



Predictors of waste management behaviours in coastal communities in Indonesia: The role of community attachment and environmental concern

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ABSTRACT

The global challenge of marine plastic pollution requires systemic change in our relationship with plastic. The current linear plastic economy must transition to a sustainable circular model, but is hindered by behavioural change difficulties, particularly in coastal regions facing resource limitations and a lack of research attention.

This study investigates waste management (WM) behaviours in Java and Bali, Indonesia, through a household survey ($N = 506$). By examining the roles of community attachment and environmental concern in WM behaviours, we contribute to the theoretical understanding of these concepts within a novel context. Our findings reveal that community attachment and environmental concern predict WM behaviours, yet lead to divergent outcomes. Furthermore, the provision of infrastructure is associated with changes in some, but not all, WM behaviours. These results underscore the importance of considering a variety of waste management behaviours and adopting a balanced approach that integrates both infrastructural and psychological interventions.

1. Introduction

Plastic waste is accumulating worldwide and is one of the largest contributors to both land-based and marine pollution (Jambeck et al., 2015). In 2019 22 % of plastic waste was mismanaged globally, and up to 64 % in some Global South countries (OECD, 2022). This mismanagement leads to significant environmental, social and economic issues (MacLeod et al., 2021), such as biodiversity loss (Azevedo-Santos et al., 2021), human health impacts (Blackburn and Green, 2022) and financial losses (Beaumont et al., 2019).

Systemic change is needed to address plastic pollution effectively (Courteney-Jones et al., 2022). Balancing corporate accountability and individual sustainable choices is challenging. Understanding embedded human behaviours and their motivations is crucial for identifying and elaborating intervention points and strategies. This paper focuses on household plastic waste management behaviours, which, at their

simplest, cover actions of waste aggregation and removal from the household. The specific actions necessary, however, differ between locations. For example, one may be placing all of the waste into a general waste bin, or take it to a landfill. If recycling, one is required to not just aggregate, but also separate the waste into different containers (with some items requiring cleaning and a certain level of disassembling) and either take recyclables to a recycling location or place them in a designated collection spot outside the house. The number of bins, frequency of collection, etc. differ in different locations (Zhou et al., 2019). In some Global South regions, where no waste management is available, behaviours may include open dumping, littering, and burning (Wilson et al., 2006).

Research on waste management behaviours has focused on recycling and littering (Heidbreder et al., 2019), influenced by psychological (Chaudhary et al., 2021; Geiger et al., 2019; White et al., 2009) and contextual factors (Madigele et al., 2017; Schultz et al., 2013; Vogt and

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Nunes, 2014). Moreover, most studies concentrate on the Global North with limited research on the Global South focusing primarily on demographic variables (Chaudhary et al., 2021). The diverse waste management behaviours, informal systems and their drivers in the Global South remain underexplored (Heidbreder et al., 2019).

This study addresses these gaps by focusing on Indonesia (Java and Bali) as an under-researched Global South location with a rich marine environment, and exploring human and nature-centred community attachment and environmental concern as antecedents of waste handling behaviours. The article is structured as follows: first, we review household waste management in Indonesia, then explore community attachment and environmental concern. We present our research questions and methods, followed by findings and discussion within the context of previous research and Indonesia's specific background.

2. Literature review

2.1. Waste management behaviours in Indonesia

Indonesia is the world's largest archipelago, consisting of over 17,000 islands and possessing one of the longest coastlines globally, extending over 54,000 km. The country's vast marine areas make it especially vulnerable to marine litter, particularly plastic leakage. Studies have identified Indonesia as one of the largest contributors to ocean plastic pollution, with an estimated 620,000 to 1.29 million metric tons of plastic waste entering its marine ecosystems annually (Jambeck et al., 2015). Waste management in Indonesia varies widely, from municipally managed separated recycling in urban areas, to waste burning or river dumping in rural regions lacking official waste disposal options (Phelan et al., 2020; Sekito et al., 2013; Wibisono et al., 2020). The combination of high population density, coastal proximity, and insufficient waste management infrastructure exacerbates the potential for plastic leakage into the ocean. Indonesia generates about 7.8 million tons of plastic waste annually, with 4.9 million tons unmanaged, and 83 % leaking into the marine environment (World Bank, 2021). In urban areas, 40 % of waste is not formally collected and this figure rises to 85 % in rural areas (World Bank, 2021). The country has a vast informal sector for waste management built upon the collection and selling of recyclable plastic items to intermediary traders or depositing them in waste banks for small rewards (Nurani et al., 2020; Nurjanahl et al., 2016; Wijayanti and Suryani, 2015). This presents a more complex picture of waste management behaviours compared to the Global North. This study aims to document predominant waste management practices across various sociodemographic and geographic categories in East Java and West Bali.

2.2. Waste management behaviour antecedents in Indonesia

Monetary motivation is suggested as a key reason for separating recyclable items (Ulhasanah and Goto, 2018; Warmadewanthi et al., 2021), with little willingness-to-pay for waste collection services or to handle plastic waste items with no trading value (Dhokhikah et al., 2015; Sekito et al., 2020; Setiawan, 2020; Trihadiningrum et al., 2015). Waste sorting is often perceived as time-consuming and burdensome (Sekito et al., 2020) and a lack of knowledge/competence and environmental awareness contributes to low waste sorting intentions (Dhokhikah et al., 2015; Kamil et al., 2021; Phelan et al., 2020; Sunarti et al., 2021; Trihadiningrum et al., 2015). This showcases a variety of perceived barriers to participation in more structured waste management.

Limited evidence suggests that community attachment (communal activities, community wellbeing) might motivate people to separate and recycle waste in Indonesia (Brotosusilo et al., 2020; Schlehe and Yulianto, 2020; Warmadewanthi et al., 2021). However, the sociocultural aspects of waste-related behaviours remain underexplored limiting the effectiveness of existing waste management interventions (Phelan

et al., 2020). Schlehe and Yulianto (2020) found that community attachment plays a more significant role in waste management decisions than attachment to the natural environment, while Ekasari and Zaini (2020) describe community health and wellbeing being primary motivations for using reusable eco-bags. Thus, Indonesia is a valuable case study to explore human and nature-centred community attachment in waste management behaviours.

2.3. Community attachment

The concept of community attachment has many similarities to one of place attachment; in fact, the two concepts have often been used so closely and sometimes even interchangeably, that the distinction between them would merit a separate investigation (Trentelman, 2009). Place attachment has been described as sense of place, a bond people experience with a certain location (Jorgensen and Stedman, 2001). Community attachment was originally defined as one's social bonds and affective sentiment towards their community members (McCool and Martin, 1994). It is important to note that recent definitions of place attachment acquire some social properties, while community attachment definitions grew to include the natural and physical aspects of one's community, making the distinction even harder to drive (Trentelman, 2009). Conceptually, community attachment was a more suitable construct for our research purpose of exploring the role of community (rather than geographical location in general) in one's waste management decisions. Because of that, in this short overview we cover research that specifically uses the term "community attachment" or, following Trentelman's (2009) suggestion of looking at "what any given work is about instead of the terms, methodologies or paradigms" (p. 205), research that explicitly focuses on community-linked (rather than more generic) place attachment.

Due to its explicitly "social" roots, community attachment has often been measured through the length of residence, quality of social connections, shared religion, number of friends/relatives living in the community, etc. (Beggs et al., 1996). In the Global North, it is associated with pro-environmental behaviours (such as recycling, composting, donating, etc.) (Takahashi and Selfa, 2015), avoiding littering and picking up the litter left by others (Rosenthal and Ho, 2020), as well as anti-littering civic engagement (Rosenthal and Yu, 2022).

However, it has been suggested that the concept should be expanded upon to reflect one's attachment to the natural environment of their community (Brehm et al., 2006, 2004), as people have been found to appreciate the natural environment of their community in similarly strong but different way from their social connections. Operationalizing the concepts through natural environment attachment (NEA) and social attachment (SA), NEA predicted attitudes towards environmental resource protection, while SA tended to affect attitudes towards local environment and/or health issues (Brehm et al., 2006; Pradhananga and Davenport, 2017). Furthermore, natural but not social community attachment predicted a variety of pro-environmental behaviours (e.g., garbage removal) when controlling for sociodemographic variables (Scannell and Gifford, 2010). Given that different dimensions of community attachment may potentially lead to different, if not opposite sentiments (e.g., choosing between community prosperity due to a new powerplant or preservation of the community's natural environment), it is important to distinguish between the two. However, to date few studies have addressed this issue (Brehm et al., 2006; Raymond et al., 2010; Scannell and Gifford, 2010; Vorkinn and Riese, 2001). Our objective therefore is to apply the two-dimensional concept of community attachment to a novel context and explore variations in association of waste management behaviours with social and natural community attachment.

2.4. Concern about impacts of plastic pollution

As well as being attached to the community, concern for the impacts

a socio-environmental issue can have can also impact people's decisions and behaviours. Environmental concern represents one's sentiment towards environmental issues (Fransson and Gärling, 1999) and personal readiness to participate in their resolution (Dunlap and Jones, 2002). It has been associated with sustainable consumption (Magnier and Schoormans, 2015; Mohd Suki, 2016; Yamaguchi and Takeuchi, 2016) and tourism (Miller et al., 2015). In waste management behaviours in the Global North environmental concern has been identified as one of the key drivers of plastic packaging waste avoidance, sorting and recycling (Aprile and Fiorillo, 2019; Fogt Jacobsen et al., 2022), as well as higher willingness to address plastic pollution more generally (Hartley et al., 2018; Muralidharan and Sheehan, 2016).

Crucially, however, environmental concern has been measured and operationalised in a variety of ways, with up to 26 different scales used in previous research (Cruz and Manata, 2020). While measuring general environmental concern is still a popular approach, similar to community attachment, there has been a simultaneous shift towards a more complex structure. Stern and Dietz (1994) suggest that environmental concern is based on altruistic, egoistic or biospheric values. Building on that, Schultz (2001) developed a scale measuring these dimensions as sets of valued objects, finding them to be associated with different values and constructs. For example, a connection to nature was found to be related to biospheric concern, but not other dimensions of concern (Schultz, 2001).

While some studies have explored the role of these values in waste management (Aprile and Fiorillo, 2019; Cecere et al., 2014; Chao et al., 2021), the three-dimensional measure of environmental concern (Schultz, 2001) has not been applied to the waste management context in the Global South. Concern about plastic pollution may exist for different motives (e.g., danger to community members, personal health, or animal wellbeing) (Schultz, 2000), leading to different waste management choices. This study uses this measure in a new context to examine how different types of concern about plastic pollution, particularly altruistic concern, may impact waste management behaviours.

2.5. Attached, concerned, or both?

Community attachment may motivate people to be tackle community issues if they recognize the issues and believe they affect something significant to them (Axelrod and Lehman, 1993). However, this requires an existing level of concern about the issues. Uzzell et al. (2002), found that community attachment alone may not encourage pro-environmental behaviours (Uzzell et al., 2002) without existing environmental concern. Local attachment has been connected to under-evaluation of local environmental issues, leading to lack of pro-environmental engagement (Bonaiuto et al., 1996; Fresque-Baxter and Armitage, 2012; Junot et al., 2018). This study argues that the roles of community attachment (human and nature-centred) and environmental concern in waste management behaviours should be examined both separately and together, to compare their contributions to behaviour choices.

3. Aims and rationale

In areas lacking formal waste management, understanding available options and factors guiding people's choices is crucial. In ensuring they are supported to make safer and more environmentally friendly waste management decisions. This paper uses quantitative survey to explore two research questions (RQ) in two case study sites of Indonesia (East Java and West Bali):

RQ1. What are the most commonly self-reported waste management behaviours?

RQ2. What is the association between community attachment (social and natural), environmental concern (biospheric, altruistic, and egoistic) and waste management behaviours?

The study aims to:

1. Describe waste management behaviours in Indonesia.
2. Explore and compare the roles of community attachment and environmental concern in waste management choices through hierarchical regression analysis.

By addressing these questions, the research contributes novel insights to existing knowledge by:

1. Examining community attachment and environmental concern in a new geographical context enhancing theoretical understanding of both concepts;
2. Adding to the limited literature on psychological antecedents of waste management behaviours in the Global South;
3. Providing insights for on-going and future contextually appropriate interventions to reduce plastic pollution in Indonesia.

4. Methods

4.1. Sample & procedure

The survey targeted household members in two case-study areas in Indonesia (East Java and West Bali) to encompass the heterogeneous demographics (e.g., the two main religions and great variation in socioeconomic status), and geographies (e.g., directly coastal and more inland villages), along with varying accessible waste management infrastructure (see Fig. 1). Specifically, data were collected from 41 villages (*desa*) across Bali and Java. In East Java, this included the two districts/*kecamatans* of Blimbingsari and Rogojampi in the Banyuwangi regency/*Kabupaten*, while in West Bali, the two districts/*kecamatans* of Jembrana and Mendoyo of Jembrana regency were included. These locations were chosen for their geographic proximity across the Bali strait, offering similar natural conditions, differing in religious and cultural background.

Respondents were selected based on two criteria: 1) being over 18 years old; 2) being responsible for household waste management. Due to the second criterion, women were targeted more, resulting in approximately 75 % of women and 25 % of men in the sample. To accommodate varying literacy levels, data collectors administered the questionnaire using paper surveys. The procedure, including providing study information and obtaining informed consent, took about 40 min for each participant. The study received ethical approval from the University of Plymouth and was permitted by the National Research and Innovation Agency of Indonesia (80/SIP/IV/FR/7/2022).

Data were collected from 506 individuals between November 2022 and January 2023. The sociodemographic characteristics of each district were similar, except for differences in religious affiliation (Table 1).

4.2. Measures

4.2.1. Dependent variable – waste management behaviours

Participants were asked to select the most typical way they disposed of nine specific plastic items: plastic bags, bottles, pots, Styrofoam containers, sachets, diapers, sanitary napkins, cups, and straws, from a list of ten disposal methods (see Supplementary Materials). This approach ensured consistent interpretation, as asking about “waste” in general could lead to varied understandings. The selection of specific items was based on their prevalence in plastic waste and litter as highlighted in previous research and parallel data collection by the project team (Cordova et al., 2022).

The chosen disposal method for each item was then aggregated into counts ranging from 0 (none of the items handled this way,) to 9 (all items handled this way) for each respondent. These aggregated variables served as dependent variables in the regression analysis. Independent and control variables are listed in Table 2.

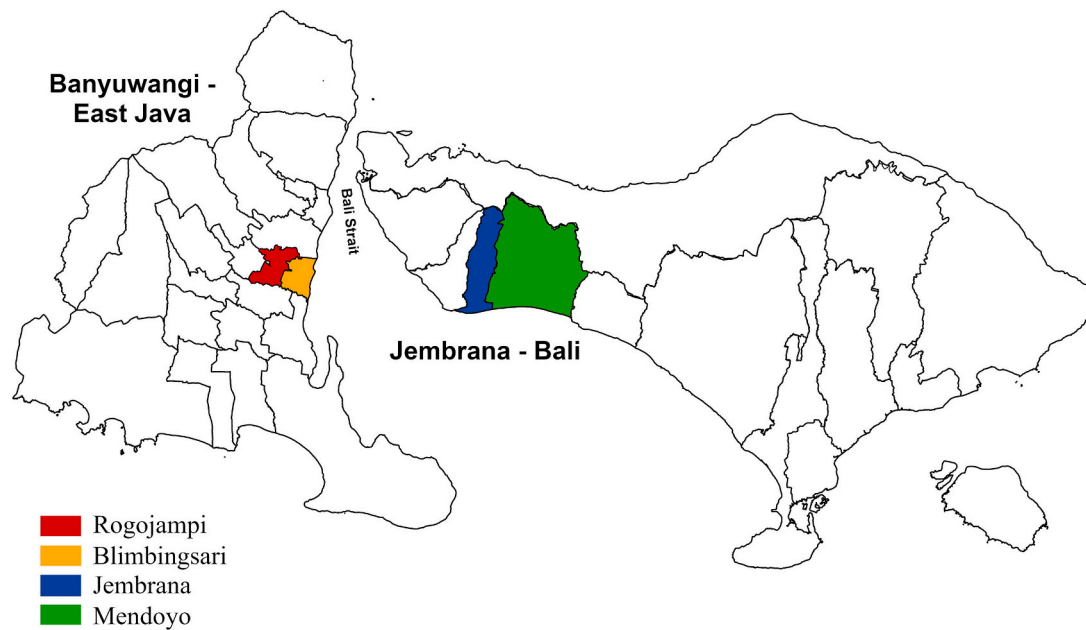


Fig. 1. Data collection map.

Table 1
Sociodemographic characteristics of the respondents in each kecamatan.

		Blimbingsari (Java)		Rogojampi (Java)		Jembrana (Bali)		Mendoyo (Bali)	
	Variable	N	%	N	%	N	%	N	%
Gender	Men	30	24 %	33	26.19 %	32	24.62 %	32	25.6 %
	Women	95	76 %	93	73.81 %	98	75.38 %	93	74.4 %
Age	[18,40)	29	23.2 %	27	21.43 %	23	17.69 %	38	30.4 %
	[40,50)	32	25.6 %	25	19.84 %	34	26.15 %	31	24.8 %
	[50,60)	38	30.4 %	46	36.51 %	46	35.38 %	29	23.2 %
	[60,90)	26	20.8 %	28	22.22 %	27	20.77 %	27	21.6 %
Religion	Muslim	120	97.56 %	117	95.12 %	28	21.54 %	17	13.6 %
	Hindu	2	1.63 %	1	0.81 %	98	75.38 %	101	80.8 %
	Other	1	0.81 %	5	4.07 %	4	3.08 %	7	5.6 %
Education	No education	7	5.6 %	1	0.82 %	4	3.12 %	6	4.88 %
	Elementary level	59	47.2 %	40	32.79 %	54	42.19 %	30	24.39 %
	High school level	48	38.4 %	68	55.74 %	66	51.56 %	68	55.28 %
	Beyond school	11	8.8 %	13	10.66 %	4	3.12 %	19	15.45 %
Income	≤1mln IDR	18	17.31 %	19	18.1 %	17	16.67 %	11	11.34 %
	1-3mln IDR	64	61.54 %	66	62.86 %	65	63.73 %	59	60.82 %
	>3mln IDR	22	21.15 %	20	19.05 %	20	19.61 %	27	27.84 %

4.3. Statistical analyses

To address the first RQ, the frequencies of specific waste management behaviours were analysed. Comparisons between locations and sociodemographic groups were conducted using Mann-Whitney U and Kruskal-Wallis tests, with details provided in the supplementary materials. Multiple hierarchical regression was applied to each of the most commonly reported waste management behaviours identified. Given that the outcome variables were counts, Poisson regression was initially chosen. However, due to a significant number of zeros and overdispersion in the data, zero-inflated (ZI) negative binomial Poisson regression models were employed. These models incorporate a binary logit model predicting zero outcomes (e.g., no burning), and a truncated Poisson regression predicting positive counts (e.g., the usage of waste collection service for more/fewer plastic items) (Feng, 2021).

For each behaviour, the regression model was run without (unadjusted model) and with (adjusted) sociodemographic controls. This approach allowed examination of the direct associations between psychological constructs and waste management behaviours and the effects of sociodemographic factors such as gender and income on these

associations. Reference categories for controls were chosen based on normative groups for education and income (elementary-level education, 1-3million IDR income), the youngest age group (18–40), and kecamatan Blimbingsari, which showed the most behavioural differences compared to other kecamatans.

For ease of interpretation (Blasko et al., 2015; Maisto et al., 2017), results from the ZI part of the models are presented as associations between predictors and outcomes, such as “a higher/lower likelihood of [behaviour]”, to avoid confusing double or triple negatives.

5. Results

5.1.1. How do people manage their waste? (RQ1)

The analysis revealed no single behaviour universally employed for managing all types of waste, indicating diverse waste management practices (see Supplementary Materials for context and more details). The most common behaviours included burning, river dumping,

Table 2
Independent and control variables.

Variable	Description	Reliability
Community attachment: social (SA) and natural environment (NEA) attachment (Brehm et al., 2006)	A Likert-type scale of 1 (not important) to 5 (very important) depending on how important seven items were to participants' attachment to their community. Two subscales averaged to obtain scores for SA and NEA	CFA: SRMR = 0.076, CFI = 0.862, AIC = 7454.909 $\alpha = 0.71$ for SA $\alpha = 0.84$ for NEA
Environmental concern (Schultz, 2001): altruistic (AC), biospheric (BC) and egoistic (EC) concern.	A Likert-type scale of 1 (not important) to 5 (very important) depending on how important ten items were for the level of participants' concern about plastic pollution. Three subscales were averaged to obtain scores for AC (4 items), BC (4 items), and EC (2 items)	Initial CFA: SRMR = 0.102, CFI = 0.799, AIC = 11,652.499 (unsatisfactory). Removed two items from the AC (Cruz and Manata, 2020) due to fit issues. Final CFA: SRMR = 0.050, CFI = 0.937, AIC = 9309.314. $\alpha = 0.88$ for AC $\alpha = 0.80$ for BC $\alpha = 0.86$ for EC
Control variables	Gender, age, household income, level of education, geographical location (kecamatan)	Not applicable

informal dumpsite usage, selling to traders, selling to a waste bank, and using waste collection services. Fig. 2 illustrates the proportion of plastic items managed through each behaviour overall and by control variable categories. Less common behaviours, which received few or no positive responses, were aggregated into an “other” category. These included taking waste to TPA/communal bins, ocean dumping, littering,¹ and burying).

5.1.2. The associations of social attachment and natural environment attachment and environmental concern with waste management behaviours (RQ2)

For further analysis, the three most frequent waste management behaviours were selected as outcome variables: burning, using an informal dumpsite, and using a waste collection service. Selling was excluded due to its limitation to specific sellable items (bottles, cups and trays, see Supplementary Materials). No evidence of multicollinearity between predictors was found, confirmed by the Variance Inflation Factor tests (see the correlation table and the descriptive data for all predictor variables in Supplementary Materials). The only correlation above 0.50 level was found between burning and using a waste collection service (-0.56^{***}).

Table 3 displays the Akaike Information Criterion (AIC) values for different behaviours to evaluate and compare the models (Aswi et al., 2022). AIC considers both the maximum likelihood estimate and the number of included predictors, penalising increased number of predictors to avoid overfitting. The table shows that environmental concern has a significantly lower AIC compared to community attachment thus seen to contribute significantly more at explaining the variance in behavioural outcomes. Comparing models, the full model, which includes both environmental concern and community attachment, has a significantly greater reduction in AIC than the separate models,

demonstrating its greater explanatory power (see Supplementary materials).

5.1.3. Community attachment (Table 4)

Different patterns emerged for the two aspects of the community attachment.

Respondents with higher NEA burned and used informal dumpsites with fewer plastic items. NEA was not a significant predictor in the ZI model.

SA was not a significant predictor for burning or dumpsite use in unadjusted models. In the ZI model, higher SA decreased the likelihood of burning and increased the likelihood of use of waste collection services. With control variables, the link between SA and waste collection use became non-significant.

5.1.4. Environmental concern (Table 5)

In the unadjusted models, the respondents with higher EC tended to submit fewer items to the waste collection service, but neither altruistic (AC) nor biospheric concern (BC) significantly predicted the extent of waste management behaviours.

In the ZI portion of the model, respondents with higher AC were more likely to engage in burning. Respondents with higher biospheric concern (BC), in contrast, avoided burning and using informal dumpsites, and had a higher likelihood of using a waste collection service. Respondents with higher egoistic concern (EC) were also more likely to use a waste collection service but also the informal dumpsites too.

With control variables, only BC's avoidance of informal dumpsites and EC's use of informal dumpsites in the ZI model remained significant.

5.1.5. Combined: community attachment and environmental concern (Table 6)

Finally, we entered both community attachment and environmental concern together as predictors (in order to test their relative contributions).

NEA continued to be associated with fewer plastic items burned or dumped. SA continued to be associated with increased waste collection use, but its negative relationship with burning became non-significant.

BC remained the most consistent predictor associated with decrease in the likelihood of burning and informal dumpsite use, and increase in the likelihood of waste collection use. AC was associated with a higher likelihood of burning; EC was associated with a higher likelihood of use of both waste collection and informal dumpsites.

Control Variables led to most associations with environmental concern becoming insignificant except for informal dumpsite use, which remained significant for BC (avoidance) and EC (use).

5.1.6. Sociodemographic controls

Kecamatans: Respondents in Jembrana, Mendoyo, and Rogojambi were more likely to avoid burning and use waste collection services than those in Blimbingsari. Jembrana residents also avoided informal dumpsites more.

Education Level: Higher education was linked to lower informal dumpsite use and higher waste collection service use. High school education specifically was associated lower likelihood of burning.

Gender: Women were more likely to use informal dumpsites in the community attachment model.

6. Discussion

Predictors of diverse waste management behaviours, especially the psychological antecedents, remain underexplored in the Global South. Using a household survey in four kecamatans in Indonesia, this study is the first to systematically quantify and examine the role of community attachment (natural and social dimensions) and environmental concern on waste management behaviours. We review these behaviours, associated factors, and the importance of contextual and psychological

¹ Note that littering was a different behaviour from using informal dumpsites, as littering covered disposing of the plastic items by leaving them at unspecified/random parts of the community roads/riverbanks/etc., while using informal dumpsites, however similar in effect, involved taking the waste items to a communally designated and agreed space for waste disposal.

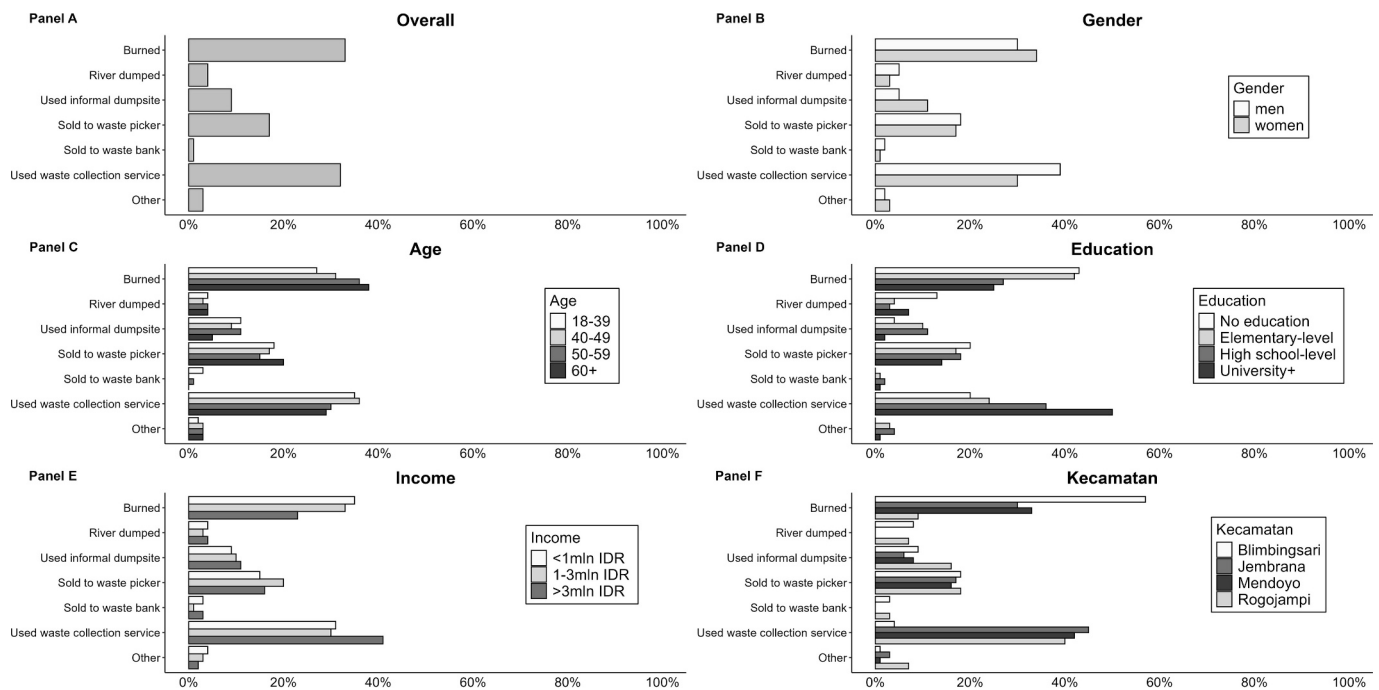


Fig. 2. Proportion of plastic items treated through the six most reported waste management behaviours.

Table 3

AIC values for each stage of the hierarchical model.

	Open burn	Open burn (adj)	Inf. dumpsite	Inf. dumpsite (adj)	Service	Service (adj)
Community attachment (SA + NEA)	1590.12	1161.13	711.76	594.63	1448.78	1118.50
Environmental concern (AC + BC + EC)	1336.54	982.18	646.70	551.51	1146.52	918.48
Community attachment + environmental concern (SA + NEA + AC + BC + EC)	1306.02	967.53	614.85	534.38	1114.39	899.05

determinants.

6.1. How people manage their waste: overview

We identified six key waste management practices: burning, river dumping, informal dumpsite usage, selling to a trader, selling to a waste bank, and using waste collection service. Phelan et al. (2020) found that nearly half of their respondents preferred burning, with none using waste collection services or waste banks. In contrast, in our study burning and waste collection service are reported equally (~35 % each), with minimal ocean dumping compared to Phelan et al.'s 25 %. Phelan et al. focused on remote islands in South and Southeastern Sulawesi, while our data was collected in significantly more well-connected areas of Java and Bali. At the same time, the extent of burning in our case was higher than reported in Semarang, which is the capital of Central Java (Sekito et al., 2013). Thus, while the range of described behaviours in our study was similar to the previous research, their extent was different, demonstrating the importance of context.

Our study is also the first to highlight the interdependencies between the behaviours. In areas with higher burning, waste collection service use was notably lower and vice versa. This suggests that burning and using waste collection services may be substitutes for one another. Informal dumpsite usage or other behaviours, however, did not show such connections. Overall, it is likely that the plastic items that are taken to an informal dumpsite, for example, are not the same items that are usually burned/taken by a waste collection service (see Supplementary Materials). Thus, implementing a waste collection service may not eliminate all potentially harmful behaviours like dumping.

Regarding sociodemographics, age and income showed no

associations with waste management behaviours, contrary to some studies (Dhokhikah et al., 2015; Pandey et al., 2018). However, higher education correlated negatively with burning and positively with using waste collection services (similar to Santos et al., 2005). The starkest differences by far were observed between different kecamatan: respondents in Blimbingsari burned waste more and used waste collection services less, while respondents in Rogojampi had lower burning rates. This variation may stem from differing infrastructure and local legislation, with Blimbingsari lacking a formal waste management system and Rogojampi's proximity to an airport prohibiting burning. While we know that infrastructure and legislation on their own are not sufficient for lasting behaviour change (Dikgang and Visser, 2012; Jakovcevic et al., 2014; Ritch et al., 2009), they are still important to provide people with behavioural options and support new norms (Rivers et al., 2017).

6.2. The role of psychological factors

Our study explored how community attachment and environmental concern influence these behaviours. Our conclusions support previous research (Bonaiuto et al., 1996; Fresque-Baxter and Armitage, 2012; Junot et al., 2018; Uzzell et al., 2002) that while community attachment alone may not drive pro-environmental actions, concern for environmental issues is a stronger motivator. Although community attachment played a role, environmental concern had a greater impact on explaining behaviours overall. However, the nuanced understanding of behavioural antecedents emerged from distinguishing between social and natural facets of these constructs.

Table 4

Community attachment predicting waste management behaviours (open burning, using informal dumpsite, using waste collection service). Statistically significant predictors are in boldface. CE = Count estimate. OR = Odds ratio. SE = Standard error.

	Open burn	Open burn (adj)	Inf. dumpsite	Inf. dumpsite (adj)	Service	Service (adj)
The extent of each performed behaviour	CE (SE)	CE (SE)	CE (SE)	CE (SE)	CE (SE)	CE (SE)
SA	0.04 (0.05)	−0.03 (0.07)	−0.06 (0.10)	−0.13 (0.15)	−0.03 (0.05)	0.01 (0.08)
NEA	−0.10 (0.03)**	−0.09 (0.04)*	−0.26 (0.07)***	−0.24 (0.10)*	−0.05 (0.04)	−0.08 (0.05)
Gender(woman)		0.04 (0.09)		−0.17 (0.19)		0.04 (0.07)
Age 40–49		0.12 (0.11)		0.03 (0.18)		−0.03 (0.09)
Age 50–59		0.12 (0.11)		0.08 (0.17)		−0.02 (0.09)
Age 60+		0.12 (0.12)		0.18 (0.26)		−0.05 (0.10)
No education		−0.06 (0.14)		−0.21 (0.48)		0.23 (0.35)
High-school level		−0.05 (0.09)		0.01 (0.15)		−0.01 (0.08)
Beyond school		−0.13 (0.14)		0.34 (0.46)		0.16 (0.11)
Income<1mln IDR		0.07 (0.09)		−0.01 (0.23)		0.10 (0.09)
Income>3mln IDR		0.07 (0.10)		0.15 (0.18)		0.14 (0.08)
Kec Jembrana		0.09 (0.09)		0.59 (0.24)*		0.47 (0.19)*
Kec Mendoyo		0.16 (0.09)		0.21 (0.21)		0.42 (0.18)*
Kec Rogojampi		−0.25 (0.14)		0.26 (0.19)		0.45 (0.18)*

Likelihood of not performing the behaviour	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)
	Open burn	Open burn (adj)	Inf. dumpsite	Inf. dumpsite (adj)	Service	Service (adj)
SA	0.47 (0.18)**	0.55 (0.26)*	0.08 (0.26)	−0.36 (0.34)	−0.61 (0.19)**	−0.29 (0.26)
NEA	−0.14 (0.12)	−0.11 (0.16)	−0.30 (0.17)	−0.20 (0.20)	−0.12 (0.12)	−0.26 (0.16)
Gender(woman)		−0.17 (0.28)		−1.02 (0.43)*		0.19 (0.28)
Age 40–49		0.09 (0.36)		0.58 (0.42)		−0.20 (0.35)
Age 50–59		−0.50 (0.35)		0.19 (0.40)		0.09 (0.34)
Age 60+		−0.30 (0.39)		1.01 (0.53)		0.26 (0.38)
No education		−0.75 (0.78)		−0.00 (0.86)		1.90 (1.12)
High-school level		0.56 (0.29)		0.02 (0.36)		−0.29 (0.29)
Beyond school		0.30 (0.45)		2.47 (1.08)*		−1.18 (0.45)**
Income<1mln IDR		0.15 (0.35)		0.53 (0.47)		−0.20 (0.34)
Income>3mln IDR		0.43 (0.33)		−0.22 (0.40)		0.05 (0.32)
Kec Jembrana		1.69 (0.35)***		1.35 (0.50)**		−2.64 (0.45)***
Kec Mendoyo		1.28 (0.35)***		0.57 (0.45)		−2.40 (0.45)***
Kec Rogojampi		3.05 (0.40)***		−0.17 (0.40)		−2.03 (0.45)***
AIC	1590.12	1161.13	711.76	594.63	1448.78	1118.50
Log Likelihood	−788.06	−549.57	−348.88	−266.32	−717.39	−528.25
Num. obs.	487	385	487	385	487	385

SA = Social attachment; NEA = Natural environment attachment.

Reference categories = men (gender), 18–39 (age), elementary-level (education), 1–3mln IDR (income), Blimbingsari (kecamatan).

*** $p < 0.001$.

** $p < 0.01$.

* $p < 0.05$.

6.2.1. Social facet

In our analysis social attachment (SA) was associated with a lower likelihood of burning waste, whereas concern about plastic pollution's impact on others (AC) higher odds of burning. This paradox suggests that while social attachment may reduce burning to avoid irritating neighbours, concern about the broader impacts of waste might lead individuals to burn plastic as a means of controlling waste and minimising the negative impacts on one's community members in the absence of better options (Pathak et al., 2023). This reflects how concern, typically linked to pro-environmental behaviours, can sometimes result in choices with harmful impacts instead, in this case contributing to air pollution and the spread of microplastics (Pathak et al., 2023). The influence of social attachment on burning became insignificant when both factors were considered together, highlighting the stronger role of environmental concern.

6.2.2. Natural facet

The natural facets of both community attachment and environmental concern showed similar patterns, being associated with lower levels of environmentally harmful behaviours like burning and using informal dumpsites. This aligns with literature from the Global North, where biospheric values are strongly tied to pro-environmental behaviours and concerns (Helm et al., 2018; Schultz, 2000; Steg, 2016). However, the impact of biospheric concern diminished for burning and waste

collection service use (but not for dumpsite usage) when controlling for kecamatans and other sociodemographics. This suggests that local context (likely the infrastructure availability) for some behaviours plays a crucial role in whether individuals can act on their environmental concerns, however high they may be (Bunyan et al., 2016; Helm et al., 2018).

6.2.3. Egoistic concern

Egoistic concern about plastic pollution did not fit neatly into the social/natural distinction, but played an interesting role in waste management behaviours. Unadjusted models showed that egoistic concern was linked to increased use of waste collection services, suggesting that self-interest can sometimes drive pro-environmental actions (De Dominicis et al., 2017). However, it also correlated with higher use of informal dumpsites, as these sites are often located away from residential areas, offering a way to dispose of waste without immediate environmental impact. This indicates that egoistic concern does not always lead to pro-environmental behaviours and can result in less ecological practices (e.g., informal dumping). Overall, our study highlights that both social and natural psychological factors influence waste management behaviours, with the context and availability of infrastructure significantly shaping these effects.

Table 5

Environmental concern predicting waste management behaviours (open burning, using informal dumpsite, using waste collection service). Statistically significant predictors are in boldface. CE = Count estimate. OR = Odds ratio. SE = Standard error.

	Open burn	Open burn (adj)	Inf. dumpsite	Inf. dumpsite (adj)	Service	Service (adj)
The extent of each performed behaviour	CE (SE)	CE (SE)	CE (SE)	CE (SE)	CE (SE)	CE (SE)
AC	0.00 (0.04)	0.01 (0.04)	−0.07 (0.08)	−0.11 (0.10)	0.07 (0.05)	0.07 (0.06)
BC	−0.02 (0.05)	−0.02 (0.07)	0.02 (0.14)	0.07 (0.14)	0.06 (0.06)	0.06 (0.08)
EC	−0.06 (0.05)	−0.09 (0.07)	−0.01 (0.12)	0.07 (0.14)	−0.12 (0.05)*	−0.11 (0.06)
Gender(woman)		0.05 (0.09)		−0.19 (0.18)		0.03 (0.08)
Age 40–49		0.16 (0.12)		−0.05 (0.20)		−0.01 (0.10)
Age 50–59		0.13 (0.12)		0.15 (0.18)		−0.06 (0.11)
Age 60+		0.14 (0.14)		−0.06 (0.30)		−0.08 (0.12)
No education		−0.13 (0.14)		−0.27 (0.48)		0.15 (0.37)
High-school level		−0.11 (0.09)		−0.14 (0.16)		−0.00 (0.10)
Beyond school		−0.17 (0.15)		−0.10 (0.47)		0.13 (0.13)
Income<1mln IDR		0.09 (0.10)		0.11 (0.24)		0.14 (0.11)
Income>3mln IDR		0.09 (0.11)		0.50 (0.17)**		0.08 (0.09)
Kec Jembrana		0.08 (0.09)		0.34 (0.25)		0.50 (0.20)*
Kec Mendoyo		0.12 (0.09)		0.11 (0.20)		0.47 (0.20)*
Kec Rogojampi		−0.33 (0.16)*		0.28 (0.19)		0.44 (0.21)*

Likelihood of not performing the behaviour	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)
	Open burn	Open burn (adj)	Inf. dumpsite	Inf. dumpsite (adj)	Service	Service (adj)
AC	−0.42 (0.15)**	−0.34 (0.19)	0.15 (0.18)	0.24 (0.22)	0.25 (0.15)	0.12 (0.19)
BC	0.46 (0.20)*	0.40 (0.27)	0.91 (0.27)***	0.71 (0.33)*	−0.57 (0.20)**	−0.43 (0.28)
EC	0.23 (0.18)	0.29 (0.25)	−0.73 (0.24)**	−0.95 (0.30)**	−0.43 (0.19)*	−0.31 (0.24)
Gender(woman)		−0.24 (0.31)		−0.73 (0.45)		0.13 (0.32)
Age 40–49		−0.03 (0.39)		0.47 (0.45)		−0.05 (0.38)
Age 50–59		−0.43 (0.39)		0.08 (0.43)		0.20 (0.38)
Age 60+		0.20 (0.45)		1.03 (0.62)		0.05 (0.44)
No education		−0.38 (0.76)		0.04 (0.85)		1.46 (1.14)
High-school level		0.84 (0.32)*		0.01 (0.39)		−0.74 (0.33)*
Beyond school		0.40 (0.50)		2.32 (1.09)*		−1.47 (0.49)**
Income<1mln IDR		0.11 (0.39)		0.54 (0.51)		−0.40 (0.40)
Income>3mln IDR		0.50 (0.37)		−0.02 (0.44)		0.05 (0.36)
Kec Jembrana		1.76 (0.38)***		0.91 (0.51)		−2.86 (0.50)***
Kec Mendoyo		1.27 (0.37)***		0.32 (0.47)		−2.23 (0.48)***
Kec Rogojampi		2.90 (0.43)***		−0.20 (0.44)		−1.70 (0.49)***
AIC	1336.54	982.18	646.70	551.51	1146.52	918.48
Log Likelihood	−659.27	−458.09	−314.35	−242.75	−564.26	−426.24
Num. obs.	397	318	397	318	397	318

AC = Altruistic concern; BC = Biospheric concern; EC = Egoistic concern.

Reference categories = men (gender), 18–39 (age), elementary-level (education), 1–3mln IDR (income), Blimbingsari (kecamatan).

*** p < 0.001.

** p < 0.01.

* p < 0.05.

6.3. Implications for policy and practice

Overall, this study demonstrates the need for a) attention to a variety of waste management behaviours; b) a balanced approach in terms of infrastructural/psychological interventions.

First, we show that to improve waste management one would need to break waste management down to specific behaviours, which vary greatly in our Indonesian sample. All of these behaviours will have a variety of environmental and human wellbeing impacts. Burning plastic, for example, may keep the natural environment relatively clean from litter, but will have a worrisome effect on human health and contributes to air pollution locally and globally (Wu et al., 2021). Using dumpsites removes the plastic waste items from the community members' immediate vicinity, but has a strongly negative impact on the natural environment and subsequently human health through water and air pollution and release of carcinogenic substances (Siddiqua et al., 2022). It is therefore important to prioritise and choose what behaviours need targeting. As we found that some behaviours are dependent on others, it is also vital when focusing on specific behaviours to also consider the (desired and also unwanted) impacts on other behaviours.

Secondly, in terms of targeting behaviours, both infrastructural and psychological approaches are evidently important. Infrastructure

provides people with a choice of options. However, people need to be motivated to uptake structured waste management options. In our study we could see a clear juxtaposition between burning and waste collection service usage in Java kecamatans, but a roughly equal usage of both in Bali. This means that the presence of waste collection service on its own may not be enough to motivate a behaviour change. Furthermore, as controlling for kecamatans (and other sociodemographic variables) played no role in the use of dumpsites, it may mean that the presence of infrastructure may not have the desired effect on the reduction in dumping of plastic waste items. One would also need to directly address psychological factors. In our study, natural attachment and biospheric concern were consistently associated with pro-environmental waste management choices. Thus, in addition to making people's access to infrastructure more equal and equitable, it could be important to raise people's connection to the natural environment and their concern about the impact of plastic pollution on the natural environment, perhaps by increasing the subjective value and enjoyment of the natural environment (Schultz, 2000; Steg, 2016).

Finally, in designing the intervention, it is important to be careful with appealing to social and individual benefits. Our study has shown that those may have unintended consequences, such as increase in dumping due to concern about one's own wellbeing. Successful

Table 6

Community attachment and environmental concern predicting waste management behaviours (open burning, using informal dumpsite, using waste collection service). Statistically significant predictors are in boldface. CE = Count estimate. OR = Odds ratio. SE = Standard error.

	Open burn	Open burn (adj)	Inf. dumpsite	Inf. dumpsite (adj)	Service	Service (adj)
The extent of each performed behaviour	CE (SE)	CE (SE)	CE (SE)	CE (SE)	CE (SE)	CE (SE)
SA	0.03 (0.06)	−0.07 (0.08)	−0.05 (0.12)	−0.10 (0.19)	−0.03 (0.07)	−0.02 (0.09)
NEA	−0.10 (0.04)**	−0.08 (0.05)	−0.29 (0.07)***	−0.28 (0.11)**	−0.04 (0.04)	−0.07 (0.05)
AC	0.00 (0.04)	0.03 (0.05)	−0.06 (0.07)	−0.08 (0.10)	0.08 (0.05)	0.09 (0.06)
BC	−0.00 (0.05)	−0.01 (0.07)	0.19 (0.13)	0.20 (0.16)	0.07 (0.06)	0.05 (0.08)
EC	−0.02 (0.06)	−0.04 (0.07)	0.02 (0.11)	0.09 (0.17)	−0.09 (0.06)	−0.07 (0.07)
Gender(woman)		0.08 (0.10)		−0.14 (0.20)		0.05 (0.09)
Age 40–49		0.15 (0.12)		0.00 (0.22)		−0.01 (0.10)
Age 50–59		0.13 (0.12)		0.12 (0.18)		−0.03 (0.11)
Age 60+		0.20 (0.14)		0.14 (0.34)		−0.02 (0.12)
No education		−0.06 (0.15)		−0.04 (0.49)		0.21 (0.38)
High-school level		−0.03 (0.10)		0.05 (0.17)		−0.01 (0.10)
Beyond school		−0.11 (0.15)		0.19 (0.49)		0.18 (0.13)
Income<1mln IDR		0.09 (0.10)		−0.01 (0.26)		0.16 (0.11)
Income>3mln IDR		0.08 (0.11)		0.18 (0.20)		0.10 (0.10)
Kec Jembrana		0.11 (0.10)		0.54 (0.29)		0.55 (0.21)**
Kec Mendoyo		0.18 (0.10)		0.13 (0.22)		0.48 (0.20)*
Kec Rogojampi		−0.34 (0.17)*		0.24 (0.20)		0.44 (0.21)*

Likelihood of not performing the behaviour	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)	OR (SE)
	Open burn	Open burn (adj)	Inf. dumpsite	Inf. dumpsite (adj)	Service	Service (adj)
SA	0.35 (0.21)	0.37 (0.30)	−0.04 (0.30)	−0.33 (0.38)	−0.69 (0.23)**	−0.46 (0.32)
NEA	−0.07 (0.13)	−0.12 (0.19)	−0.27 (0.20)	−0.18 (0.24)	−0.00 (0.14)	−0.04 (0.18)
AC	−0.43 (0.15)**	−0.33 (0.19)	0.18 (0.19)	0.29 (0.22)	0.26 (0.16)	0.14 (0.20)
BC	0.47 (0.20)*	0.39 (0.27)	1.00 (0.29)***	0.74 (0.34)*	−0.59 (0.21)**	−0.49 (0.28)
EC	0.16 (0.19)	0.27 (0.26)	−0.66 (0.26)*	−0.91 (0.32)**	−0.23 (0.20)	−0.23 (0.25)
Gender(woman)		−0.24 (0.32)		−0.65 (0.46)		0.18 (0.33)
Age 40–49		0.10 (0.40)		0.53 (0.47)		−0.25 (0.39)
Age 50–59		−0.41 (0.39)		0.13 (0.44)		0.08 (0.38)
Age 60+		0.25 (0.46)		1.14 (0.63)		0.04 (0.45)
No education		−0.48 (0.79)		0.23 (0.87)		1.78 (1.15)
High-school level		0.88 (0.33)**		0.04 (0.41)		−0.59 (0.34)
Beyond school		0.43 (0.51)		2.46 (1.10)*		−1.32 (0.50)**
Income<1mln IDR		0.11 (0.39)		0.50 (0.52)		−0.39 (0.40)
Income>3mln IDR		0.41 (0.38)		−0.12 (0.45)		0.17 (0.37)
Kec Jembrana		1.61 (0.40)***		1.18 (0.55)*		−2.64 (0.51)***
Kec Mendoyo		1.07 (0.39)**		0.43 (0.50)		−2.01 (0.50)***
Kec Rogojampi		2.91 (0.45)***		−0.19 (0.46)		−1.74 (0.50)***
AIC	1306.02	967.53	614.85	534.38	1114.39	899.05
Log Likelihood	−640.01	−446.77	−294.42	−230.19	−544.19	−412.52
Num. obs.	386	310	386	310	386	310

SA = Social attachment; NEA = Natural environment attachment; AC = Altruistic concern; BC = Biospheric concern; EC = Egoistic concern.

Reference categories = men (gender), 18–39 (age), elementary-level (education), 1–3mln IDR (income), Blimbingsari (kecamatan).

*** p < 0.001.

** p < 0.01.

* p < 0.05.

interventions require finely targeted materials which align with specific communities in terms of their consumption and use of diverse media and which take account of the heterogeneity of users. This includes factors such as age, gender, education and religious beliefs as well as more nuanced understandings of how specific tools are used in practice in everyday life. For example, the ownership of smart phones amongst low-income women living in coastal communities in East Java is high however these are frequently used to enhance educational opportunities of younger relatives or to conduct work related financial transactions. This may work against the use of phones as an ideal tool for messaging to bring about social change in relation to environmental behaviours and promoting the economic benefits of reduced open burning could be more salient (Henderson and Kulsum, in preparation). Overall, in our study, sociodemographic predictors of waste management behaviours may provide indications of which groups may need to be prioritised for targeting, while psychological predictors suggest intervention contents.

6.4. Limitations and implications for future research

Our study represents an important step towards the exploration of a wider range of waste management behaviours in the Global South through a contextual and psychological lens. We have demonstrated that the importance of a nuanced measuring of community attachment and environmental concern goes beyond the Global North context, by showing consistent distinctions between the role of social/personal and natural facets of both constructs. We have also contributed to advancing the understanding of the role of the two constructs in pro-environmental behaviours by connecting them to a previously unexplored range of waste management behaviours. In particular, we have examined the social/natural facets of community attachment and environmental concern and have demonstrated that those facets may have an impact on one's behaviour in their own right – meriting continuation of the exploration of this distinction.

However, we recognize a number of important limitations to be addressed in further research. First, our outcome behaviour variables displayed a much higher proportion of zero responses than expected.

Considering such proportion was particularly high for “undesirable” behaviours, such as river dumping, we hypothesise that the issue here might lie partially within social desirability: people being reluctant to report such behaviours, even when guaranteed anonymity. As a result, some behaviours could only be explored through correlational/group comparison analysis, and could not be included into a regression model. In future, it is important to improve on our behaviour measures to both attempt to collect more frank responses and to create more detailed models.

Further, as we are the first study to try to capture the antecedents of a wide range of waste management behaviours, our recording and exploration of such behaviours had to be quite broad. We captured a variety of important factors, but the next step could be, perhaps, to explore the behaviours separately or in thematically similar bundles. For example, we recorded some regional differences in the usage of waste traders and waste banks, which are an important part of the informal and semi-formal waste management systems in the Global South (Coletto and Bisschop, 2017). A separate targeted exploration of the predictors and behavioural patterns of selling plastic items to these actors would be crucial for any circular economy aspirations (Velis, 2017).

Furthermore, as we found that the behaviours are contextually dependent and whilst our findings are comparable to other countries, especially in the Global South, some findings are unique to Indonesia with its specific challenges and aspirations in waste management (Arisman and Fatimah, 2023). As noted above, our findings show the importance of examining specific behaviours in specific context to fully understand who is doing what and why. Community attachment in particular has been shown to have cultural antecedents (Dallago et al., 2009; Devadason, 2011). It is therefore important to replicate the conceptual framework of the study in other countries of the Global South that practice the wider range of waste management behaviours.

Finally, while it is not exactly a limitation in its own right, it is still important to stress the need to move on up the consumption chain from the end-of-pipe behaviours and decisions that contribute to plastic pollution. For example, single-use single-portion plastic sachets contribute greatly to the plastic pollution in Indonesia (GAIA, 2022) due to being unrecyclable and therefore of no value to be sold, and thus being either burned or discarded directly into the environment. It is therefore important to examine the reasoning behind the purchasing of such items, especially in terms of the contribution of people's concern about plastic pollution.

CRedit authorship contribution statement

Anastasia Voronkova: Writing – review & editing, Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Conceptualization. **Kayleigh Wyles:** Writing – review & editing, Supervision, Methodology, Investigation, Data curation, Conceptualization. **Nur Syamsiyah:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Sudarso:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization. **Eddy Soedjono:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization. **Lesley Henderson:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Wesley Schultz:** Writing – review & editing, Methodology, Conceptualization. **Susan Jobling:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization. **Sabine Pahl:** Writing – review & editing, Supervision, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.marpolbul.2025.117741>.

Data availability

Data will be made available on request.

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