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Behavioural Determinants of Beach Litter Management Practices among Beach Users along the Kenyan Coast

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Abstract — Beach-litter management involves taking measures to minimize waste accumulation along the coastal environments towards healthy marine ecosystem. It involves various strategies including anthropogenic waste prevention, monitoring, mitigation and removal. Installation and positioning of trash bins, and interactive signage is one of the basic mechanism that plays key role in eradication of beach litter. Beach-litter management also entails environmental awareness, targeted campaigns and other behavioural interventions to reduce the gap between beach users' actual behavioural characteristics and standard environmental values. However, evidence on specific paired behavioural relationships among Kenyan coastal beach users remains limited. This study examined four relationships between bin visibility versus bin use, disposal guidance versus litter-disposal behaviour, noticing litter versus concern about litter and frequency of beach visits versus litter-disposal behaviour. Cross-sectional questionnaire survey was conducted on selected beaches in Mombasa, Kilifi and Kwale involving 287 valid respondents. Responses were categorised, cross-tabulation and Pearson's chi-square was determined. Simulated p-values were undertaken where necessary with Cramer's V for association magnitude determined. There was statistical significance between the first three relationships, that is, bin visibility versus bin use, which had the largest observed association magnitude of 39.4%, disposal guidance versus litter-disposal behaviour and noticing litter versus concern about litter. The fourth relationship, frequency of beach visits versus litter-disposal behaviour was not statistically significant. This suggests that visiting beach many times does not necessarily influence change in beach user's behaviour towards littering.

Keywords— Beach litter, Beach users, behaviour, management.

I. INTRODUCTION

Disposal of garbage is one of the key causes of environmental sanitation damage along the coast. It affects marine life and harms mangrove tree development [1]. Measures need to be put in place to eradicate garbage menace. Concerted effort should be made to reduce the effect of marine ecosystem damage. Marine litter and plastic pollution are major environmental challenges since they have negative impacts to both economies and marine ecosystems [2]. Marine plastic pollution has an effect on ecosystem services. Substantial social and economic costs are generated by this pollution [3]. Beach ecosystem services are affected by beach wrack and litter [4]. After carrying out a study of six Kenyan beaches, it was found that identifiable products from the beach litter were locally sourced products [5]. This implied that locally generated litter has a strong impact on Kenyan beaches.

There are multiple existing beach litter management responses. Beach clean-up activities by volunteer groups is one of the basic initiatives [6]. Local authorities undertaking the process of organizing beach clean-up event becomes a key step in managing the litter [7]. Waste collection and disposal services especially in urban-coastal settlements is a method that help minimize effect of litter. However lack of such a plan increases the beach problem [8]. Modifying the number of trash bins and positioning them at strategic locations on beaches has capability of influencing waste collection [9]. Various Beach recycling methods and strategies have been studied [10] [11] [12]. Different approaches in recycling enhance ultimate goal of minimizing beach litter menace. Monitoring and surveys through use of Artificial Intelligence provide solutions for detection and classification of macrolitter [13]. Citizen science makes marine-litter collection process to be realized, with engagement of stakeholders becoming established [14]. Use of citizen science has the capability of changing perceptions and behavior towards marine litter [15]. In order to effectively prevent land-based marine plastics, proper enforcement of legal, institutional and waste management frameworks is required [16]. There are different Policies that have been formulated as part of beach litter management process [17]. From the above study, different management methods have been highlighted with the aim of providing solution to prevailing beach litter challenges. Accumulation of litter problem is minimized through use of beach clean-up activities. Collection and disposal of litter is handled by deploying waste

infrastructure. Recycling converts the litter to reusable materials that can become an economic lifeline. Monitoring, detection and measuring process of litter is automated through use of Artificial Intelligence. Local communities' involvement in beach litter management is achieved through use of citizen science, a data collection process that provide necessary information about beach litter. However, use of these methods does not replace the desire to comprehend human behavior associated with generation and disposal of litter. Littering has psychological, situational and administrative dimensions [18].

II. LITERATURE REVIEW

Littering problems requires multiple management methods to minimize it. Any preventive measure ought to consider clear understanding of the reason that causes people to litter or dispose waste. The behavior that cause human to dispose waste cannot be attributed to only one factor. The conditions around which a person interact with, shape individual characteristics that lead to littering behavior. Systematic review of literature associated with human littering behaviour was carried out [18]. 70 journal articles were reviewed, covering 48 years of research. Determinants of littering behavior were grouped broadly into psychological, situational and administrative factors. However, in the conducted studies, there were inconsistencies in the effect of some determinants. Implication of the study was that littering behaviour is multidimensional, and cannot be attributed to one specific characteristic. Various situational conditions that can affect the behavior of beach goers is availability of disposal facilities such as litter bins. Lack of bins can easily lead to littering of beaches. Accessibility of bins and distance of bins from the beach area raises possibility of littering. The positioning of the bins may encourage or discourage disposal of litter. Therefore, convenience in litter disposal possibly shape the decision and action taken by a person. Availability of bins do not predict littering, but the distance from a litter bin can predict more littering [19].

Effort has been made to put signs, instructions or prompts so as to improve behavioural clues of the people who encounter them. Expected behavior can be communicated through such guidance. However, the context and presentation of these guidance determine their effectiveness. After conducting research on effect of asking visitors to use waste cans while they were visibly picking up existing litter, it was established that the litter which was left per visitor reduced by 35% [20]. By guiding the visitors, there was change in littering along the beaches.

Difference in perception of people when they notice environmental litter exists. The level of concern about noticing litter is also different among people. The results of a study showed that 95% of the respondents reported encountering litter [21]. There was a high level of concern about marine litter among the respondents.

Many studies on repeat-visit have dwelt on issues such as tourism behavior, visitor satisfaction, beach quality, destination loyalty, perceptions of litter. Tourist characteristics and environmental values were connected to willingness of tourist to participate in beach clean-ups[22]. The effect on frequency of visits by beach users on different disposal behaviours was not examined. It has been found that willingness to participate in beach clean-ups being associated with previous participation, collective responsibility and policy support [23]. There exists individual and broader contextual dimensions within coastal anti-littering behaviour. Investigation on societal (Macro) and individual (micro) factors that shape littering behaviours among coastal-user group along the coastal regions was conducted [24]. They found important differences in perceptions among coastal-user groups. The study proposed a framework that is capable of improving and sustaining anti-littering behaviour. This finding shows that it is not possible to detach coastal setting where behaviour occurs from behavioural findings.

The problem of beach litter in Kenya has been established empirically. Composition of beach litter, distribution, accumulation rates as well as litter origin and brand details was measured from coast region counties of Kilifi, Mombasa and Kwale [5]. The study indicates that there is relevance between human local waste generation and management of Kenyan litter problem. In another study on meso-litter pollution along coastal beaches of Kenya, the same researchers surveyed 23 Kenyan beaches and examined factors like proximity to urban beaches, beach activities that are predominant and action of waves on litter. In the study, these factors had no statistically significant influence on amount of meso-litter.

The study on Mombasa County examined the influence of beach attributes on preferences among local recreationists [25]. It also explored how these preferences are moderated by recreationists. The results indicated strong preference for beaches which are clean, uncrowded, litter-free and are patrolled. They emphasized the importance of targeted management strategies towards improvement of experiences along the beaches. The three studies establish valuable research findings related to local contribution to litter in Kenyan beaches and preferences of local recreationists. However, preference for clean beaches neither translates to responsible disposal

behaviour nor does being a frequent visitor show evidence of responsible disposal.

The research and findings related to litter, nature of beaches and preferences in Kenyan beaches have been established. However, the current study is interested on the relationship between various characteristics of beach users and conditions associated with their litter-related behaviour. Availability of litter disposal infrastructure does not imply that beach visitors actually use it. The issue of noticing guidance on where to dispose litter as well as frequency of visiting a beach may be considered separate from litter-disposal behaviour. Noticing of litter by beach users and level of concern about litter may be handled separately. Therefore, knowledge about existence of these characteristics does not indicate if there is any association between the paired characteristics. Evidence on individual components of these behaviours has been provided by international studies reviewed earlier.

Studies on Kenyan beaches have established important information on litter and beach-users. However, evidence related to the specific paired relationships among Kenyan coastal beach users is insufficiently established.

The current study focuses on beach users along the coastal region of Kenya. The main purpose is to examine the relationships among selected litter-related behavioural and infrastructural characteristics. The key emphasis is association between responses instead of description of individual responses. The four relationships that were considered in this study are:

- Availability of litter-disposal bins vs use of bins
- Environmental/disposal guidance vs litter-disposal behavior
- Noticing litter vs Concern about litter
- Frequency of beach visits vs litter-disposal behavior.

The study was carried out on selected areas in Kenyan coast. The respondents were drawn from Mombasa, Kilifi and Kwale counties. The four specific paired relationships were brought into one investigation. There was a distinction between existences of characteristics from association between characteristics. It allowed determination of whether an association was statistically supported and where appropriate, determine the strength of that association. Context-specific evidence for Kenyan coastal beach users was provided. The purpose of the study was to ascertain which behavioural relationships deserve management attention. It helped to distinguish between relationships supported by the empirical evidence from the relationships that are not supported statistically in the study sample. Evidence provided from the study may inform beach waste infrastructure, environmental guidance, awareness/engagement strategies and beach-user management.

III. METHODOLOGY

The survey was conducted on six beaches within the three counties on the Kenyan coast. The beach sites were selected purposively. The beaches provided access to different groups of beach users. Other considerations made were frequency of human activity, proximity, security and ease of access. Quantitative approach was applied with cross-sectional questionnaire survey being used, with beach users being the respondents. The behavioural characteristics of respondents in terms of beach-use and litter was captured in the questionnaire. Beach users were provided with structured questionnaires within the selected coastal locations.

The responses were later screened. 287 valid respondents formed the analysed data set.
Target population of beach users was no precisely known. Sample size was computed using the following Cochran's formula [26].

$$n_0 = \frac{Z^2 \cdot p(1-p)}{e^2}$$

where:

- n0 = required sample size;
- Z=1.96 at 95% confidence;
- p=0.50 = assumed population proportion;
- e=0.05 = margin of error.

Therefore:

$$n_0 = \frac{(1.96)^2(0.50)(1-0.50)}{(0.05)^2} = 384.16 \approx 385$$

The target rounded to: 385
The target questionnaires were distributed among the six beaches. The allocation was a reflection of estimated relative visitor volumes used during field planning. The questionnaires were given to respondents encountered at study locations, with participation being carried out on voluntary basis. The willing eligible respondents completed the questionnaires. There were 287 valid responses out of a target of 385 individuals. The analytical sample n = 287. This represented a response rate of 74.5%. The questionnaire responses were coded and consolidated into analytical categories where applicable. Association testing was based on these categorical variables. Four paired relationships were operationalized.

The original response categories were retained for descriptive analysis. The variables are displayed together with their original response categories and recoded analytical categories in the table below:

Table 1. Variables with their original response categories and recoded analytical categories.

Variable	Original responses	Recoded category
Bin visibility/use/ guidance/litter noticing	Always + Often	High
	Sometimes	Moderate
	Rarely + Never	Low
Visit frequency	Daily + Weekly	Frequent
	Twice-a-month + Monthly	Moderate
	Quarterly + Yearly	Rare
Concern	Extremely + Very concerned	High
	Moderately concerned	Moderate
	Slightly + Not concerned	Low
Disposal behaviour	Put in bin + dispose properly later	Responsible
	Keep it	Neutral
	Throw away + leave there	Irresponsible

The four paired relationships are:
Relationship A – Waste infrastructure: Bin Visibility x Bin Use
Relationship B – Environmental guidance: Disposal guidance x Litter disposal behavior
Relationship C – Litter concern: Noting litter x Concern about litter
Relationship D – Frequency of visitation: Visit frequency x Litter-disposal behaviour

Descriptive analysis was carried out using frequencies and percentages. Response categories from the original questionnaires were retained for descriptive statistics. Construction of four cross-tabulations was done and row percentages calculated. Pearson's chi-square test of independence with a significance level of 0.05 was computed. The expected frequencies were examined. Simulated p-values were calculated using 10,000 replicates for tables with sparse expected cell frequencies. The simulation was carried out on Relationship C and D. Cramér's V was computed as well. Analysis was conducted using R programming language.

IV. RESULTS

Table 2. Distribution of original questionnaire responses among surveyed beach users (n=287)

Variable	Response category	n	%
Visit frequency	Daily	76	26.5
	Weekly	120	41.8
	Twice-a-month	33	11.5
	Monthly	36	12.5
	Quarterly	7	2.4
	Yearly	15	5.2
Noticing litter	Always	95	33.1
	Often	51	17.8
	Sometimes	104	36.2
	Rarely	30	10.5
	Never	7	2.4
Visibility of bins	Always	74	25.8
	Often	35	12.2
	Sometimes	47	16.4
	Rarely	73	25.4
	Never	58	20.2
Visibility of guidance	Always	52	18.1
	Often	22	7.7
	Sometimes	51	17.8
	Rarely	67	23.3
	Never	95	33.1
Disposal behaviour	Put it in a dustbin	137	47.7
	Dispose properly later	43	15.0
	Keep it	43	15.0
	Throw it away	33	11.5
	Leave it there	31	10.8
Use of bins	Always	94	32.8
	Often	18	6.3
	Sometimes	51	17.8
	Rarely	52	18.1
	Never	72	25.1
Concern about litter	Extremely concerned	104	36.2
	Very concerned	113	39.4
	Moderately concerned	34	11.8

	Slightly concerned	18	6.3
	Not concerned at all	18	6.3

The table shows a high percentage of 68.3% for those beach users who visit the beach on a daily and weekly basis. Beach users who always and often notice litter showed 50.9% rate of noticing litter. There was a notable high level of concern among beach users. Those who were very concerned and extremely concerned scored 75.6% of total respondents. More than half of the respondents showed low level of noticing guidance. Those who rarely and never noticed guidance had a total score of 56.4%. There was a total response of 45.6% for the respondents who rarely and never noticed trash bins. 47.7% of the respondents directly disposed trash into the bin. However, 22.3% reported either throwing away the litter or leaving it there.

Table 3. Cross-tabulation of the Paired Behavioural Relationships

Relationship	Category of Variable 1	Category of Variable 2	n	Row %
A. Bin visibility × Bin use	High visibility	High use	73	67.0
		Moderate use	19	17.4
		Low use	17	15.6
	Moderate visibility	High use	14	29.8
		Moderate use	17	36.2
		Low use	16	34.0
	Low visibility	High use	25	19.1
		Moderate use	15	11.5
		Low use	91	69.5
B. Disposal guidance × Disposal behaviour	High guidance	Responsible	57	77.0
		Neutral	11	14.9
		Irresponsible	6	8.1
	Moderate guidance	Responsible	36	70.6
		Neutral	5	9.8
		Irresponsible	10	19.6
	Low guidance	Responsible	87	53.7
		Neutral	27	16.7
		Irresponsible	48	29.6
C. Noticing litter × Concern about litter	High noticing	High concern	116	79.5
		Moderate concern	14	9.6
		Low concern	16	11.0
	Moderate noticing	High concern	74	71.2
		Moderate concern	19	18.3
		Low concern	11	10.6
	Low noticing	High concern	27	73.0
		Moderate concern	1	2.7
		Low concern	9	24.3
D. Visit frequency × Disposal behaviour	Frequent	Responsible	125	63.8
		Neutral	28	14.3
		Irresponsible	43	21.9
	Moderate	Responsible	39	56.5
		Neutral	11	15.9
		Irresponsible	19	27.5
	Rare	Responsible	16	72.7
		Neutral	4	18.2
		Irresponsible	2	9.1

67.0% of the respondents with high bin visibility reported high bin use. Low bin use had 69.5%, among those with low bin visibility.

Respondents who indicated they have noticed disposal guidance had a 77.0% responsible disposal while low notice of disposal guidance among respondents showed 53.7% responsible disposal and 29.6% irresponsible disposal.

Among the respondents with high litter noticing, 79.5% reported high concern. Those with moderate noticing of litter indicated a high concern of 71.2%. Respondents who had a low rate of noticing litter also reported a high concern of 73.0%.

Those beach users who are frequent in visiting the beach demonstrated 63.8% of responsible behavior. Moderate beach visitors showed 56.5% responsible behaviour. Those who rarely go to the beach reported 72.7% responsible behaviour.

A Chi-Square test of independence was conducted to examine the relationship between pair of variables in Relationship A to D. The results are provided in the table below:

Table 4: Associations among selected behavioural and environmental characteristics.

Behavioural association	χ^2	df	p-value	Cramér's V	Outcome
Bin visibility × bin use	89.151	4	< .001	.394	Significant
Disposal guidance × disposal behaviour	16.991	4	.0019	.172	Significant
Noticing litter × concern about litter	12.160	4	.0153*	.146	Significant
Visit frequency × disposal behaviour	3.646	4	.4619*	.080	Not significant

*Simulated p-values based on 10,000 replicates were used for relationships with sparse expected cell frequencies.

Relationship A – Bin visibility x bin use
There was statistically significant association with $\chi^2(4) = 89.151, p < .001;$ V=.394 was the largest V among the four tested relationships..
Relationship B –Disposal guidance x Litter disposal behavior
The association between these variables was statistically significant, $\chi^2(4) = 16.991, p = .0019;$ and V=.172
Relationship C –Noting litter x Concern about litter
The simulated p = .0153, demonstrating statistical significance in the relationship. Cramér's V was .146
Relationship D –Visit frequency x Litter-disposal behaviour
The simulated p was .4619, meaning the relationship between the two variables was not statistically significant. Cramér's V was the smallest of the four relationships with V=0.080.

V. DISCUSSION

The purpose of this study was to determine whether environmental and behavioural characteristics of Kenya coastal beach users were associated. The key consideration was the relationships between characteristics. It was not a determination of whether such characteristics existed or not.

Four relationships among variables were examined, with three relationships being statically significant. One relationship failed statistical significance test. Therefore, those characteristics that appear relevant to litter management do not necessarily reflect the same statistical relationship with behavioural outcomes. The supported relationships involved Bin visibility and bin use, Disposal guidance and disposal behaviour as well as Noticing litter and concern about litter.
The unsupported relationship was frequency of beach visits and disposal behaviour.

The Cramér's V values among the relationship were .394>.172>.146>.080
The relationships were not equally pronounced. Bin visibility x bin use had the highest observed association magnitude among the four relationships.
There was no statistically significant association between beach visit frequency and litter-disposal behaviour, with

$$\chi2(4)=3.646,p=.4619,V=.080$$

Willingness to participate in beach clean-ups was associated with factors such as previous participation, collective responsibility and policy support [23]. Evidence that connected visitor characteristics with environmental participation was reported [22]. However, this outcome differ from the reported litter-disposal behaviour. Increased visitation of the beach might be expected to strengthen familiarity with the surrounding environment, leading to responsible disposal habits. However, the data collected in this study did not support that inference.

The association between bin visibility and bin use was statistically significant and had the largest observed association magnitude (V=.394). Disposal outcomes on beaches are affected by location and abundance of waste receptacles [9]. The current study is complemented by Robinson's evidence. Providing disposal infrastructure and its visibility to beach users should therefore not be treated as separate considerations. Disposal guidance and reported disposal behaviour were significantly associated (V=.172). Waste disposal signage influenced waste sorting performance [27]. Among Kenyan coastal beach users, noticing disposal guidance was associated with reported litter-disposal behaviour.

Noticing litter and concern about litter were significantly associated (V=.146). Respondents who encounter marine litter report high concern [21]. In this current study, concern among respondents was high; however, the observed association between noticing litter and concern should not be interpreted as evidence of responsible disposal behaviour.

The results suggest that environmental infrastructure, environmental guidance, concern and frequency of beach visits were not uniformly related to litter-related outcomes. Bin visibility and bin use had the largest observed association.

Frequent beach visits and disposal behaviour were not statistically associated. Any characteristics that appear relevant to beach-litter behaviour should be assessed based on specific behavioural relationship involved. There should be no assumption that they operate similarly.

Management ought to find out whether trash bins are available, visible and identifiable to beach users. The significant relationship between guidance and disposal behaviour supports the relevance of disposal guidance as a complementary management consideration. The finding on non-significant visit-frequency and disposal behaviour association has implications for anti-litter interventions. The target of these interventions need to be all beach users, not occasional visitors only. Although concern about litter was high, there should be no assumption by the management that environmental concern automatically represents responsible disposal practice.

Since the questionnaires were filled by respondents, self-reported behaviour may differ from actual behaviour observed on the beach. The mentioned associations cannot establish causality or direction of influence. The study targeted specific beaches in Mombasa, Kilifi and Kwale. This means that any broader generalization should be treated with care. Some details contained in the original response options were reduced when original questionnaire responses were consolidated into broader categories.

VI. CONCLUSION

This study focussed on association between selected environmental characteristics and reported litter-related behaviour among users of selected Kenya coastal beaches. The results showed that three out of the four tested relationship was statistically significant while one was not. The strongest relationship was bin visibility versus bin use, with Cramer's V of .394. The characteristics that are relevant to beach-litter management were not uniformly associated with litter-related outcomes. Specifically, frequency of beach visitation alone did not statistically distinguish responsible from irresponsible reported disposal behaviour, while infrastructure visibility and disposal guidance showed statistically supported relationships. Visibility of disposal infrastructure and guidance deserve consideration alongside simply providing bins. However, it is important to note that high environmental concern should not be interpreted automatically as responsible disposal behaviour. Beach-litter interventions should be based on specific demonstrated behavioural relationship instead of assumptions that all relevant beach-user characteristics operate in the same manner.

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