



Perceived Segregation Cues and Social Norms as Predictors of Self-Reported Waste Segregation Practices among Construction Workers in Peshawar

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ABSTRACT

Construction and demolition waste (CDW) is one of the largest and fastest-growing global waste streams, yet the behavioural determinants of waste segregation among the workers who handle this waste on site remain understudied, particularly in South Asia. This cross-sectional survey examined perceived segregation cues (PSC), perceived descriptive norms (DN), and perceived injunctive norms (IN) as predictors of self-reported waste segregation practices (SRWSP) among 300 construction workers in Peshawar, Pakistan. Multiple regression analysis showed that PSC and IN were significant predictors of SRWSP, while DN, though significantly correlated with SRWSP at the bivariate level, was not significant once IN and PSC were included, likely reflecting high shared variance between DN and IN. The model explained 45.7% of variance in SRWSP. Findings are associative and based entirely on self-reported data, with implications for site-level guidance regarding perceived cues and norms.

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Introduction

Construction and demolition waste (CDW) constitutes one of the largest waste streams generated globally, estimated at 2–3 billion tonnes annually and accounting for roughly a quarter to a third of all waste produced worldwide (Sakthibala et al., 2025). Global municipal solid waste generation continues to rise faster than previously anticipated, with conditions in many low- and lower-middle-income countries remaining particularly serious (Cook et al., 2026). Within this broader waste burden, construction activity contributes a substantial share of generated material, much of which could in principle be diverted from landfill through effective on-site segregation. Reducing the environmental burden of construction waste is also directly relevant to global sustainability commitments, including Sustainable Development Goal targets on responsible consumption and production and on reducing the environmental impact of cities (United Nations, 2024).

In Pakistan specifically, the construction industry contributes a significant proportion of the country's annual solid waste, and poor awareness has been identified as one of the leading barriers to effective waste management adoption in the sector (Shahid & Ali, 2025). Despite this, the individual-level behavioural determinants of segregation practice among the workers who physically handle CDW on a daily basis remain comparatively underexamined. Most empirical research on the

behavioural determinants of waste segregation has instead focused on household or municipal contexts rather than construction sites, and on countries outside South Asia (Jampala & Shivnani, 2024). Construction workers occupy a distinct behavioural context. They operate under time pressure, variable supervision, and site conditions that differ markedly from residential or office settings where most existing segregation research has been conducted. Segregation-related infrastructure on construction sites is also typically less standardized than in municipal waste systems, which may make workers' subjective perceptions of cues, rather than the infrastructure itself, a more tractable object of study.

Two broad categories of psychological constructs are commonly proposed to explain pro-environmental sorting behaviour. The first concerns situational and perceptual cues in the immediate environment, such as signage and bin placement, which have been shown to influence sorting accuracy in non-construction settings (Lotti et al., 2023). The second concerns social norms, distinguished into descriptive norms (perceptions of what most others actually do) and injunctive norms (perceptions of what is socially approved or disapproved), both of which form part of a broader normative-influence tradition in behavioural theory. Whether these two categories of constructs are similarly associated with self-reported waste segregation practices among construction workers, a population with limited representation in the existing literature, remains an open empirical question.

The problem this study addresses, in short, is that perceived cues and social norms are both theoretically plausible correlates of waste segregation practice, but their relative associations with self-reported segregation practice have not been established for construction-worker populations in South Asia. This leaves a gap between general behavioural theory and the specific occupational context in which most physical CDW handling actually occurs. Existing survey-based research on South Asian construction and demolition waste has more often examined organizational barriers, material recovery rates, or contractor-level attitudes than the perceptions of the frontline workers who carry out day-to-day sorting tasks. As a result, the perceptual and normative correlates of individual worker practice remain comparatively unexamined, even as the broader importance of the construction sector to regional waste totals is well established.

Problem Statement

Construction and demolition waste is a large, growing global waste stream. Yet little is known about why construction workers segregate it, or not, on site. Perceived cues, like signage and bins, and social norms may shape this behaviour, but their relative importance is untested among South Asian construction workers. Most existing research looks at households or campuses, not construction sites. This study fills that gap, examining perceived cues and social norms as predictors of self-reported waste segregation among Peshawar construction workers.

Research Objectives

- To examine the association between perceived segregation cues and self-reported waste segregation practices among construction workers in Peshawar.
- To examine the association between perceived descriptive and injunctive social norms and self-reported waste segregation practices among construction workers in Peshawar.

Research Questions

- What is the association between perceived segregation cues and self-reported waste segregation practices among construction workers in Peshawar?
- What is the association between perceived descriptive and injunctive social norms and self-reported waste segregation practices among construction workers in Peshawar?

Literature Review

CDW management has received growing academic attention, with recent bibliometric analysis identifying a substantial and expanding body of research spanning waste generation prediction, material classification, transportation, and recycling or disposal (Gao et al., 2025). Global reference reports converge on the scale of the challenge: municipal solid waste generation continues to increase globally, particularly in low- and lower-middle-income countries where waste management infrastructure remains limited (Cook et al., 2026; United Nations Environment Programme [UNEP], 2024). In the European Union, CDW represents almost 40% of total waste generated, and techno economic assessment indicates that improved reuse and recycling of individual material fractions could yield significant environmental benefits (Cristóbal García et al., 2024). In South Asia, regional field studies similarly document substantial and rising CDW generation; a recent field investigation in the Greater Dhaka area of Bangladesh estimated construction and demolition waste generation rates of approximately 90 and

464 kilograms per square metre of floor area, respectively, underscoring the scale of the challenge across the region (Haque et al., 2025). Despite this scale, official development finance directed specifically at solid waste management remains a very small share of total development assistance globally. It suggests that infrastructure and behavioural improvements at the local and site level remain especially important levers for change (Lerpiniere et al., 2025).

Within Pakistan's construction sector specifically, a fuzzy-DEMATEL analysis of construction stakeholders found that lack of regulation, financial constraints, and poor awareness were consistently ranked among the most influential root-cause barriers to waste minimization across clients, consultants, contractors, and regulators (Shahid & Ali, 2025). This suggests that perceptual and informational conditions on site may play a meaningful role in shaping worker practices independent of formal policy. In a comparable South Asian context, a survey-based study of Indian construction professionals using the Relative Importance Index method, finding that human skill and quality control were the most critical factors in reducing waste across several material categories. The study recommended workforce training as a key mitigation strategy, while explicitly noting that reliance on self-reported survey data was a limitation of the approach (Samal et al., 2025). At a more local operational scale, a European study found that controlled on-site storage, frequent supervision, and procedural control were each associated with improved CDW management by micro and small construction companies, and that regular awareness, training, and supervision activities were associated with the acquisition of new habits among waste producers over time (Ramos et al., 2023).

A body of research links situational and perceptual cues to sorting behaviour. Lotti et al. (2023) conducted a quasi-experimental study on a university campus and found that combining a visual nudge (an image of human eyes) with pre-existing sorting instructions was associated with fewer sorting errors. Whereas the visual nudge presented alone was associated with more errors relative to the control condition, a pattern the authors attributed to the cue redirecting attention toward existing instructions rather than to a purely reputational mechanism. This finding indicates that the configuration of situational cues, rather than their mere presence, is associated with sorting accuracy, and underscores the relevance of examining perceived segregation cues as a distinct construct.

Social norms constitute a second major behavioural determinant examined in the literature. Cialdini et al. (1990) proposed the focus theory of normative conduct, distinguishing descriptive norms from injunctive norms, and demonstrated in field studies on littering that behaviour shifted in line with whichever norm type was made salient to participants. Sevillano and Olivos (2019) similarly reviewed descriptive and prescriptive (injunctive) social norms applied to pro-environmental behaviour more broadly. It concludes that normative messages are more effective when they avoid inadvertently signalling that undesirable behaviour is common, and when feedback and personal involvement accompany the normative message.

Ajzen's (1991) Theory of Planned Behavior (TPB) provides a complementary theoretical foundation. The theory positioned subjective norms as one of three core determinants of behavioural intention, alongside attitude and perceived behavioural control. TPB has been widely applied to waste segregation research. Jampala and Shivrani (2024), in a PLS-SEM study of household waste segregation across two Indian cities, found that subjective norms were a significant positive predictor of segregation intention, with the normative path exhibiting the largest structural coefficient among the three TPB predictors in the pooled model.

Evidence on the role of norms specifically within construction waste management is more limited and mixed. Yi et al. (2025) conducted a randomized controlled trial among renovation clients in Shenzhen, China, testing green nudges based on self-interest, environmental concern, and descriptive and injunctive social norms; nudges emphasizing self-interest and environmental concerns significantly increased willingness to adopt sustainable renovation practices, whereas nudges built specifically on descriptive and injunctive norms had either a weak or no significant effect. In a related Chinese context, Liang et al. (2024) found that structural nudge tools, such as timing and fixed-point separation systems and cleaning-staff guidance, were associated with improved household waste separation, mediated by habit and perceived separation efficiency rather than by norm-based messaging directly. Using a metaverse serious-game simulation with participants holding construction site management experience, Zhuang et al. (2026) found that green nudges incorporating moral suasion and social comparison, delivered with timely feedback, were associated with improved sorting accuracy and waste collection performance, and that attitudes and perceived convenience significantly influenced on-site CWM performance. Separately, Zhao et al. (2024) examined Chinese construction contractors' implicit and explicit attitudes toward construction waste resource utilization and found that publicity and education policies were associated with improved awareness of waste collection and sorting, and that explicit attitudes were more shaped by social expectations and moral norms than implicit attitudes.

Taken together, the literature suggests that both perceived situational cues and perceived social norms are plausible correlates of waste segregation practice, but their relative importance, and particularly the distinct roles of descriptive versus

injunctive norms, has not been established for construction-worker populations. Most of the reviewed behavioural studies also originate from household, campus, or contractor/management-level samples rather than frontline site labour, and none were conducted in Pakistan. This study addresses that gap by examining PSC, DN, and IN as predictors of SRWSP among construction workers in Peshawar.

Methodology

This study employed a quantitative cross-sectional survey design, consistent with prior South Asian survey-based approaches to construction waste behaviour (Samal et al., 2025). Data was collected from 300 construction workers in Peshawar using a structured self-administered questionnaire. Respondents provided informed consent prior to participation, and the questionnaire recorded demographic information (age group, education, work experience, work type, and prior training received) alongside four multi-item scales measuring perceived segregation cues (PSC; 6 items), perceived descriptive norms (DN; 4 items), perceived injunctive norms (IN; 4 items), and self-reported waste segregation practices (SRWSP; 5 items). All substantive items were rated on structured response scales, and composite scores for each construct were computed by averaging item responses, such that higher scores indicated stronger perceived cues, stronger perceived norms, or more frequent self-reported segregation practice, respectively.

The internal consistency reliabilities were determined for each scale using Cronbach's alpha and a value of .70 or higher was considered acceptable. The data set was initially checked for missing values and duplicate response identifiers to ensure that all data is complete and that each case is unique before substantive analysis. All the study variables were subjected to descriptive statistics and then the bivariate correlation analysis to determine the association between each pair of variables (PSC, DN, IN and SRWSP). To test H1, H2a and H2b, a multiple regression analysis was performed with SRWSP as the outcome variable, and PSC, DN, and IN as the predictor variables. Since DN and IN were conceptually and empirically connected, multicollinearity diagnostics such as variance inflation factor (VIF) and tolerance values were evaluated for the stability of regression coefficients for each predictor. No behavioural observation was undertaken in this study and conclusions about causation cannot be drawn from the reported associations as all analyses were based on self-reported questionnaire data only. Standard statistical software was used for all analysis.

Theoretical Framework and Conceptual Model

This study integrates two complementary theoretical perspectives. The first perspective is the Focus Theory of Normative Conduct (Cialdini et al., 1990), which distinguishes between descriptive norms and injunctive norms. Descriptive norms refer to perceptions of what other people commonly do, whereas injunctive norms represent perceptions of behaviours that are socially approved or expected. These two forms of norms may influence construction workers' waste segregation behaviour through different pathways.

The second theoretical foundation is Ajzen's (1991) Theory of Planned Behavior (TPB). TPB explains behavioural outcomes through attitudes, subjective norms, and perceived behavioural control. In this study, perceived segregation cues (PSC) represent workplace conditions that may facilitate waste segregation, including visible signs, appropriate bin placement, and other environmental prompts.

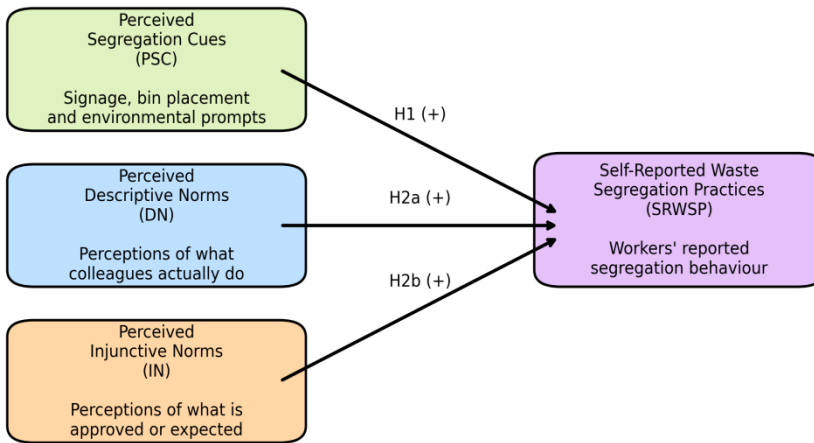
Based on these theoretical perspectives, the study proposes that self-reported waste segregation practices (SRWSP) are associated with three perceptual constructs: perceived segregation cues (PSC), perceived descriptive norms (DN), and perceived injunctive norms (IN). These constructs are considered theoretically distinct, although they may demonstrate empirical overlap.

Figure 1 presents the conceptual framework of the study. PSC, DN, and IN are treated as independent predictors of SRWSP. Each predictor is hypothesized to have a positive association with waste segregation practices. The framework represents statistical relationships tested in the study and does not indicate causal relationships among the predictors.

Figure 1. Conceptual Framework

Perceived segregation cues (PSC), perceived descriptive norms (DN), and perceived injunctive norms (IN) as predictors of self-reported waste segregation practices (SRWSP).

Conceptual Framework of Construction Waste Segregation Practices



PSC, DN, and IN represent independent predictors of SRWSP.
The framework illustrates hypothesized statistical associations and does not imply causal ordering.

Hypotheses

H1: Perceived segregation cues are positively associated with self-reported waste segregation practices among construction workers in Peshawar.

H2a: Perceived descriptive norms are positively associated with self-reported waste segregation practices among construction workers in Peshawar.

H2b: Perceived injunctive norms are positively associated with self-reported waste segregation practices among construction workers in Peshawar.

Results and Data Analysis

Data Screening

The final data included responses of 300 construction workers in Peshawar ($N = 300$). Data screening was carried out prior to the main analysis. There were no missing values in the data set, and no duplicate response identifiers. So, all 300 responses were kept and analysed. There was no imputation of data or deletion of cases.

Sample Characteristics

The majority of the participants were working age adults. The largest age category was 30–39 years (35.3%), followed by 20–29 years (31.7%) and 40–49 years (16.3%). Eight percent (8.3%) of respondents were under 20 years old and eight percent (8.3%) were 50 years and above. The educational profile showed that the level of formal education among construction workers was generally low. About 35.7% did not get any formal education while only 4.7% obtained intermediate education or higher.

Regarding work experience, the largest group of respondents (27.7%) had 4–6 years of work experience on the construction site. Labourers were the largest occupational group (35.3%) while masons were on the next record (21.3%) with helpers at 15.7%. The remaining respondents were involved in other construction-related trades such as carpenters, steel fixers, electricians/plumbers, and other workers. 24% of the respondents indicated that they received previous training in handling or segregation of waste. This suggests that there is little formal construction waste management knowledge among the workers surveyed.

Descriptive Statistics and Reliability Analysis

Descriptive statistics and reliability values of the study constructs are shown in Table 1. Cronbach's alpha was used to determine the reliability of the instrument. The internal consistency of all the constructs was acceptable, with alpha ranging from .875 to .923. The scores of the individual variables in the study were not all similar. PSC recorded the lowest mean score ($M = 2.43$, $SD = 0.90$), whereas SRWSP showed the highest mean score ($M = 3.43$, $SD = 0.94$).

Table 1: Descriptive Statistics and Reliability of Study Variables

Variable	Mean (M)	Standard Deviation (SD)	Cronbach's Alpha (α)
PSC	2.43	0.90	.923
DN	3.06	0.95	.891
IN	3.31	0.94	.875
SRWSP	3.43	0.94	.915

Note: N = 300.

The mean score of the four study variables is presented in Table 1. SRWSP obtained the highest mean score (3.43), followed by IN (3.31), DN (3.06), and PSC (2.43).

Correlation Analysis

Pearson correlation analysis was used to explore the relationships between PSC, DN, IN and SRWSP. This is presented in table 2. SRWSP was significantly and positively related with PSC ($r = .529$, $p < .001$). SRWSP was also positively associated with DN ($r = .564$, $p < .001$). Likewise, the score for IN showed an even stronger positive correlation with SRWSP ($r = .584$, $p < .001$). The highest correlation was found between DN and IN ($r = .881$, $p < .001$).

Table 2: Correlation Analysis of Study Variables

Variable Pair	r	P
PSC-DN	.412	<.001
PSC-IN	.370	<.001
PSC-SRWSP	.529	<.001
DN-SRWSP	.564	<.001
IN-SRWSP	.584	<.001
DN-IN	.881	<.001

Note: Pearson correlation coefficients are reported.

The strength of the correlation between predictors and SRWSP is shown in Table 2. IN showed the strongest association with SRWSP ($r = .584$), followed by DN ($r = .564$) and PSC ($r = .529$).

Multicollinearity Diagnostics

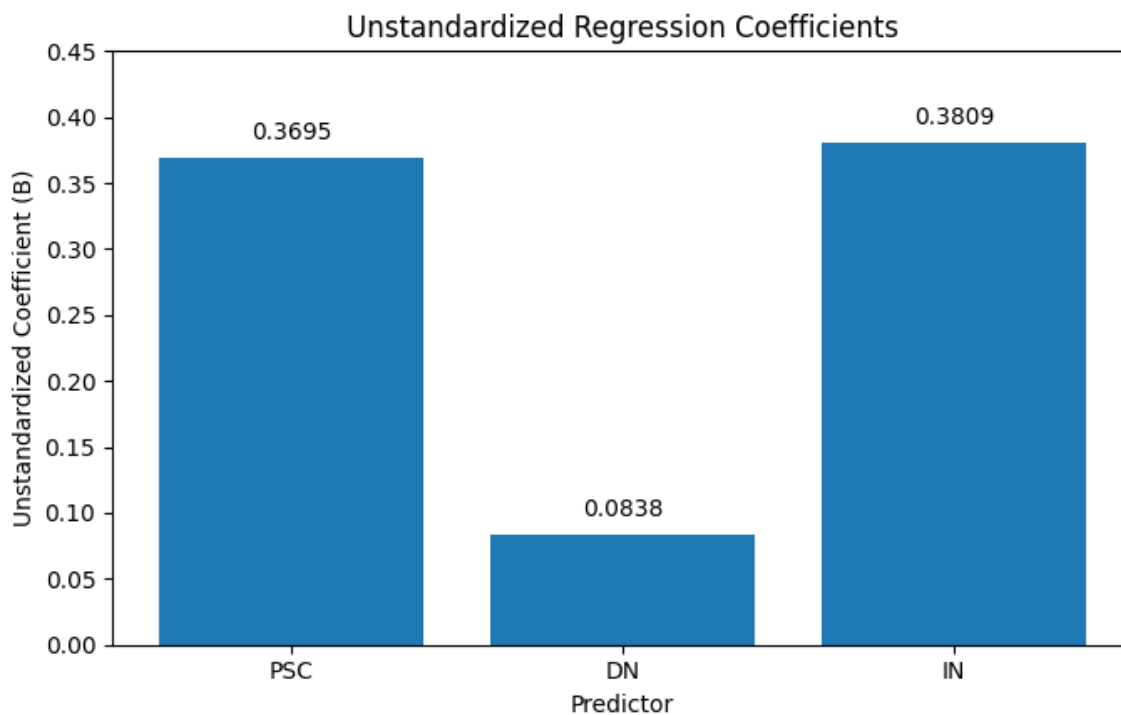
Because of the high correlation between DN and IN, the diagnostics of multicollinearity were explored prior to regression analysis. The variance inflation factor (VIF) and tolerance values are presented in Table 3. The multicollinearity was low for PSC as the VIF value was 1.20, and the tolerance value was 0.830. The comparatively higher VIF values were obtained for DN (4.63) and IN (4.45). Nevertheless, both of these values were under the accepted threshold of 5. High tolerance values for DN (0.216) and IN (0.225) suggest that there is high shared variance between these two predictors.

Table 3: Multicollinearity Diagnostics

Predictor	VIF	Tolerance
PSC	1.20	0.830
DN	4.63	0.216
IN	4.45	0.225

Multiple Regression Analysis

Multiple regression analysis was performed to examine the predictive effects of PSC, DN, and IN on SRWSP. All three predictors were entered simultaneously into the model. The regression model was statistically significant, $F(3, 296) = 82.92$, $p < .001$. The model explained 45.7% of the variance in SRWSP ($R^2 = .457$; Adjusted $R^2 = .451$). PSC was a significant positive predictor of SRWSP ($B = 0.3695$, $p < .001$). IN was also a significant positive predictor ($B = 0.3809$, $p < .001$). Among the predictors, IN showed the highest regression coefficient. DN did not significantly predict SRWSP after controlling for PSC and IN ($B = 0.0838$, $p = .360$). However, because DN showed a significant bivariate relationship with SRWSP, this result may be influenced by the high shared variance between DN and IN.

Figure 2. Regression Coefficients Predicting SRWSP

Model summary: $R^2 = .457$, Adjusted $R^2 = .451$, $F(3,296) = 82.92$, $p < .001$.

Figure 2 presents the regression coefficients of the predictors. IN showed the strongest effect ($B = 0.3809$), followed closely by PSC ($B = 0.3695$). DN showed a smaller and statistically non-significant effect ($B = 0.0838$).

Hypothesis Testing Summary

The results of hypothesis testing are summarized in Table 4. PSC demonstrated a significant relationship with SRWSP in both correlation and regression analyses. Therefore, H1 was supported. DN showed a significant correlation with SRWSP but did not remain significant in the regression model. Therefore, H2a was partially supported at the bivariate level only. IN was significantly associated with SRWSP in both analyses. Therefore, H2b was supported.

Table 4: Summary of Hypothesis Testing

Hypothesis	Result
H1: PSC is associated with SRWSP	Supported
H2a: DN is associated with SRWSP	Partially supported (bivariate relationship only)
H2b: IN is associated with SRWSP	Supported

Discussion

This study examined perceived segregation cues (PSC), perceived descriptive norms (DN), and perceived injunctive norms (IN) as predictors of self-reported waste segregation practices (SRWSP) among construction workers in Peshawar. PSC and IN emerged as significant predictors, while DN lost significance once IN and PSC were included in the regression model, despite a significant bivariate correlation with SRWSP.

The significant PSC–SRWSP association is consistent with evidence that situational and perceptual cues are associated with sorting behaviour. Lotti et al. (2023) found that a visual nudge combined with clear sorting instructions was associated with fewer sorting errors, while the same visual nudge presented alone was associated with more errors, indicating that the configuration of situational cues, rather than their presence alone, matters. This is broadly consistent with the present finding that workers' perceptions of their immediate segregation environment are associated with reported practice, although the present design cannot identify which specific cues drive this association. Zhuang et al. (2026) similarly found that green nudges delivering timely feedback were associated with improved sorting accuracy among participants with construction site management experience, and that perceived convenience significantly influenced performance, lending further support to a

role for perceived situational conditions. In the same national context as the present study, Shahid and Ali (2025) identified poor awareness as a major barrier to waste management adoption in Pakistan's construction industry, lending indirect support to the relevance of perceptual and informational conditions for reported practice.

The significant IN–SRWSP association aligns with the broader normative-influence literature. Cialdini et al. (1990) demonstrated that injunctive norms can shift behaviour independently of descriptive norms, particularly when descriptive norms are inconsistent or unfavourable, and Sevillano and Olivos (2019) similarly emphasized that the effectiveness of normative messaging depends on how the norm is framed and communicated. Behavioural intention within the Theory of Planned Behavior (Ajzen, 1991) identifies normative perceptions as a core determinant. Jampala and Shivnani (2024), in a directly comparable South Asian waste-segregation context, found that subjective norms were the strongest predictor of segregation intention among the TPB constructs examined. One plausible interpretation is that injunctive expectations communicated through supervisors or site rules may carry particular weight in construction settings where descriptive norms around segregation are inconsistent. This interpretation is theoretically motivated rather than directly tested by the cited studies, none of which examined norm types specifically within construction sites.

The non-significance of DN in the regression model should be interpreted cautiously. DN and IN were very highly correlated ($r = .881$, $p < .001$), and multicollinearity diagnostics showed substantial shared variance between them (DN: VIF = 4.63; IN: VIF = 4.45). This suggests DN's null multivariate result may reflect statistical overlap with IN rather than the absence of any relationship between descriptive norms and SRWSP, particularly given DN's significant bivariate correlation with SRWSP ($r = .564$, $p < .001$). Notably, Yi et al. (2025) found that norm-based green nudges, including both descriptive and injunctive framings, had a weak or non-significant effect on renovation clients' willingness to adopt sustainable practices, even as self-interest and environmental-concern nudges were significant. This finding partially undercuts, rather than simply supports, the present study's normative results. That trial tested experimentally manipulated norm-based interventions on behavioural willingness, whereas the present study measured perceived norms in a correlational, self-report design; a perceived norm associated with self-reported practice is not equivalent to a norm-based nudge that changes behaviour. Consistent with this caution, Liang et al. (2024) found that structural nudge tools rather than norm-based messaging per se were associated with improved household waste separation, mediated by habit and perceived efficiency. Zhao et al. (2024) offer a partial counterpoint, finding that construction contractors' explicit attitudes toward waste resource utilization were more shaped by social expectations and moral norms than their implicit attitudes, consistent with a normative role in self-reported measures specifically – the same measurement level as SRWSP in the present study.

Overall, these findings should be understood as associative rather than causal. PSC and IN are best described as predictors of self-reported waste segregation practices among construction workers in this sample, while DN's weaker independent role appears attributable, at least in part, to its high shared variance with IN rather than to descriptive norms being unrelated to segregation practice. Given the consistency of the PSC finding with the situational-cue literature, site-level guidance regarding signage and bin placement may be a reasonable focus for future research attention, alongside further investigation of injunctive norm communication.

Conclusion

This study examined perceived segregation cues and social norms as predictors of self-reported waste segregation practices among 300 construction workers in Peshawar, a population and setting that has received limited attention in the existing behavioural waste-management literature. Perceived segregation cues (PSC) and perceived injunctive norms (IN) were significant predictors of self-reported waste segregation practices (SRWSP) in a multiple regression model explaining 45.7% of the variance in reported practices, indicating that both perceptual conditions on site and workers' sense of socially approved conduct are meaningfully associated with reported segregation practice. Perceived descriptive norms (DN) were significantly correlated with SRWSP at the bivariate level but were not a significant predictor once IN and PSC were included, a pattern most plausibly attributable to the high shared variance between DN and IN rather than to descriptive norms being unrelated to reported practice; H2a is therefore considered only partially supported, while H1 and H2b were supported. All reported relationships are correlational and based entirely on self-reported data collected through a single cross-sectional questionnaire, and should not be interpreted as evidence of observed behaviour or of any causal relationship between perceived cues, social norms, and waste segregation practice among construction workers. Future research building on these associations would benefit from methods that reduce reliance on single-source self-report data, from samples extending beyond a single city, and from further examination of discriminant validity between descriptive and injunctive norm measures in construction-site populations.

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