Public awareness and behavioural drivers of electric waste disposal in urban Ghana

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Abstract. E-waste disposal practices in urban Ghana remain poorly characterised at the population level, particularly for households and small businesses. This study examines how public awareness and behavioural determinants shape formal e-waste disposal in Accra and Kumasi, drawing on a quantitative cross-sectional survey of 384 participants. Applying the Knowledge-Attitude-Practice (KAP) framework alongside the Theory of Planned Behaviour (TPB), binary logistic regression was used to identify independent predictors of formal disposal. Some 61.7% of respondents rated their own knowledge as low to moderate, and only 8.9% reported using formal disposal channels. Awareness of health risks was the strongest predictor of formal disposal (OR = 3.41; $p < 0.001$), followed by prior e-waste education (OR = 2.87) and perceived behavioural control (OR = 2.39). Proximity to a collection point was an independent structural predictor (OR = 2.10). As the first large-sample quantitative KAP assessment in this context, the study argues that expanding take-back infrastructure and introducing deposit-refund schemes are likely to shift behaviour more effectively than awareness campaigns alone.

1. Introduction

The global generation of electronic waste (e-waste) reached 62 million tonnes in 2022 and is expected to rise to 82 million tonnes by 2030, making it the fastest-growing solid waste stream worldwide [1]. Sub-Saharan Africa currently produces relatively little new e-waste itself, but has become an important destination for used and end-of-life electronics, with about 15% of informal e-waste flows ultimately reaching the region [2]. Ghana sits at a particularly acute intersection of this crisis. Agbogbloshie in Accra is one of the most contaminated e-waste processing sites in the world [3]. Thousands of workers, including children, recover metals through open burning, acid leaching and manual dismantling. The health and environmental consequences are severe and well-documented [4].

The legislative response to this, in the form of the Hazardous and Electronic Waste Control and Management Act (Act 917, 2016), has yet to translate into substantive change on the ground. Producer registration remains sparse, formal collection infrastructure is largely confined to Greater Accra, and enforcement is hampered by weak institutional capacity [5]. Against this backdrop, disposal behaviour at the household and business levels emerges as a critical yet largely underexplored determinant of waste-generation outcomes.

The Knowledge-Attitude-Practice (KAP) framework and the Theory of Planned Behaviour (TPB) offer complementary lenses for understanding disposal behaviour. KAP research emphasises that knowledge alone does not imply behavioural change without supportive structural conditions [6]. TPB adds the dimensions of subjective norms and perceived behavioural control, which capture the extent to which behavioural intention is influenced by perceived social expectations and perceived feasibility [7]. When used in together, these frameworks provide more information about e-waste disposal behaviour than either does individually.

There is a gap in empirical quantitative research in the field that uses the KAP and TPB models to examine e-waste disposal behaviour in Ghana's urban areas. Existing studies, however, are qualitative or geographically restricted, or focus on an informal sector rather than the general household and SME population. This research addresses this gap by analysing the relationship among public awareness, behavioural factors, and e-waste disposal behaviour among urban households and businesses in Accra and Kumasi.

The specific research objectives are to: assess e-waste knowledge levels amongst urban households and SMEs in Accra and Kumasi; document current disposal practices and predominant informal channels; examine the relationships between knowledge, attitude, subjective norms, perceived behavioural control, and formal disposal behaviour; and identify the behavioural and structural predictors of formal disposal through regression analysis. The study also seeks to determine the relative influence of these factors on individuals' willingness to participate in formal e-waste management systems.

2. Literature Review

2.1 E-waste as a global and regional challenge

E-waste is a broad range of electrical and electronic products, such as household appliances, mobile phones, computers, televisions, and lighting products, whose material composition is at once an economic asset and an environmental disaster [1]. The presence of recoverable concentrations of gold, silver, copper, and palladium is juxtaposed with toxic substances such as lead, mercury, cadmium, and brominated flame retardants. Improper management of these toxic substances contaminates soil, water, and air, with well-documented health consequences [8]. In low- and middle-income countries, where adequate processing infrastructure has yet to be developed, informal recycling is the predominant mode of recycling, extracting economic value at considerable environmental and health costs [9].

In Ghana, e-waste has risen with the surge in the adoption of mobile phones, computers, and TVs. The Ghana Statistical Service [10] reports that more than 98% of urban households have access to at least one mobile phone, 61% of urban households own a television and computer ownership by urban SMEs is reported to be more than 80%. Authors in [11] estimated that in the late 2000s, Ghana imported approximately 215,000 tonnes of used electrical and electronic equipment each year, a significant proportion of which was already non-functional upon arrival.

2.2 KAP framework applied to e-waste behaviour

KAP surveys have been widely applied in environmental health and waste management research to diagnose gaps between awareness and action. In e-waste contexts, KAP studies consistently show higher knowledge of the nature of e-waste and its hazards than of appropriate disposal mechanisms [12]. Attitudes toward formal disposal tend to be positive when respondents are aware of health risks, but these attitudes do not necessarily translate into formal disposal behaviour in the absence of infrastructure that reassures them [13].

KAP studies in West African settings are limited but instructive. [14] found that awareness of e-waste hazards and willingness to participate in take-back programmes were positively associated, but willingness declined significantly if the take-back location was more than 1 km away. In Nigeria, authors in [15] reported strong dedication to formal disposal alongside informal practices, mainly due to a lack of collection infrastructure and the need to sell devices to scrap dealers.

2.3 Theory of planned behaviour and waste disposal

According to the TPB, "behaviour is proximally determined by behavioural intention which is in turn determined by three determinants: attitude toward the behaviour, subjective norms (one's sense of pressure as perceived by relevant others) and perceived behavioural control (one's perceived ease, or difficulty, in undertaking the behaviour)" [7]. Applied to e-waste disposal, the TPB predicts that the level of formal disposal in a household will be high when the household has a positive attitude towards formal disposal, the social environment normalises responsible behaviour towards e-waste, and the take-back point is easy to access.

Empirical applications of the TPB in solid waste research consistently demonstrate that perceived behavioural control is the most powerful predictor of actual disposal behaviour, overriding attitude and subjective norms. This finding has policy implications: structural interventions such as expanding take-back infrastructure and reducing waste disposal costs are likely to produce greater behaviour change than awareness campaigns, which still play a key role in shifting attitudes and norms.

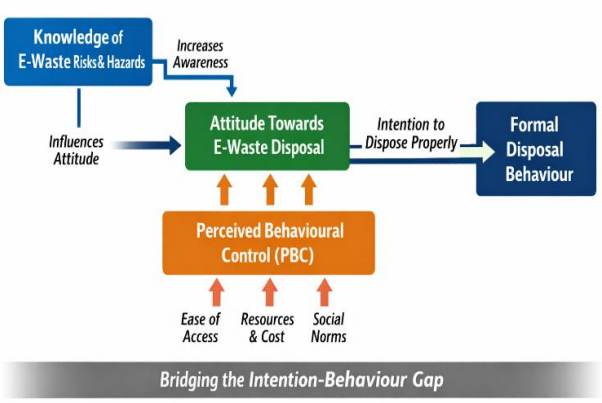

Fig. 1. Conceptual framework integrating the KAP framework and theory of planned behaviour to explain formal e-waste disposal behaviour

2.4 Ghana's regulatory and infrastructural context

Act 917 (2016) established Ghana's legislative framework for e-waste management, placing obligations on producers, importers, and distributors to register with the Environmental Protection Agency (EPA) Ghana, develop take-back systems, and contribute to a national e-waste fund. Eight years on, implementation remains incomplete. EPA Ghana identified persistent gaps: low producer registration rates, a non-functional national e-waste fund, and the concentration of the few existing formal collection points within Greater Accra. This infrastructure deficit directly constrains perceived behavioural control over formal disposal, even among motivated households, perpetuating informal disposal as the default practice.

3. Methodology

3.1 Research design and setting

A quantitative cross-sectional survey design was used. Cross-sectional designs are appropriate for KAP studies

that describe the distribution of knowledge, attitudes, and practices within a defined population at a specific point in time. The study was conducted in Accra and Kumasi, Ghana's two largest urban centres, which together account for approximately 38% of the country's urban population and the bulk of its formal and informal e-waste flows [10].

3.2 Sample size and sampling procedure

The minimum sample size was calculated using Cochran's formula for proportions. With Z = 1.96 for a 95% confidence level, p = 0.50 to assume maximum variance, and e = 0.05 for a 5% margin of error, the required minimum was 384 respondents. A 10% non-response allowance raised the target to 425. Of the 412 questionnaires returned, 384 were complete and usable, meeting the minimum sample size requirement exactly.

A stratified random sampling scheme was applied, using strata by location (Accra: 60%, Kumasi: 40%), type of respondent (households: 70%, SMEs: 30%), and gender (minimum 40% female). Within each stratum, persons were selected using systematic random sampling from residential neighbourhoods and business districts identified in the Ghana Statistical Service's census enumeration areas [10]. SMEs were selected from the Ghana Revenue Authority's Small Taxpayer Register.

3.3 Instrument design

A structured, self-administered questionnaire was created in five sections. Section A was used to record sociodemographic characteristics. Section B assessed e-waste knowledge based on a 10-item scale related to e-waste definition, hazardous substances, health risks, and disposal channels and was scored in binary correct/incorrect ways to give a total score (0 to 10). Section C consisted of attitude measures rated on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree) adapted from [12]. Section D took TPB constructs in terms of subjective norms (3 items), perceived behavioural control (4 items) and behavioural intention (3 items) into account. Section E documented existing disposal practices.

The questionnaire was tested with 30 respondents in the Tema Metropolitan Area. Cronbach's alpha coefficients were as follows: knowledge scale, 0.74; attitude scale, 0.81; subjective norms, 0.77; perceived behavioural control, 0.79; behavioural intention, 0.83; all values which are much higher than the threshold of 0.70 recommended for social science instruments. The instrument was translated into Twi for respondents who preferred it, and back-translation was done to ensure accuracy.

3.4 Data analysis

Statistics describing knowledge scores were grouped into three categories: low (0 to 3), moderate (4 to 6) and high (7 to 10). Pearson correlation coefficients were used to study bivariate associations. Binary logistic regression was used to identify the independent predictors of formal disposal behaviour (i.e., the use of a formal take-back point, an authorised recycler, or a manufacturer collection scheme for at least one item in the past 12 months). Predictor selection was based on bivariate significance ($p < 0.05$) and theoretical relevance. Analyses were performed using IBM SPSS Statistics version 26. Ethical clearance was obtained from the Director of Research, Innovation, Publication & Technology Transfer of Accra Technical University (Ethics ID: RE #188-2025-DRIPTT).

4. Results

4.1 Sociodemographic characteristics

Table 1 summarises the sociodemographic profile of the 384 participants. The majority (58.1% of the sample) were aged 25–44, consistent with the sample's urban, working-age composition. Female respondents were 44.3%. Educational attainment was comparatively high, with 63.0% of respondents having attained senior high school level or above. Households accounted for 70.3% of respondents, and SMEs for 29.7%. Monthly income was predominantly in the GHS 1,001-3,000 range (43.5%), consistent with urban lower-middle-income profiles in Ghana.

Table 1. Sociodemographic characteristics of respondents (N = 384).

Variable	Category	n	%
Age (years)	18-24	68	17.7
	25-34	114	29.7
	35-44	109	28.4
	45-54	62	16.1
	55+	31	8.1
Gender	Male	214	55.7
	Female	170	44.3
Education	No formal	18	4.7
	Primary	41	10.7
	JHS	84	21.9
	SHS	121	31.5
	Tertiary	120	31.3
Type	Household	270	70.3
	SME	114	29.7
Income (GHS)	<500	52	13.5
	501-1,000	88	22.9
	1,001-3,000	167	43.5
	>3,000	77	20.1
Location	Accra	230	59.9
	Kumasi	154	40.1

JHS = Junior High School; SHS = Senior High School; GHS = Ghanaian Cedi; n = Frequency; % = Percentage. Percentages may not total 100.0 due to rounding.

The sample was predominantly working-age, urban, and moderately educated, providing a representative basis for examining e-waste disposal behaviour across household and SME populations in Ghana's two largest cities.

4.2 E-waste knowledge levels

The mean score was 4.84 (SD = 2.11) out of 10, indicating that the majority had moderate knowledge. Knowledge was lowest regarding those that contained specific hazardous substances (correct response rate: 23.4%) and the locations of formal take-back points (19.8%). Knowledge was greatest for basic definitional items (81.5% correctly identified mobile phones and computers as e-waste) and for health-risk association (68.2%). A combined 61.7% scored in the low (31.3%) or moderate (30.4%) categories (Table 2). Knowledge deficits were widespread, with nearly two-thirds of respondents scoring in the low-to-moderate range. Awareness of formal disposal channels was particularly poor, suggesting that motivational knowledge outpaces instrumental knowledge in this population.

Table 2. Distribution of e-waste knowledge scores (N = 384).

Category	Range	n (%)	Mean	SD
Low	0-3	120 (31.3)	2.14	0.89
Moderate	4-6	117 (30.4)	5.02	0.74
High	7-10	147 (38.3)	8.31	0.96
Total	-	384 (100.0)	4.84	2.11

SD = Standard Deviation.

Knowledge varied significantly by education level ($F = 18.43$, $p < 0.001$), with tertiary-educated respondents having a mean of 6.92, compared with 2.81 among those with no formal education. SME respondents scored modestly higher than household respondents (5.21 vs. 4.67; $t = 2.89$, $p = 0.004$). No significant gender difference was observed ($t = 1.14$, $p = 0.255$).

4.3 E-waste disposal practices

Informal disposal dominated: 74.3% of respondents used informal channels, with sale to itinerant scrap dealers (37.8%) and dumping with general household waste (22.4%) the most common practices (Table 3). Only 8.9% reported using a formal take-back or authorised collection point. A notable 13.5% stored end-of-life devices at home indefinitely, likely due to uncertainty about disposal options. Most informal disposal, over 74%, involved selling to scrap dealers, highlighting the economic benefits of informal channels when formal options are unavailable.

Table 3. E-waste disposal practices for the most recently discarded item (N = 384).

Disposal method	n	%
Sold to an itinerant scrap dealer	145	37.8
Dumped with general waste	86	22.4
Stored indefinitely	52	13.5
Given/donated to another user	39	10.2
Formal take-back/authorised point	34	8.9
Returned to manufacturer/retailer	16	4.2
Dumped at an open/illegal site	12	3.1
Total	384	100.0

Each respondent reported the disposal method used for their most recently discarded electrical or electronic item.

4.4 Attitudes, subjective norms, and perceived behavioural control

Table 4 presents mean scores for TPB constructs. Attitudes toward formal disposal were generally positive (mean: 3.82/5.00). Subjective norms were weaker (mean: 2.94), reflecting limited social normalisation of formal e-waste disposal. Perceived behavioural control was the lowest-scoring construct (mean: 2.61), consistent with practical barriers to formal disposal, particularly the scarcity of accessible collection infrastructure. Behavioural intention toward formal disposal was moderate (mean: 3.21). Attitudes toward formal disposal were generally positive, yet perceived behavioural control scored lowest of all constructs. This gap between willingness and perceived feasibility is the primary explanation for the observed low rate of formal disposal.

Table 4. Descriptive statistics for TPB constructs (N = 384).

TPB Construct	Items	Mean	SD	Min	Max
Attitude toward formal disposal	5	3.82	0.74	1.20	5.00
Subjective norms	3	2.94	0.88	1.00	5.00
Perceived behavioural control	4	2.61	0.91	1.00	4.75
Behavioural intention	3	3.21	0.82	1.00	5.00

Note: All constructs were measured on a five-point Likert scale (1 = strongly disagree; 5 = strongly agree). SD = Standard Deviation.

4.5 Correlation analysis

Table 5 presents the Pearson correlation matrix. Knowledge score was positively and significantly correlated with attitude ($r = 0.481$, $p < 0.001$), perceived behavioural control ($r = 0.312$, $p < 0.001$), behavioural intention ($r = 0.394$, $p < 0.001$), and formal disposal behaviour ($r = 0.428$, $p < 0.001$). Attitude was the most significant correlate of behavioural intention ($r = 0.552$, $p < 0.001$). Perceived behavioural control had the

strongest direct correlation with formal disposal behaviour ($r = 0.511$, $p < 0.001$), consistent with TPB predictions. All key variables were significantly and positively correlated. Perceived behavioural control showed the strongest direct association with formal disposal behaviour, consistent with TPB predictions and confirming its central role in the analytical model.

Table 5. Pearson correlation matrix for key study variables (N = 384).

	KS	A	SN	PBC	BI	FDB
KS	1.000					
A	0.481**	1.000				
SN	0.263**	0.387**	1.000			
PBC	0.312**	0.441**	0.358**	1.000		
BI	0.394**	0.552**	0.419**	0.487**	1.000	
FDB	0.428**	0.463**	0.341**	0.511**	0.538**	1.000

*KS = Knowledge Score; A = Attitude; SN = Subjective Norms; PBC = Perceived Behavioural Control; BI = Behavioural Intention; FDB = Formal Disposal Behaviour. ** $p < 0.001$ (two-tailed).*

4.6 Binary logistic regression: predictors of formal disposal

The binary logistic regression results are shown in Table 6. The model was statistically significant ($\chi^2 = 124.37$, $df = 8$, $p < 0.001$) and explained 38.4% of the variance in formal disposal (Nagelkerke $R^2 = 0.384$) with an overall classification accuracy of 79.2%. Awareness of health risks emerged as the strongest predictor (OR = 3.41, 95% CI: 2.18–5.34; $p < 0.001$), indicating that respondents who were aware of health risks were more than three times as likely to use formal channels. Prior e-waste education (OR = 2.87; $p < 0.001$) and perceived behavioural control (OR = 2.39; $p < 0.001$) were similarly significant, consistent with TPB expectations. Proximity to a formal collection point emerged as an independent predictor (OR = 2.10; $p < 0.001$), confirming that physical access shapes disposal decisions beyond individual attitudes alone. Health risk awareness emerged as the strongest independent predictor of formal disposal, followed by prior e-waste education and perceived behavioural control. Proximity to a collection point was also significant, underscoring the independent role of physical infrastructure alongside behavioural factors.

Table 6. Binary logistic regression: predictors of formal e-waste disposal (N = 384).

Predictor	B	SE	Wald	OR	95% CI	P
Knowledge score	0.284	0.091	9.74	1.33	1.11-1.59	0.002
Health risk awareness	1.227	0.228	28.99	3.41	2.18-5.34	<0.001
Prior e-waste education	1.054	0.242	18.96	2.87	1.79-4.61	<0.001
Attitude score	0.613	0.184	11.10	1.85	1.29-2.65	0.001
Subjective norms	0.318	0.156	4.15	1.37	1.01-1.87	0.042
Perceived behavioural control	0.872	0.198	19.41	2.39	1.62-3.53	<0.001
Monthly income (>GHS 3,000)	0.491	0.221	4.94	1.63	1.06-2.52	0.026
Proximity to the collection point	0.741	0.189	15.34	2.10	1.45-3.04	<0.001

B = unstandardised regression coefficient; SE = standard error; OR = odds ratio; CI = confidence interval. Model chi-square = 124.37, df = 8, $p < 0.001$; Nagelkerke R2 = 0.384; Classification accuracy = 79.2%.

5. Discussions

5.1 Knowledge deficits and their consequences

The finding that 61.7% of respondents had low to moderate knowledge is consistent with KAP surveys in similar low- to middle-income urban settings. Reference [12] reported similar knowledge gaps regarding hazards in urban China, and [15] found similar results in Nigeria. The strong lack of awareness of the formal disposal channels (only 19.8% correctly identified that a formal take-back point (in their city) exists) is more than a lack of knowledge: it is a lack of infrastructure communication. Existing awareness campaigns in Ghana focus on the perils of improper disposal, thereby addressing the motivational component of behavioural intention while leaving aside the instrumental knowledge of where and how to act on this motivation. A complementary campaign strand delivered through mobile messaging, community radio, and point-of-sale communications with retailers would address this gap at low cost.

5.2 The dominance of informal disposal and the scrap dealer economy

The finding that 37.8% of respondents disposed of their most recent e-waste item by selling it to an itinerant scrap dealer reflects not uninformed behaviour but rational economic behaviour. Scrap dealers provide an instant return on investment, domiciliary collection, convenience, and zero transaction costs. Formal disposal is very difficult to manage, in the absence of analogous infrastructure and financial incentives: respondents will bear private costs to deliver public benefits that are largely diffuse. Extended Producer Responsibility (EPR) deposit-refund mechanisms are specifically designed to address this structural challenge by creating economic incentives for proper end-of-life management of electrical and electronic equipment [8].

Under a deposit-refund scheme, a recoverable deposit is incorporated into the product's purchase price and refunded when the item is returned through an authorised collection or recycling channel. By transforming formal disposal from a private cost into a private financial benefit, the scheme encourages consumer participation in formal recovery systems while simultaneously aligning individual economic interests with broader environmental and resource-conservation objectives [8].

5.3 TPB constructs: attitude leads, perceived behavioural control constrains

Attitude toward formal disposal was generally positive and significantly predicted behavioural intention, consistent with TPB. However, the gap between intention (mean: 3.21) and actual formal disposal (8.9% usage rate) is large, and is most directly explained by low perceived behavioural control scores (mean: 2.61). Respondents broadly wished to dispose of e-waste formally. However, they perceived significant practical barriers, a condition in which [7] identifies perceived behavioural control as the primary determinant of the intention-behaviour gap.

The finding that perceived behavioural control (OR = 2.39) was a stronger predictor of actual formal disposal than attitude (OR = 1.85) is consistent with meta-analytic evidence from solid waste behaviour research and confirms that structural interventions expanding take-back infrastructure, reducing transport barriers, and introducing deposit-refund incentives will generate larger behavioural returns than attitude-focused campaigns alone. This is not an argument against awareness campaigns: the strong predictive effects of health risk awareness (OR = 3.41) and prior e-waste education (OR = 2.87) demonstrate that awareness matters. The case, in short, is not against awareness campaigns but for pairing them with structural enablers.

5.4 SME versus household differences

SME respondents recorded modestly higher knowledge levels but no statistically significant difference in formal disposal rates compared with household respondents (10.5% vs. 8.2%; chi-square = 0.94, p = 0.332). This parity, despite superior knowledge, suggests that structural barriers, infrastructure inaccessibility and the absence of financial incentives constrain businesses and households alike. SMEs, which generate higher per-entity volumes of e-waste and are subject to regulatory obligations under Act 917, do not demonstrably outperform households in compliance with formal disposal requirements, indicating a regulatory enforcement gap.

5.5 Limitations and future research

Several limitations warrant acknowledgement. The cross-sectional design enables identification of associations but does not support causal inference. Self-reported disposal behaviour is susceptible to social desirability bias and may overestimate formal disposal rates. The study is limited to two cities, constraining generalisability to rural or peri-urban contexts. The KAP and TPB instruments, while piloted and validated for internal consistency, have not been externally validated against observed disposal behaviour in Ghana. Future research should adopt longitudinal designs, incorporate observational methods, expand the geographic scope to include rural settings, and conduct qualitative work with scrap dealers and informal-sector actors.

6. Conclusion and recommendation

This study provides the first large-sample quantitative KAP and TPB assessment of e-waste disposal behaviour among urban households and SMEs in Ghana. Knowledge deficits, particularly around formal disposal channels, are widespread. Informal disposal, dominated by sale to itinerant scrap dealers and general waste dumping, accounts for over 74% of reported behaviour. While attitudes toward formal disposal are generally positive and health risk awareness is a strong predictor of formal behaviour, perceived behavioural control is the binding constraint on translating positive intentions into formal disposal actions.

These findings support tiered policy recommendations. EPA Ghana and the Ministry of Environment, Science, Technology and Innovation should operationalise Act 917 through a functioning national e-waste fund and a formal producer contribution mechanism. The Ghana Health Service and public communication agencies should design awareness campaigns that pair health risk information with clear guidance on accessing formal collection points, delivered via mobile messaging and community radio. Electronics retailers and importers should be required, as a condition of import licensing, to communicate take-back obligations and collection point locations at the point of sale. A deposit-refund pilot scheme for high-volume devices, such as mobile phones and televisions, warrants systematic design and evaluation. The informal scrap dealer economy should be engaged as a collection intermediary rather than treated as an obstacle to formalisation.

The evidence indicates that informal e-waste disposal in urban Ghana is not primarily a product of individual irresponsibility or cultural resistance. It reflects structural deficits: inadequate collection infrastructure, weak financial incentives for formal disposal, and insufficient actionable information. Addressing these gaps within the existing but under-utilised framework of Act 917 offers a feasible, evidence-grounded path towards more sustainable e-waste management in Ghana’s rapidly growing urban economy.

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