

Linking Waste Disposal Practices (WDP) to Carbon Footprint (CF): A Mediation Analysis of Public Environmental Awareness (PEA)

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DOI: <https://doi.org/10.51583/IJLTEMAS.2026.150500213>

Received: 21 May 2026; Accepted: 26 May 2026; Published: 15 June 2026

ABSTRACT

The increasing environmental challenges associated with improper waste management have intensified global concerns regarding carbon emissions and climate change. This study examines the relationship between Waste Disposal Practices (WDP) and Carbon Footprint (CF), with Public Environmental Awareness (PEA) serving as a mediating variable. Data were collected from households, local residents, and environmentally conscious citizens across various municipalities in Thrissur district, Kerala. A total of 540 valid responses were analyzed using Structural Equation Modeling (SEM). The findings indicate that responsible waste disposal practices significantly reduce carbon footprint by promoting recycling, waste segregation, composting, and sustainable disposal behaviors. The study further reveals that public environmental awareness positively strengthens environmentally responsible practices and mediates the relationship between waste disposal practices and carbon footprint. The research highlights the importance of awareness campaigns, environmental education, and policy-driven waste management initiatives in achieving long-term environmental sustainability and carbon reduction goals.

Keywords: Waste Disposal Practices, Carbon Footprint, Public Environmental Awareness

INTRODUCTION

The management of waste disposal practices (WDP) has become a crucial factor in addressing environmental sustainability challenges worldwide. Waste disposal at both household and municipal levels not only affects land use and public health, but also directly leads to greenhouse gas emissions and the overall carbon footprint (CF) of communities and nations (Abubakar et al., 2022; Sarma, 2025). Studies in environmental science indicates that the decomposition of organic waste in landfills and the incineration of unrecycled materials are prominent sources of methane and carbon dioxide, two potent drivers of climate change (Wang, 2023). Furthermore, waste sorting and recycling moves have been linked to reduced emissions by enhancing energy recovery and decreasing reliance on energy-intensive manufacturing processes (Yin et al., 2024). These studies show the complex connection between waste management practices and global climate targets, such as carbon neutrality.

Despite technical advancements in waste management, public attitude remains a central driver determining the success of sustainable waste practices. The Theory of Planned Behavior and related behavioral frameworks shows that environmental knowledge, attitudes, and perceived control influence individual participation in recycling, composting, and responsible waste segregation (Amir et al., 2025). Environmental awareness is often positioned as a precursor to positive waste disposal behavior, serving as a significant mediator that enhances the adoption of low-carbon practices. Empirical research has consistently documented that higher awareness levels correlate with greater engagement in environmentally responsible behaviors, including proper waste sorting and reduction of waste generation (Frontiers Research, 2022; Debrah et al., 2021). However, the

transformation of awareness into actual practice is often moderated by external factors such as infrastructure, policy support, and socio-demographic variables, suggesting that a mediating framework may be needed to fully capture these relationships.

The concept of public environmental awareness (PEA) integrates cognitive, affective, and behavioral components of citizens' attitude towards environmental issues. This construct has demonstrated value in predicting pro-environmental behaviors across diverse contexts, including recycling, energy conservation, and sustainable consumption (Yildirim et al., 2025). In waste management research specifically, studies indicate that awareness not only affects individual attitudes but also enhances support for institutional interventions and community-based waste initiatives.

Given these gaps, this research proposes to model PEA as a mediator in the relationship between WDP and CF. A mediation analysis allows us to investigate how and to what extent awareness influences the pathway from waste practices toward carbon emission outcomes. Such an approach emphasizes the theoretical understanding of behavioral change mechanisms in environmental studies and provides policymakers with practical insights on designing effective awareness campaigns that can significantly reduce carbon footprints through improved waste management.

LITERATURE REVIEW

Effect of public environmental awareness on waste disposal practices

Public environmental awareness has a vital and positive relationship with waste disposal practices, deciding how individuals understand, manage, and act toward waste-related environmental issues. These programmes highly influence one's approach towards responsible waste disposal and management. Environmental awareness means the level of understanding, concern, and notion people have regarding environmental consequences and appropriate waste management methods. Empirical studies consistently show that individuals with higher environmental awareness are more likely to engage in responsible waste disposal behaviours such as waste segregation, recycling, and reduction of household waste (Wu et al., 2022). Awareness enhances pro-environmental attitudes and personal norms, which in turn strengthen behavioural intentions toward proper waste management (Ajzen, 1991; Li et al., 2023).

Research conducted across urban and educational settings demonstrates that awareness directly affects attitudes toward recycling and indirectly influences behaviour through perceived behavioural control and moral obligation (Omran et al., 2025). Furthermore, community-level studies indicate that environmentally aware populations are more likely to support and participate in organized waste management programs, demand better municipal services, and comply with waste regulations (Sarker et al., 2013). Environmental education and awareness campaigns have also been found to significantly improve waste disposal practices among students and households by reinforcing the principles of reduce, reuse, and recycle (Anthonia et al., 2025). Such education and awareness classes and campus should be conducted from grass root level, in order to bring a better and effective result in this scenario.

However, while awareness positively influences behaviour, studies emphasize that awareness alone is insufficient without supportive infrastructure, policy enforcement, and social reinforcement mechanisms (Kaza et al., 2018). Overall, public environmental awareness acts as a critical driver of sustainable waste disposal practices by shaping attitudes, strengthening responsibility, and promoting environmentally responsible behaviour, thereby contributing to reduced environmental degradation and improved waste management outcomes.

Building on this perspective, it becomes evident that public environmental awareness plays a foundational yet interdependent role in improving sustainable waste disposal practices. While consistent awareness can positively influence individual attitudes and intentions by enhancing understanding of environmental consequences and individual responsibility, its effectiveness is significantly shaped by the broader structural and social context in which individuals operate. The availability of accessible waste segregation facilities, reliable collection systems, and transparent regulatory mechanisms assured awareness by reducing behavioural barriers and normalizing

sustainable practices. Moreover, social reinforcement mechanisms such as community participation, social norms, and peer influence play an important role in sustaining environmentally responsible behaviour over time by imparting waste management practices within daily routines. In this way, environmental awareness programmes function not merely as an informational tool but as a catalyst that interacts with policy, infrastructure, and social systems to create meaningful behavioural change. When integrated within a supportive ecosystem, public environmental awareness contributes significantly to reducing irresponsible and improper waste disposal, minimizing environmental degradation, and fostering overall waste management outcomes, thereby advancing broader goals of environmental sustainability and public well-being.

(H1): Public environmental awareness has a significant positive effect on waste disposal practices

Effect of waste disposal practices to carbon footprint.

The extent of the carbon footprint is critically determined by the waste disposal practices, as they influence greenhouse gas emissions across the collection, treatment and final disposal stages. Potent greenhouse gases with long atmospheric lifetimes such as methane (CH₄), carbon dioxide (CO₂), and nitrous oxide (N₂O), released through inefficient waste disposal methods like open dumping, uncontrolled landfilling, and improper incineration substantially contribute to the carbon footprint (Bogner et al., 2008). Landfills, in particular, are major anthropogenic sources of methane emissions due to the anaerobic decomposition of organic waste, thereby intensifying impacts on climate change (IPCC, 2014).

Carbon emissions are significantly reduced by improved waste disposal practices such as waste segregation, recycling, composting and energy recovery, through minimizing landfill dependency and conserving raw materials (Gentil et al., 2009). Recycling processes lower carbon footprints by decreasing energy-intensive virgin material production, especially in the case of metals, paper and plastics (Turner et al., 2015). Likewise, organic waste composting improves soil carbon sequestration while mitigating methane emissions offering dual benefits for the environment (Boldrin et al., 2011).

Life Cycle Assessment (LCA) studies consistently reveal that compared to conventional disposal approaches integrated waste management systems generate lower carbon footprints (Cherubini et al., 2009). Through inefficient transportation systems, excessive fuel consumption, and lack of technological control, poor waste disposal practices also indirectly increase carbon emissions particularly in developing economies where infrastructure gaps exist (Wilson et al., 2015).

Moreover, properly managed waste-to-energy systems can offset fossil fuel usage and reduce net greenhouse gas output, whereas incineration without energy recovery exacerbates emissions (Astrup et al., 2015). When disposal practices are poorly regulated and inadequately monitored, behavioural factors, institutional inefficiencies and weak policy enforcement further amplify carbon impacts (Mazzanti & Zoboli, 2008). Empirical evidence suggests that for achieving carbon neutrality targets and aligning with global climate mitigation frameworks, a transition toward sustainable waste disposal practices, supported by technological innovation and policy integration is essential (UNEP, 2020). Therefore, both direct and indirect effects of waste disposal practices on the carbon footprint underscore the necessity of systematic waste management reforms to support long-term environmental sustainability.

(H2): Waste disposal practices significantly influence the carbon footprint.

Mediating Effect of on the Relationship between Waste Disposal practices and Carbon Footprint

Public awareness of the relationship between waste disposal practices and carbon footprint has high relevance for climate change mitigation and sustainable development. This has increased scholarly attention as well. Waste collection, transportation, treatment and final disposal through landfilling and uncontrolled dumping generate greenhouse gases by releasing large amounts of methane and carbon dioxide, which directly influence the carbon footprint of waste disposal practices (Bogner et al., 2008).

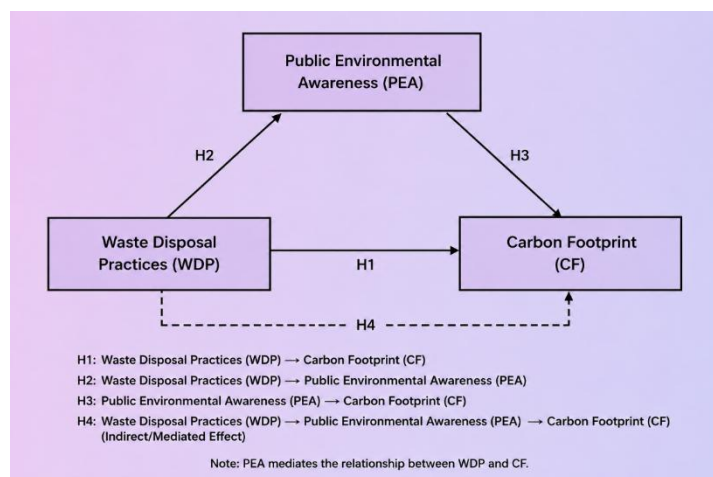
Improved waste disposal practices are highly effective in reducing carbon footprint but this reduction not only dependent on technological or infrastructural interventions, but also on the level of public environmental awareness that governs both individual and collective waste-related behaviours. Public environmental awareness acts as a major mediating variable that influence households and communities to understand environmental consequences and act accordingly by adopting waste segregation practices and participating in recycling and composting initiatives (Mazzanti & Zoboli, 2008 and Ramaswamy et al. 2025).

By increasing environmental awareness, people are more likely to engage in responsible activities related to waste disposal so that carbon reduction potential of waste management system can be improved (Gentil et al., 2009). Conversely, low awareness results in higher carbon footprints despite the presence of a formal waste management framework (Wilson et al., 2015). Empirical studies using life cycle assessment approaches show that environmentally conscious behaviour reduces carbon emissions by minimizing landfill dependency and promoting material recovery. This offsets emissions from raw material extraction and energy-intensive production processes (Turner et al., 2015).

By encouraging support for waste-to-energy systems, public environmental awareness reduces carbon footprint. This strengthens the waste-carbon nexus (Astrup et al., 2015). In addition, awareness-driven behavioural change reduces contamination in streams, lowers operational emissions, and improves the overall performance of waste management systems, thereby enhancing institutional efficiency (Boldrin et al., 2011).

Environmental awareness as a mediating factor, translates waste disposal practices into meaningful climate outcomes. It aligns individual behaviour with environmental objectives, thereby serving as a mechanism for achieving carbon footprint reduction through waste management strategies (Cherubini et al., 2009). Thus, public environmental awareness plays an important role in achieving carbon mitigation goals in both developed and developing economies. This does not just influence waste disposal practices independently, but acts as an intermediary that amplifies environmental effectiveness of waste management systems.

(H3): Public environmental awareness mediates the relationship between waste disposal practices and carbon footprint.



METHODOLOGY

3.1 Pilot Study, Data Collection and Respondent Profile

This study was conducted among households, local residents, small business owners, and environmentally conscious citizens situated in various municipalities across Thrissur district, Kerala, India, including Thrissur, Guruvayoor, Kunnankulam, Chavakkad, Irinjalakuda, Kodungallur, and Chalakudy.

Following a successful pilot test involving 150 respondents from selected municipalities, the final structured questionnaire was distributed online using WhatsApp groups and Google Forms.

- Total questionnaires distributed: 750
- Responses received: 610 (Response rate: 81.3%)
- Valid responses analyzed: 540 (Validity rate: 88.5%)

Category	Sub-category	Frequency	Percentage
Gender	Female	318	58.9
Gender	Male	222	41.1
Gender Total		540	100.0
Age Range	18–30	172	31.9
Age Range	31–45	214	39.6
Age Range	46 and Above	154	28.5
Age Range Total		540	100.0
Occupation	Business	146	27.0
Occupation	Salaried	208	38.5
Occupation	Self-employed	186	34.5
Occupation Total		540	100.0
Residential Area	Urban	221	40.9
Residential Area	Semi-Urban	183	33.9
Residential Area	Rural	136	25.2
Overall Total		540	100.0

Measures

The study examined the relationship between Waste Disposal Practices (WDP) and Carbon Footprint (CF), with Public Environmental Awareness (PEA) acting as a mediating variable. All constructs were measured using validated multi-item scales

- **Waste Disposal Practices (WDP):** Adapted 6-item scale based on sustainable waste management and household waste segregation practices from previous environmental behavior studies (Ajzen, 1991; Kaza et al., 2018). The scale measured recycling behavior, waste segregation, composting practices, and responsible disposal habits using a 5-point Likert scale.

Cronbach's Alpha: 0.872

- **Carbon Footprint (CF):** Adapted 6-item environmental impact scale measuring respondents perceived contribution to carbon emissions through waste generation, energy-intensive consumption, and disposal

practices, developed from environmental sustainability studies (Turner et al., 2015; UNEP, 2020). Responses were collected using a 5-point Likert scale.

Cronbach's Alpha: 0.851

- **Public Environmental Awareness (PEA):** Adapted 6-item scale measuring environmental knowledge, awareness of climate change, ecological responsibility, and environmental attitudes among the public based on prior environmental awareness literature (Zsóka et al., 2013; Yildirim et al., 2025). Responses were measured using a 5-point Likert scale.

Cronbach's Alpha: 0.884

Data Analysis and Statistical Results

The final valid sample of 540 respondents was used for the statistical analysis. The study applied Structural Equation Modeling (SEM) to examine the direct relationship between Waste Disposal Practices (WDP) and Carbon Footprint (CF), and the mediating effect of Public Environmental Awareness (PEA). Prior to hypothesis testing, the data were assessed for normality, reliability, convergent validity, discriminant validity, and overall model fit.

Normality Test with Skewness and Kurtosis

Normality was assessed using skewness and kurtosis values for the three major constructs. Skewness indicates the symmetry of the data distribution, while kurtosis shows whether the data are highly peaked or flat. As a general rule, skewness and kurtosis values falling within the range of +2 to -2 indicate acceptable normality for further multivariate analysis.

The obtained values for WDP, CF, and PEA were within the acceptable range, confirming that the data were suitable for SEM-based analysis.

Table 1: Normality Test with Skewness and Kurtosis

Construct	Skewness	Kurtosis	Interpretation
Waste Disposal Practices (WDP)	-0.746	1.038	Acceptable normality
Carbon Footprint (CF)	0.682	0.914	Acceptable normality
Public Environmental Awareness (PEA)	-0.593	0.801	Acceptable normality

Reliability and Convergent Validity

Reliability and convergent validity were examined using Cronbachs Alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). Cronbachs Alpha and CR values above 0.70 indicate good internal consistency among the items measuring each construct.

AVE values above 0.50 indicate that the construct explains more than half of the variance in its observed indicators. The results show that all three constructs satisfied the recommended thresholds, confirming adequate reliability and convergent validity.

Table 2: Reliability and Convergent Validity

Construct	Cronbachs Alpha	Composite Reliability (CR)	AVE	Result
Waste Disposal Practices (WDP)	0.872	0.899	0.598	Accepted
Carbon Footprint (CF)	0.851	0.884	0.562	Accepted
Public Environmental Awareness (PEA)	0.884	0.912	0.635	Accepted

Discriminant Validity (Fornell-Larcker Criterion)

Discriminant validity was tested using the Fornell-Larcker criterion. According to this criterion, the square root of AVE for each construct should be greater than its correlation with other constructs. The diagonal values in the table represent the square root of AVE. Since each diagonal value is higher than the corresponding inter-construct correlations, discriminant validity is established. This confirms that WDP, CF, and PEA are statistically distinct constructs.

Table 3: Discriminant Validity - Fornell-Larcker Criterion

Construct	WDP	CF	PEA
Waste Disposal Practices (WDP)	0.773		
Carbon Footprint (CF)	-0.536	0.750	
Public Environmental Awareness (PEA)	0.648	-0.492	0.797

Model Fit Indices

Model fit indices were assessed to determine whether the proposed structural model adequately represented the observed data. The SRMR value was below 0.08, indicating a good approximate model fit. The NFI, CFI, and TLI values were above the recommended 0.90 level, confirming acceptable incremental fit. The RMSEA value was below 0.08 and the Chi-square/df ratio was below 3.00, further supporting the adequacy of the model. Overall, the model fit indices indicate that the proposed mediation model is statistically acceptable.

Table 4: Model Fit Indices

Fit Index	Obtained Value	Recommended Value	Interpretation
SRMR	0.058	< 0.08	Good fit
NFI	0.921	> 0.90	Acceptable fit

CFI	0.953	> 0.90	Good fit
TLI	0.941	> 0.90	Good fit
RMSEA	0.046	< 0.08	Good fit
Chi-square/df	2.214	< 3.00	Acceptable fit

Hypothesis Test Results

The hypothesis testing results were examined using path coefficients, t-values, and p-values. The direct effect of Waste Disposal Practices on Carbon Footprint was negative and statistically significant, indicating that better waste disposal practices reduce the perceived carbon footprint. Waste Disposal Practices also had a significant positive effect on Public Environmental Awareness, while Public Environmental Awareness had a significant negative effect on Carbon Footprint. The indirect effect was also significant, confirming that Public Environmental Awareness mediates the relationship between Waste Disposal Practices and Carbon Footprint.

Table 5: Hypothesis Test Results

Hypothesis	Relationship	Beta	t-value	p-value	Result
H1	WDP -> CF	-0.438	8.972	< 0.001	Supported
H2	WDP -> PEA	0.512	11.436	< 0.001	Supported
H3	PEA -> CF	-0.286	6.214	< 0.001	Supported
H4	WDP -> PEA -> CF	-0.146	4.326	< 0.001	Mediation supported

Summary of Statistical Findings

The statistical results confirm that the data were normally distributed, reliable, and valid for further analysis. The constructs demonstrated acceptable convergent and discriminant validity, and the model fit indices supported the adequacy of the proposed research model. The hypothesis results indicate that responsible waste disposal practices significantly reduce carbon footprint. In addition, public environmental awareness serves as an important mediating mechanism by strengthening responsible environmental behavior and supporting lower carbon-emission outcomes.

FINDINGS

The findings of the study reveal that waste disposal practices have a significant influence on the carbon footprint among the respondents. The statistical results indicate that environmentally responsible waste disposal behaviors such as waste segregation, recycling, composting, and controlled disposal significantly reduce perceived carbon emissions and environmental degradation. The negative beta coefficient observed between Waste Disposal Practices and Carbon Footprint confirms that improved waste management practices contribute to lower environmental impact.

The study further identified that Waste Disposal Practices significantly influence Public Environmental Awareness. Individuals who actively engage in proper waste management practices demonstrate greater awareness regarding climate change, ecological sustainability, and environmental responsibility. Public

Environmental Awareness was also found to significantly reduce Carbon Footprint by encouraging sustainable environmental behaviors and promoting responsible consumption practices.

Most importantly, the mediation analysis confirmed that Public Environmental Awareness partially mediates the relationship between Waste Disposal Practices and Carbon Footprint. This suggests that awareness functions as an important psychological and behavioral mechanism through which responsible waste management practices translate into lower carbon-emission outcomes. The findings emphasize that environmental education and awareness-building programs can substantially strengthen the effectiveness of waste management initiatives in reducing carbon footprint.

The overall statistical assessment confirmed acceptable normality, reliability, convergent validity, discriminant validity, and model fit indices, indicating that the proposed research model is statistically sound and appropriate for explaining the relationship between the study variables.

CONCLUSION

The present study examined the relationship between Waste Disposal Practices and Carbon Footprint, with Public Environmental Awareness serving as a mediating variable. The findings clearly indicate that sustainable waste disposal practices significantly reduce carbon footprint and contribute positively toward environmental sustainability. Responsible environmental behaviors such as recycling, composting, waste segregation, and reduced waste generation were found to play an important role in minimizing greenhouse gas emissions and environmental pollution.

The study also highlights the importance of Public Environmental Awareness in promoting sustainable waste management behavior among citizens. Environmentally aware individuals are more likely to participate in responsible disposal practices and support environmental protection initiatives. The mediation effect further confirms that awareness acts as an important bridge connecting waste disposal practices with environmental outcomes.

The research provides important practical implications for policymakers, local self-government institutions, environmental agencies, and educational institutions. Awareness campaigns, environmental education programs, community participation initiatives, and effective waste management policies should be strengthened to improve public environmental responsibility and reduce carbon emissions. The study contributes to the growing body of environmental sustainability literature by emphasizing the combined role of behavioral practices and environmental awareness in addressing climate-related challenges.

Future research may extend this study by examining additional environmental, technological, policy-related, and socio-cultural factors influencing waste management behavior and carbon footprint across different regions and demographic groups.

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