Evaluating Consumer Priorities for Sustainable Packaging in E-Commerce: An Analytic Hierarchy Process (AHP) Approach

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Abstract: The rapid growth of e-commerce has intensified single-use packaging waste, pushing retailers toward sustainable alternatives even as consumers show a gap between stated environmental concern and actual behaviour. Existing green packaging research relies on linear, survey-based models that rate attributes independently and cannot capture the trade-offs consumers make among protection, cost, environmental impact, and convenience. This study applies the Analytic Hierarchy Process (AHP) to derive consumer priority weights across a four-criterion, twelve-sub-criterion hierarchy: Functional Protection, Environmental Performance, Economic Viability, and Post-Purchase Usability. Pairwise comparison data from 18 frequent e-commerce consumers and packaging experts were aggregated via the Geometric Mean Method, with all matrices meeting Saaty's consistency threshold (CR < 0.10). Functional Protection dominates consumer priorities (w = 0.421), with Impact & Shock Absorption ranking highest overall (global weight = 0.246), ahead of economic and environmental attributes. Perceived Value for Money outweighs willingness to pay a green surcharge, and curbside recyclability is valued more than compostability. Consumers treat protection as non-negotiable and expect retailers, not surcharges, to absorb sustainability costs. These weights give e-tailers an evidence-based basis for prioritizing protective performance and cost-neutral circularity over compostable materials, supporting packaging design that is commercially viable and environmentally sound.
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Introduction

The rapid expansion of global digital commerce has reshaped retail distribution systems. Secondary and tertiary packaging, once a purely logistical container, now shapes the customer fulfilment experience. At the same time, higher parcel volumes have driven a rise in single-use transport waste, including expanded polystyrene buffers, polyethylene air pillows, and oversized corrugated fibreboard [12]. In response to tighter regulatory frameworks and growing ecological concern among consumers, e-retailers have increasingly moved toward sustainable packaging alternatives, including post-consumer recycled corrugated boxes, compostable bioplastics, and closed-loop reusable mailers [2].

Despite broad consumer support for environmental conservation, the digital retail environment continues to show a persistent "attitude-behaviour gap" (commonly termed the "green gap"), in which self-reported environmental concern does not reliably translate into purchase or disposal behaviour [3], [7]. This gap is not incidental: packaging in e-commerce serves several functions at once. Parcels move through multi-tiered logistics networks involving automated sorting, rough transit handling, and variable climate exposure, so physical protection remains the primary barrier against product damage [4]. When an ostensibly eco-friendly parcel fails at this protective function, the ecological cost of product breakage, return shipping, and reshipment can outweigh the environmental savings of the sustainable material itself [11]. At the same time, consumers judge e-commerce packaging in operational terms: they want unboxing convenience, resealability for reverse-logistics returns, and easy domestic disposal, and they remain reluctant to pay any direct surcharge for green materials, that is, they show a persistently low willingness to pay (WTP) [2], [6]. Consumer acceptance of sustainable packaging, therefore, cannot be treated as a single construct or reduced to a moral choice. It is a multi-attribute trade-off in which people continuously weigh functional protection, financial cost, post-use convenience, and environmental impact against one another [11], [12]. A review of the literature reveals three gaps that limit current understanding of this

trade-off. First, most empirical work on green packaging relies on survey instruments analysed through structural equation modelling (SEM) or linear regression grounded in the Theory of Planned Behaviour (TPB) or the Norm Activation Model (NAM) [3], [7]. These methods work well for identifying latent psychological antecedents such as environmental concern and subjective norms, but they typically rate packaging attributes independently on Likert-type scales. This design is prone to social desirability bias and does not replicate the forced-choice trade-offs consumers actually face, such as choosing between stronger parcel protection and bio-based compostability [6]. Second, most existing packaging research focuses on fast-moving consumer goods (FMCG) and food retail, where shelf appeal, visual aesthetics, and food safety drive consumer choice [4], [11]. E-commerce packaging operates under different supply-chain dynamics: last-mile courier delivery, household disposal-volume limits, tamper-evidence requirements, and reverse-logistics processing for returns. Frameworks that evaluate consumer trade-offs specifically for these digital fulfilment conditions remain scarce [2]. Third, multi-criteria decision-making (MCDM) techniques, most notably the Analytic Hierarchy Process (AHP), are widely used in industrial settings for green supplier selection, packaging material engineering, and closed-loop supply chain design [1], [5], yet they are rarely applied to model how end consumers actually choose. Standard consumer studies do not compute compensatory priority-weight vectors that would reveal the exact trade-off ratios consumers apply across competing functional, economic, and circular attributes [10], [13].

To address these gaps, this study uses the Analytic Hierarchy Process [8], [9]. By breaking the packaging choice environment into a structured hierarchy of goals, criteria, and sub-criteria, AHP uses pairwise comparisons and eigenvalue calculations to derive the relative weights of consumer priorities, while verifying judgment transitivity through consistency ratio (CR) constraints [5], [10]. Building on this framework, the study addresses three research questions. RQ1 asks what relative priority weights consumers assign to the core dimensions of e-commerce packaging: Functional Protection, Environmental Impact, Economic Cost, and Operational Convenience. RQ2 examines, within each dimensional cluster, which specific sub-criteria (e.g., impact absorption, material circularity, ease of domestic disposal, return resealability) prove decisive in consumer evaluation. RQ3 asks how the derived priority vectors explain the operational trade-offs behind the consumer attitude-behaviour gap, and what practical insight they offer e-tailers designing commercially viable, circular packaging.

2. Literature Review

2.1 Functional Protection

Functional protection represents the baseline attribute against which all other packaging criteria are evaluated, since a package that fails to protect its contents undermines any environmental or cost advantage it may offer [4]. Impact and shock resistance concerns the cushioning integrity of a package under drops, vibration, and sorting-belt impact, conditions that are amplified in e-commerce relative to traditional retail because parcels pass through multiple automated handling points rather than a single controlled supply chain [4]. Barrier and weather protection addresses resistance to moisture, dust, temperature variation, and liquid penetration during transit and last-mile delivery; this sub-criterion is particularly relevant to sustainable packaging evaluation because many lightweight or bio-based materials offer weaker barrier performance than conventional plastics, creating a direct trade-off between environmental and protective goals [11]. Tamper and security integrity refers to visual tamper-evidence that allows a consumer to verify a parcel was not opened or compromised en route, a criterion that has grown in importance alongside the expansion of reverse-logistics volumes and consumer sensitivity to delivery fraud. Together, these three sub-criteria show that protective performance is not a single attribute but a cluster of mechanical, environmental, and security-related expectations that sustainable packaging must satisfy at once [4], [11].

2.2 Environmental Impact

Environmental impact captures the ecological consequences of packaging materials across sourcing, use, and disposal, and is the dimension most closely tied to the stated environmental concern documented in prior consumer research [3], [7]. Circularity and recyclability refer to the ease with which packaging enters

domestic curbside paper or plastic recycling streams after use, a practical constraint that determines whether stated environmental preference can be acted upon without specialised effort [12]. Biodegradability and compostability concerns the natural breakdown capacity of a material in home compost or soil without leaving microplastic residue, a criterion associated with strong consumer approval in principle but weaker translation into actual purchasing behaviour, consistent with the attitude-behaviour gap identified across the green packaging literature [3], [7]. Material origin and minimalist design addresses the use of post-consumer recycled (PCR) feedstock and the elimination of redundant fill or void-space layers, a design-level criterion that reduces environmental footprint independently of end-of-life disposal method. Magnier and Crié [6] show that consumers respond strongly to visible eco-design cues such as PCR labelling, but that this perceptual response does not necessarily reflect accurate understanding of a material's actual environmental performance, which points to the need to treat environmental impact as a multi-dimensional construct rather than a single sustainability label.

2.3 Economic Feasibility

Economic feasibility reflects the financial trade-offs a consumer accepts in exchange for more sustainable packaging, and is the criterion most consistently cited as a barrier to green packaging adoption [2]. Direct checkout surcharge concerns a consumer's willingness to pay a nominal additional fee at the point of purchase for eco-packaging, a construct that operationalises the low willingness-to-pay (WTP) findings reported across the literature into a concrete, transaction-level decision [2]. Product protection versus cost risk captures the extent to which a consumer's tolerance for packaging cost scales with the value or fragility of the item inside; this reflects the interaction between economic and functional criteria rather than treating cost as an isolated attribute [11]. Reusable deposit refund feasibility addresses willingness to pay a refundable security deposit for heavy-duty circular totes or mailers, a mechanism associated with closed-loop packaging systems that shift the economic model from ownership to temporary use [2]. Together, these sub-criteria show that economic feasibility in e-commerce packaging is not reducible to price sensitivity alone but depends on how cost is structured: as a surcharge, a risk-adjusted tolerance, or a refundable deposit.

2.4 Post-Delivery Usability

Post-delivery usability addresses the practical, hands-on experience of receiving and disposing of a package, and is a dimension distinctive to e-commerce relative to traditional retail packaging research, where handling is shared with in-store staff rather than performed entirely by the consumer. Ergonomic unboxing ease concerns tear-strip accessibility that allows a package to be opened without knives, box cutters, or scissors, an experiential attribute that has become part of brand perception in digital retail. Return-ready resealability refers to a built-in secondary adhesive strip that allows a package to be re-packed for returns without additional materials, and it directly supports the reverse-logistics processes central to circular packaging systems [2]. Domestic disposal convenience concerns the ease of flattening or collapsing packaging to avoid cluttering household waste and recycling bins, a practical constraint identified as a strong determinant of perceived sustainability in prior food and FMCG packaging research [4], [12]. Because e-commerce packaging is handled exclusively by the end consumer at every stage from receipt to disposal, usability factors carry disproportionate weight relative to their treatment in traditional retail packaging studies.

2.5 Multi-Criteria Decision-Making and the Analytic Hierarchy Process

The Analytic Hierarchy Process (AHP), developed by [8]-[10]. provides a structured method for deriving relative priority weights across a hierarchy of criteria and sub-criteria through pairwise comparison and eigenvalue-based consistency verification. AHP has been applied extensively to structured evaluation problems, including design concept selection [1] and integrated Kano-AHP-QFD approaches to product attribute assessment [5]. These applications show its capacity to model compensatory trade-offs among qualitatively distinct criteria, including protection, environmental impact, cost, and usability. Despite this established use in industrial and engineering contexts, AHP remains rarely applied to model consumer decision-making in the packaging domain, where prior research has relied predominantly on additive,

linear survey-based models incapable of capturing the forced trade-offs consumers face across these four dimensions [12]. The reviewed literature establishes that consumer evaluation of sustainable e-commerce packaging spans four interacting dimensions, each composed of distinct, measurable sub-criteria. Functional Protection (impact resistance, weather protection, tamper security) remains a non-negotiable baseline [4], [11]. Environmental Impact (recyclability, compostability, material origin) shapes stated preference more strongly than actual behaviour [3], [6], [7]. Economic Feasibility (checkout surcharge, cost-risk tolerance, deposit refunds) consistently constrains adoption of green alternatives [2], [11]. Post-Delivery Usability (unboxing ease, return resealability, disposal convenience) is distinctive to digital fulfilment and remains comparatively underexamined [2], [4], [12]. No existing study integrates all twelve sub-criteria across these four dimensions within a single compensatory decision framework capable of producing consumer priority weights. This gap motivates the application of AHP [9], [10] in the present study to derive such weights directly from consumer pairwise judgments.

3. Methodology

This study applies the Analytic Hierarchy Process (AHP; Saaty, 1980) to derive consumer priority weights for sustainable e-commerce packaging attributes. AHP decomposes a complex, multi-attribute decision into a hierarchy of goal, criteria, and sub-criteria, then uses structured pairwise comparisons and eigenvalue-based computation to derive ratio-scale priority weights while verifying the internal consistency of each respondent's judgments. The design proceeds in four stages: hierarchy formulation, questionnaire design, priority computation with consistency verification, and group aggregation.

3.1 Hierarchy Structure

The decision model comprises three levels. Level 1 (Goal): prioritization of consumer criteria for sustainable e-commerce packaging. Level 2 (Criteria, n = 4) and Level 3 (Sub-criteria, m = 12, three per criterion) are summarized in Table 1.

Table 1. AHP hierarchy of criteria and sub-criteria

Criterion (Level 2)	Sub-Criteria (Level 3)
C1 Functional Protection	SC11 Impact & Shock Absorption; SC12 Moisture & Barrier Resistance; SC13 Tamper & Seal Security
C2 Environmental Performance	SC21 Circular Recyclability; SC22 Biodegradability & Compostability; SC23 Material Minimization
C3 Economic & Cost Viability	SC31 Direct Green Surcharge; SC32 Free Return Reusability; SC33 Perceived Value for Money
C4 Post-Purchase Usability	SC41 Domestic Sorting & Disposal Ease; SC42 Unboxing Ergonomics; SC43 On-Pack Eco-Label Transparency

Source: Authors

3.2 Questionnaire Design and Scaling

Pairwise comparisons use Saaty's fundamental 1–9 scale (1 = equal importance, 3 = moderate, 5 = strong, 7 = very strong, 9 = extreme; 2, 4, 6, 8 = intermediate judgments). Because comparison matrices are reciprocal ($a_{ji} = 1/a_{ij}$), the number of independent comparisons for a matrix of size k is $N = k(k - 1) / 2$. This yields 6 comparisons for the Level 2 matrix (k = 4) and 3 comparisons for each of the four Level 3 matrices (k = 3, 12 comparisons total), for 18 pairwise judgments per respondent.

3.3 Priority Computation and Consistency Verification

For each respondent, judgments form a reciprocal matrix $A = [a_{ij}]$, with $a_{ii} = 1$ and $a_{ji} = 1/a_{ij}$. Local priority weights w_i are obtained by column-normalizing the matrix and averaging across rows:

$w = [w_1, w_2, \ldots, w_k]^T$, $\Sigma w_i = 1$

Judgment validity is verified through eigenvalue theory. The principal eigenvalue λmax solves Aw = λmaxw and is estimated as the mean of (Aw)i / wi across all i. The Consistency Index and Consistency Ratio are then computed as:

CI = (λmax − k) / (k − 1) CR = CI / RI

where RI is Saaty's simulated Random Index for matrix order k (Table 2). A matrix is accepted if CR < 0.10; matrices with CR ≥ 0.10 indicate intransitive judgments and require revision or exclusion.

Table 2. Random Index (RI) by matrix order

k	1	2	3	4	5	6	7	8
RI	0	0	0.6	1	1.1	1.2	1.3	1.41

Source: Authors

3.3.1 Global Priority Synthesis

Level 3 local weights are multiplied by their parent Level 2 weight to obtain global priority weights:

$W(sc_{ij}) = w(c_i) \times w(sc_{ij})$, $\Sigma_i \Sigma_j W(sc_{ij}) = 1.00$

3.3.2 Group Aggregation

Individual pairwise judgments (p = 1, …, P) are consolidated using the Geometric Mean Method, which preserves matrix reciprocity:

$a^G ij = (\Pi_p a^p ij)^(1/P)$

The synthesized group matrix A^G satisfies $a^G ji = 1/a^G ij$, from which group-level priority vectors and aggregate consistency ratios are computed using the same procedure applied to individual matrices.

4. Results and Analysis

This section reports the empirical findings derived from the aggregated Analytic Hierarchy Process (AHP) matrices. A panel of 18 frequent e-commerce consumers and packaging domain observers completed the pairwise comparison instrument. Individual matrices were first screened against the transitivity condition (CR < 0.10), and judgments meeting this criterion were synthesized using the Geometric Mean Method (GMM) to produce group-level priority vectors.

4.1 Main Criteria Prioritization (Level 2)

Table 3 presents the aggregated pairwise comparison matrix for the four Level 2 dimensions, together with the resulting local priority weights.

Table 3. Aggregated pairwise comparison matrix and local weights for main criteria

Criteria	C1	C2	C3	C4	Local Weight (w_i)
C1: Functional Protection	1	2.14	1.78	2.8	0.421
C2: Environmental Performance	0.47	1	0.81	1.6	0.214
C3: Economic Viability	0.56	1.24	1	1.9	0.246
C4: Post-Purchase Usability	0.36	0.62	0.54	1	0.119

Source: Authors

Consistency verification yielded λmax = 4.024, CI = 0.008, and CR = 0.0089 (0.89%). This is well below the 0.10 acceptance threshold (Saaty, 1980), so respondent judgments show a high degree of logical stability. The resulting priority vector indicates that Functional Protection (w = 0.421) dominates consumer decision priorities, accounting for over 42% of total decision weight. Economic Viability (w = 0.246) ranks second, closely followed by Environmental Performance (w = 0.214), while Post-Purchase Usability (w = 0.119) is prioritized last.

4.2 Sub-Criteria Evaluation (Level 3)

Local weights for each sub-criteria cluster were derived from separate 3 × 3 matrices, aggregated via the geometric mean. Results, together with associated consistency statistics, are summarized in Table 4.

Table 4. Local sub-criteria weights and consistency statistics by dimension

Main Criterion	Sub-Criterion	Local Weight (wsc)	λmax	CI	CR
C1: Functional Protection	SC11 Impact & Shock Absorption	**0.584**	3.02	0	

	SC12 Moisture & Barrier Resistance	0.135			0.016
	SC13 Tamper & Seal Security	0.281			
C2: Environmental Performance	SC21 Circular Recyclability	**0.528**	3.03	0	0.024
	SC22 Biodegradability & Compostability	0.334			
	SC23 Material Minimization	0.138			
C3: Economic Viability	SC31 Direct Green Surcharge	0.158	3.01	0	0.01
	SC32 Free Return Reusability	0.298			
	SC33 Perceived Value for Money	**0.544**			
C4: Post-Purchase Usability	SC41 Domestic Sorting & Disposal Ease	**0.592**	3.01	0	0.007
	SC42 Unboxing Ergonomics	0.182			
	SC43 On-Pack Eco-Label Transparency	0.226			

Source: Authors

All four sub-matrices returned consistency ratios well within the acceptable range (CR < 0.10), so pairwise judgments at the sub-criteria level can be treated as reliable.

4.3 Global Priority Synthesis and Ranking

Global priority weights ($Wsc_{ij} = wc_i \times wsc_{ij}$) were computed to integrate local sub-criteria performance into an overall ranking across all 12 evaluated attributes. Results are presented in Table 5.

Table 5. Global priority weights and final ranking of sub-criteria

Main Criterion (wc)	**Sub-Criterion**	**Local Weight (wsc)**	**Global Weight (Wsc)**	**Rank**
Functional Protection (0.421)	SC11 Impact & Shock Absorption	0.584	0.2459	1
	SC13 Tamper & Seal Security	0.281	0.1183	3
	SC12 Moisture & Barrier Resistance	0.135	0.0568	8
Economic Viability (0.246)	SC33 Perceived Value for Money	0.544	0.1338	2
	SC32 Free Return Reusability	0.298	0.0733	5
	SC31 Direct Green Surcharge	0.158	0.0389	11
Environmental Performance (0.214)	SC21 Circular Recyclability	0.528	0.113	4
	SC22 Biodegradability/Compostability	0.334	0.0715	6
	SC23 Material Minimization	0.138	0.0295	12
Post-Purchase Usability (0.119)	SC41 Domestic Sorting & Disposal Ease	0.592	0.0704	7
	SC43 On-Pack Eco-Label Transparency	0.226	0.0269	10
	SC42 Unboxing Ergonomics	0.182	0.0217	9

Source: Authors

5. Key Findings and Theoretical Implications

5.1 The primacy of transit utility over sustainability:

The highest-ranked attribute across all 12 sub-criteria is Impact & Shock Absorption (W = 0.2459, Rank 1). Consumers appear to treat basic product safety as a non-negotiable threshold requirement rather than a trade-off variable. This fits a systems-level view in which a failed sustainable package, and the resulting product damage, causes greater net resource loss through reverse logistics and replacement shipping than any material-level environmental saving.

5.2 Economic sensitivity overrides green willingness to pay:

Perceived Value for Money (W = 0.1338, Rank 2) outranks every environmental sub-criterion, while willingness to absorb a Direct Green Surcharge (W = 0.0389, Rank 11) ranks near the bottom of the hierarchy. This divergence gives empirical support to the structural mechanism behind the attitude-behaviour (green) gap: consumers favour sustainability in principle but expect e-tailers to absorb the cost of packaging transition rather than pass it on as a checkout surcharge.

5.3 Curbside recyclability outweighs biodegradability:

Within the environmental dimension, Circular Recyclability (W = 0.1130, Rank 4) carries substantially more weight than Biodegradability & Compostability (W = 0.0715, Rank 6). This fits consumer familiarity with established municipal recycling infrastructure (e.g., standard paper and cardboard collection), compared with compostable materials, which typically require industrial composting facilities not widely accessible to urban households.

5.4 Frictionless disposal matters more than unboxing aesthetics:

Under Post-Purchase Usability, Domestic Sorting & Disposal Ease (W = 0.0704, Rank 7) exceeds Unboxing Ergonomics (W = 0.0217, Rank 9) by a wide margin. Consumers appear to place more value on packaging that collapses cleanly into standard waste and recycling streams than on the experiential quality of the unboxing process itself.

5. Limitations and Future Research

Several limitations qualify these findings. The panel of 18 respondents, while consistent with AHP's convention of using a focused expert or informed-consumer group rather than a large probabilistic sample, limits generalizability to the broader e-commerce population. It also precludes subgroup analysis by demographic, income, or product-category characteristics, any of which could shift the relative weighting of the four criteria. AHP itself carries further methodological constraints. It captures stated preferences under a structured comparison task, which may not fully correspond to revealed behaviour at checkout or disposal, particularly given the attitude-behaviour gap this study seeks to explain. The crisp 1–9 scale also assumes respondents can translate qualitative judgments into precise numerical ratios, an assumption that fuzzy or interval-based extensions of AHP are designed to relax. The hierarchy tested here is further limited to four criteria and twelve sub-criteria drawn from the reviewed literature, excluding other potentially relevant factors such as carbon-footprint labelling, blockchain-based traceability, or brand-level sustainability reputation. Finally, the study reflects a single point in time and a single market context; consumer priorities are likely sensitive to regional regulatory environments, the maturity of local recycling and composting infrastructure, and prevailing cultural attitudes toward environmental responsibility, none of which were varied or controlled for in this design. Future research should address these constraints in several ways. Larger, more demographically diverse samples would allow segment-level comparison of priority weights, for instance across age cohorts, income brackets, or product categories with differing fragility and value profiles, to test whether the dominance of Functional Protection observed here holds uniformly or varies by segment. Methodologically, integrating fuzzy AHP or hybrid AHP-DEMATEL approaches could better accommodate the linguistic imprecision and interdependence among criteria that a crisp comparison scale cannot capture. Complementing the stated-preference data collected here with revealed-preference data, such as checkout behaviour, return rates, or willingness-to-pay experiments, would help validate whether these priority weights predict actual purchasing and disposal decisions. Cross-cultural replication in markets with differing recycling

infrastructure, regulatory stringency, and environmental norms would test the boundary conditions of the findings, particularly the observed preference for curbside recyclability over compostability, which may not generalize where industrial composting is more accessible. Future studies could also extend the hierarchy to incorporate emerging innovations, such as smart or traceable packaging and carbon-labelling schemes, and adopt longitudinal designs to assess whether consumer priorities shift in response to platform-level interventions, such as visible sustainability messaging or default checkout options that reduce the salience of green surcharges.

References

[1] H. Ariff, M. S. Salit, N. Ismail, and Y. Nukman, "Use of analytical hierarchy process (AHP) for selecting the best design concept," *J. Adv. Manuf. Technol.*, vol. 2, no. 1, pp. 1–18, 2008.

[2] M. Ertz, R. Huang, M. S. Jo, F. Karakas, and E. Sarigöllü, "From single-use to circular packaging: An empirical study on consumer willingness to pay for green packaging in digital environments," *Resour. Conserv. Recycl.*, vol. 126, pp. 234–244, Nov. 2017.

[3] M. Ketelsen, M. Janssen, and U. Hamm, "Consumers' response to environmentally-friendly food packaging: A systematic review," *J. Clean. Prod.*, vol. 254, p. 120123, May 2020.

[4] H. Lindh, H. Williams, A. Olsson, and F. Wikström, "Elucidating the role of packaging in reducing food waste: Designing sustainable packaging from a consumer perspective," *Packag. Technol. Sci.*, vol. 29, no. 4–5, pp. 225–245, Apr.–May 2016.

[5] L. Luo, X. Cheng, and X. Wu, "An integrated Kano-AHP-QFD approach for design concept evaluation and selection," *Int. J. Prod. Res.*, vol. 55, no. 21, pp. 6340–6357, Nov. 2017.

[6] L. Magnier and D. Crié, "Communicating packaging eco-friendliness: An exploration of consumers' perceptions of eco-designed packaging," *Int. J. Retail Distrib. Manag.*, vol. 43, no. 4/5, pp. 350–366, Apr. 2015.

[7] S. Otto, M. Strenger, A. Maier-Nöth, and M. Baur, "Food packaging and sustainability: Consumer perception vs. environmental impact," *J. Clean. Prod.*, vol. 298, p. 126733, May 2021.

[8] T. L. Saaty, "A scaling method for priorities in hierarchical structures," *J. Math. Psychol.*, vol. 15, no. 3, pp. 234–281, Jun. 1977.

[9] T. L. Saaty, *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*. New York, NY, USA: McGraw-Hill, 1980.

[10] T. L. Saaty, "Decision making with the Analytic Hierarchy Process," *Int. J. Serv. Sci.*, vol. 1, no. 1, pp. 83–98, 2008.

[11] N. D. Steenis, E. van Herpen, I. A. van der Lans, T. N. Ligthart, and H. C. van Trijp, "Consumer response to packaging design: The role of packaging materials and environmental claims in packaging evaluations," *Food Qual. Prefer.*, vol. 60, pp. 189–197, Sep. 2017.

[12] G. Wandosell, M. C. Parra-Meroño, A. Alcayde, and R. Baños, "Green packaging from consumer and business perspectives: A systematic literature review," *Sustainability*, vol. 13, no. 3, p. 1356, Jan. 2021.

[13] M. Gundwal and N. K. Sharma, "Optimizing sustainability in allium crop supply chains: a framework for enhancing efficiency and circular economy practices in India," *J. Int. Logist. Trade*, ahead-of-print, pp. 1–41, 2026, doi: 10.1108/JILT-07-2025-0055.