home (67.9%) and on university campus (24.1%), representing contexts where both rinsing infrastructure and motivation to segregate vary considerably.

Table I presents the demographic profile.

TABLE I. DEMOGRAPHIC PROFILE (n = 112)

Variable	Category	n (%)
Age Group	18–21	35 (31.3%)
	22–25	59 (52.7%)
	26–30	16 (14.3%)
	31–35	2 (1.8%)
Occupation	Student	93 (83.0%)
	Working Professional	17 (15.2%)
	Other	2 (1.8%)
Area Type	Urban	107 (95.5%)
	Semi-urban/Rural	5 (4.5%)
Takeaway Freq.	Once a week	67 (59.8%)
	3–5 times/week	29 (25.9%)
	Daily	11 (9.8%)
Disposal Location	At home	76 (67.9%)
	University campus	27 (24.1%)
	Office/public area	8 (7.1%)

B. Measures

Section B included a single item measuring perceived hassle: B1 ("Preparing food packaging for recycling takes up too much time"; 7-point Likert scale, 1 = Strongly Disagree to 7 = Strongly Agree). This item was retained as a standalone single-item barrier measure following reliability analysis. Section C contained seven items adapted from Tonglet et al. [1] measuring contamination awareness (C1), moral

norm/guilt (C2), perceived inconvenience (C3), recycling knowledge (C4), recycling intention (C5), and past behaviour frequency (C6, C7). Section D contained five items adapted from Zhong et al. [11] measuring dimensions of reward system motivation: willingness to rinse for loyalty/discount (D1), concern for economic value of points (D2), effort worthiness and environmental image (D3), environmental image and personal achievement (D4), and future committed rinsing if a system is in place (D5).

C. Analytical Strategy

Given non-normal distribution of all variables (Shapiro-Wilk, $p < .001$), Spearman's rank-order correlation (ρ) was used for pairwise hypothesis testing, appropriate for ordinal, non-normally distributed data [14]. For group comparisons, Kruskal-Wallis H tests were conducted to examine differences in recycling intention (C5) across age groups, followed by pairwise Mann-Whitney U tests for post-hoc comparison. Where only two groups were compared (occupation: Student vs. Working Professional), a standalone Mann-Whitney U test was used.

VII. RELIABILITY AND NORMALITY

Cronbach's alpha was computed for Sections C and D. Section C (C1–C7) demonstrated acceptable reliability ($\alpha = 0.729$). Section D (D1–D5) demonstrated good reliability ($\alpha = 0.854$), confirming that the five reward-system items measure a coherent underlying construct. Section B was initially designed with four items; however, the combined B1–B4 scale yielded poor internal consistency ($\alpha = 0.345$), attributable to the conceptual heterogeneity between attitudinal barrier items (B1: time; B2: complexity) and behavioural frequency items (B3: past rinsing; B4: past segregation frequency). Items B2–B4 were therefore excluded. B1 was retained as a single-item measure of perceived time-effort hassle, a valid approach for clearly defined unidimensional constructs [15].

Table II present's reliability results.

TABLE II. CRONBACH'S ALPHA RELIABILITY RESULTS

Section	Items	Cronbach's α	Assessment
Section B (B1 only)	B1 (single item)	N/A	Single item
Section C (C1–C7)	C1, C2, C3, C4, C5, C6, C7	0.729	Acceptable
Section D (D1–D5)	D1, D2, D3, D4, D5	0.854	Good

The Shapiro-Wilk test was used to assess normality. All variables were significantly non-normally distributed ($p < .001$ for all items), justifying the use of non-parametric statistical methods specifically Spearman's rank-order correlation.

VIII. DESCRIPTIVE STATISTICS

Table III presents means and standard deviations for all retained Likert-scale items.

TABLE III. DESCRIPTIVE STATISTICS (n = 112; 7-point scale)

Item	Description [Construct]	M	SD
B1	Preparing food packaging takes too much time [Hassle / PBC Barrier]	4.30	1.75
C1	Food residue contaminates the recycling stream [Attitude - Awareness]	4.91	1.76
C2	I would feel guilty if I did not recycle correctly [Moral Norm]	4.60	1.87
C3	Recycling food packaging is inconvenient for me [PBC Barrier]	4.04	1.75
C4	I know how to recycle food packaging correctly [PBC - Knowledge]	4.13	1.88
C5	I intend to recycle packaging correctly after takeaway [Intention]	4.65	1.65
C6	Frequency of correct recycling in past month [Past Behaviour]	4.03	1.91
C7	Frequency of placing packaging in correct bin [Segregation Behaviour]	4.57	1.79

Item	Description [Construct]	M	SD
D1	Willing to rinse for loyalty points or meal discount [Reward Willingness]	4.93	1.63
D2	Concerned about economic value of points - discounts/cashback [Economic Value]	4.60	1.70
D3	Points make rinsing feel worthwhile and improve environmental image [Effort Worth]	4.85	1.57
D4	Points for environmental image and personal achievement [Identity]	4.71	1.57
D5	Willing to consistently rinse if a reward system is implemented [Future Commitment]	5.15	1.62

Note. All items used a 7-point Likert scale. B1: 1 = Strongly Disagree, 7 = Strongly Agree. D1–D5: 1 = Extremely Unlikely, 7 = Extremely Likely. C7 measures frequency of correct bin placement, used as the primary behavioural indicator of packaging segregation.

Contamination awareness was the highest-rated Section C item (C1: M = 4.91), indicating broad understanding of the problem. Yet recycling knowledge (C4: M = 4.13) and past rinsing frequency (C6: M = 4.03) were notably lower, confirming the attitude-behaviour gap. Crucially, the segregation item (C7: M = 4.57) scored higher than past rinsing (C6: M = 4.03), suggesting consumers are more likely to place packaging in a correct bin than to actively clean it exactly the distinction targeted by the proposed system. Across Section D, D5 (M = 5.15) was the highest-rated item in the entire questionnaire.

IX. STATISTICAL ANALYSIS

A. Spearman Correlation Results

Table IV presents key Spearman correlation results testing the hypothesised relationships between the barrier variable (B1), TPB constructs (C3, C4, C5), and reward motivation items (D1–D5).

TABLE IV. SPEARMAN CORRELATION RESULTS

Variable Pair	Relationship Tested	ρ	p
B1 × C3	Hassle → Inconvenience (PBC)	0.340	< .001
B1 × C5	Hassle → Intention (direct)	0.064	.510 ns
C4 × C5	Recycling Knowledge → Intention	0.590	< .001
D1 × C5	Reward Willingness → Intention	0.437	< .001
D2 × C5	Economic Value → Intention	0.401	< .001
D3 × C5	Effort Worthiness → Intention	0.272	.004
D4 × C5	Identity / Achievement → Intention	0.520	< .001
D5 × C5	Future Committed Rinsing → Intention	0.399	< .001
D1 × D5	Present Willingness → Future Commitment	0.578	< .001
C4 × D1	Recycling Knowledge → Reward Willingness	0.424	< .001

Note. ns = not significant. ρ = Spearman's rho.

B. Group Comparison: Age and Occupation vs. Recycling Intention

Table V presents group means and test statistics for age and occupation comparisons on recycling intention (C5).

TABLE V. GROUP COMPARISONS OF RECYCLING INTENTION (C5) BY AGE AND OCCUPATION

Group	n	M (C5)	SD	Test Statistic
Age: 18–21	35	4.63	1.75	

Group	n	M (C5)	SD	Test Statistic
Age: 22–25	57	4.44	1.61	H (3) = 8.021
Age: 26–30	16	5.62	1.31	p = .046
Age: 31–35	2	3.50	0.71	
Occupation: Student	92	4.61	1.64	
Occupation: Working Professional	16	5.19	1.47	U = 595.0
				p = .216 ns

Note. Age groups compared using Kruskal-Wallis H test. Student vs. Working Professional compared using Mann-Whitney U test (two-tailed). ns = not significant. Post-hoc pairwise Mann-Whitney U test: 22–25 vs. 26–30: U = 264.0, p = .009.

The Kruskal-Walli's test revealed a statistically significant difference in recycling intention across age groups, H (3) = 8.021, p = .046. Post-hoc pairwise Mann-Whitney U tests indicated that the 26–30 age group (M = 5.62, SD = 1.31) reported significantly higher recycling intention than the 22–25 group (M = 4.44, SD = 1.61), U = 264.0, p = .009. No other pairwise age comparisons reached significance. No significant difference in recycling intention was found between students and working professionals (U = 595.0, p = .216), suggesting that occupation alone does not differentiate recycling intention in this sample.

X. HYPOTHESIS TESTING

H1 predicted that perceived hassle (B1) would be positively associated with perceived inconvenience (C3). This was supported: ρ = 0.340, p < .001. Consumers who experience packaging recycling as time-consuming also report it as inconvenient, confirming that time-effort hassle is a meaningful component of the PBC barrier. Importantly, B1 did not correlate directly with recycling intention (C5: ρ = 0.064, ns), consistent with TPB's structural model in which barrier perceptions influence intention indirectly through PBC.

H2 predicted that reward system engagement (D1–D5) would be positively associated with recycling intention (C5). This was strongly supported. All five reward-system items correlated significantly with C5, with ρ values ranging from 0.272 (D3, p = .004) to 0.520 (D4, p < .001). The identity and achievement dimension (D4) was the strongest correlate, followed by reward willingness (D1: ρ = 0.437) and future committed rinsing (D5: ρ = 0.399). The economic value item (D2: ρ = 0.401) was statistically significant but ranked below identity-based items, suggesting that for this sample intrinsic motivations are comparatively more important than monetary incentives. The strong D1–D5 correlation (ρ = 0.578, p < .001) indicates that present willingness reliably predicts future committed behaviour, suggesting the proposed system could produce durable rather than one-off behavioural change.

The strongest predictor of recycling intention overall was recycling knowledge (C4: ρ = 0.590, p < .001), underscoring that competence-based PBC is the most powerful driver. Notably, more knowledgeable consumers are also more willing to engage with the reward system (C4 × D1: ρ = 0.424, p < .001), suggesting that education and incentive design work synergistically.

XI. MANAGERIAL AND THEORETICAL IMPLICATIONS

A. Managerial Implications

For food delivery platforms such as Zomato and Swiggy, this study provides empirical evidence that urban consumers particularly in the 22–30 age bracket are meaningfully receptive to a container-return credit-point system. Platforms should pilot a 'Green Return' feature: at the point of placing a new order, consumers are prompted to opt in to returning their pre-cleaned, segregated containers from their previous order. The delivery agent collects these containers upon arrival, and the platform credits the consumer's account with redeemable order discounts. The platform then routes collected containers directly to certified recycling partners, bypassing restaurants entirely to avoid operational complexity. Platform UI design should foreground the identity and environmental achievement dimension (D4 was the strongest intention correlate), framing the action as an eco-identity statement rather than a financial transaction.

The significant age group difference in recycling intention (Kruskal-Wallis: H = 8.021, p = .046), with the 26–30 group reporting notably higher intention (M = 5.62) than the 22–25 group (M = 4.44), has

direct targeting implications. The 26–30 cohort likely recent graduates in early career may represent the highest-engagement early-adopter segment for a pilot programme. The 22–25 cohort, being largest in this sample, represents the highest-volume opportunity; their comparatively lower intention may respond well to social norm messaging embedded in the platform.

For municipal waste management authorities, the finding that recycling knowledge (C4) is the single strongest predictor of intention ($\rho = 0.590$) argues for awareness campaigns that specifically explain what rinsing and segregation involve and why residue contamination matters embedded in the food delivery app interface at the moment of disposal, reaching consumers at precisely the behavioural moment relevant to the target action.

B. Theoretical Implications

This study extends TPB to a novel domain the pre-disposal rinsing and segregation of app-delivered takeaway packaging introducing unique situational constraints (time pressure, absence of rinsing facilities at point of consumption) that enrich understanding of PBC's contextual boundary conditions. The positioning of the platform-integrated reward system as an external facilitating condition that modifies PBC without requiring attitudinal change advances TPB theory in line with Guagnano et al.'s [7] attitude-behaviour-context model. The finding that identity-based rewards (D4: $\rho = 0.520$) outperform economic rewards (D2: $\rho = 0.401$) in association with intention is consistent with self-determination theory [16] and suggests that reward systems in sustainability contexts should be designed to support internalised motivation rather than purely extrinsic compliance. Methodologically, the reliability finding underscores that attitudinal barrier items and behavioural frequency items are empirically distinct and should be separately instrumented in future recycling preparation scales.

XII. LIMITATIONS AND FUTURE RESEARCH

The convenience sample predominantly students aged 18-25 from a single urban Indian context limits generalisability. All measures are self-reported, introducing social desirability bias risk; the observed gap between recycling intention (C5: M = 4.65) and past rinsing frequency (C6: M = 4.03) is already indicative of an intention-behaviour discrepancy. The cross-sectional design precludes causal inference. B1 was retained as a single item after exclusion of B2–B4, limiting construct breadth for the hassle barrier. The 31–35 age group (n = 2) was too small for meaningful comparison.

Future research should employ longitudinal or experimental designs, broader demographic sampling, and a validated multi-item rinsing-and-segregation effort scale. Pilot-testing the proposed container-return system in a real food delivery context with treatment and control groups would be necessary to establish causal impact.

XIII. CONCLUSION

This study addressed a specific, consequential behavioural problem: the failure of urban consumers to rinse and segregate takeaway plastic containers before disposal, and the recycling contamination this produces. A novel closed-loop solution was proposed and empirically tested: a food delivery platform-integrated container-return system in which consumers pre-clean and segregate their containers, return them to the delivery agent, and receive credit points redeemable as order discounts, while the platform routes collected containers to recycling facilities.

Grounded in TPB and analysed using Spearman's rank-order correlation and Kruskal-Wallis group comparison tests, the findings support both hypotheses. Perceived hassle is a significant PBC barrier (H1 supported: B1 × C3, $\rho = 0.340$, $p < .001$). All five reward-system dimensions significantly predict recycling intention, with identity-based rewards showing the strongest association (H2 supported: D4 × C5, $\rho = 0.520$, $p < .001$). The group comparison analysis provides a practically important additional finding: the 26–30 age group reports significantly higher recycling intention than the 22–25 majority group (Kruskal-Wallis $H = 8.021$, $p = .046$; post-hoc $U = 264.0$, $p = .009$), identifying them as a priority early-adopter segment for a platform pilot. Occupation did not significantly differentiate intention.

The highest-rated item in the entire questionnaire future consistent rinsing and segregating if a reward system is in place (D5: M = 5.15) encapsulates the study's central finding: consumers are behaviourally ready; the infrastructure is not yet there. A well-designed, platform-integrated container-return

system represents a practically feasible, multi-stakeholder pathway to genuinely reducing recycling contamination from takeaway food packaging in urban India and beyond.

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