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Statistical Modelling of Sustainable Digital Consumerism: Data-driven Strategies for Environmental and Social Impact in Indian markets

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Abstract: In an era where sustainability is both a corporate mandate and a societal-imperative, digital-marketing offers a transformative pathway for advancing environmentally responsible and socially inclusive consumer behavior. This research investigates how Indian businesses can strategically recalibrate their digital marketing approaches to embed sustainability principles at scale. Anchored in India's distinctive socio-economic and cultural landscape, the study contextualizes Sustainable-Digital-Consumerism (SDC) through the lens of post-COVID-19 digital acceleration, heightened environmental consciousness, and evolving consumer expectations. A comprehensive mixed-methods design was adopted, integrating primary survey responses from 600 urban and peri-urban consumers with secondary e-commerce transaction data, product Life-Cycle-Assessment (LCA) metrics, and social media analytics. The Sustainable-Consumerism-Index (SCI) was developed using EFA (KMO = 0.803, Cronbach's α = 0.87), yielding five robust dimensions: environmental concern, social responsibility, trust in sustainability claims, convenience, and affordability. Advanced analytics - including Bayesian hierarchical regression, Structural-Equation-Modelling (CFI = 0.961, RMSEA = 0.044), Propensity-Score-Matching, Difference-in-Differences, and RF-classification (AUC = 0.91) - demonstrate that a one standard deviation increase in SCI boosts purchase odds by 46%, while eco-label presence increases likelihood by 34%. Interventions produced a 16.5 percentage point net uplift in sustainable purchase rates, with scalability projections indicating potential annual reductions of 5.3 Mt CO_{2e}, 1.9 billion litres in water-savings, and diversion of 260,000 tonnes of waste from landfills. Findings underscore that SDC is not only feasible but essential in India's competitive digital-economy. The proposed strategic framework - aligned with SDG-12 (Responsible-Consumption-and-Production) and SDG-13 (Climate Action) - equips marketers, policymakers, and platform designers with evidence-based, statistically-rigorous, and operationally scalable tools to drive responsible growth through innovation, transparency, and environmental stewardship.

Keywords: Bayesian Analytics, ESG Strategy, Green Digital Marketing, Sustainable Consumerism Index, Structural Equation Modelling, Sustainable Development Goals

Introduction

Over the past decade, digitalization has fundamentally reshaped consumer behavior by altering how individuals search for information, evaluate product alternatives, and make purchase decisions. In India, this transformation has been particularly striking, driven by the convergence of widespread smartphone adoption, affordable data availability, and the exponential rise of digital payment infrastructures such as the Unified Payments Interface (UPI). Together, these forces have enabled consumers to transition rapidly toward digital-first shopping experiences, with e-commerce and mobile commerce becoming integral to daily consumption practices (Kannan & Li, 2017; Kapoor et al., 2021). While this transition creates significant opportunities to scale sustainable products

through digital platforms, it also raises risks: without embedding sustainability principles into the architecture of digital marketplaces, these same systems may unintentionally accelerate unsustainable consumption patterns (Mont et al., 2021).

The rapid expansion of digital technologies has fundamentally changed the way consumers search for products, compare options, and make purchase decisions. In India, this transformation has been accelerated by the sharp increase in smartphone ownership, low-cost internet availability, and the wide adoption of digital payment systems such as the Unified Payments Interface (UPI). These developments have positioned digital platforms as a central gateway for modern consumption (Kannan & Li, 2017; Kapoor et al., 2021). The impact, however, is twofold: while digital commerce creates enormous potential to promote sustainable products at scale, it also risks reinforcing unsustainable patterns of consumption if sustainability is not embedded into consumer choice environments from the outset (Mont et al., 2021).

This creates the urgent need to understand and strengthen sustainable digital consumerism. For the purpose of this study, sustainable digital consumerism is described as consumer decision-making in digital ecosystems that is actively influenced by interventions designed to lower environmental footprints and enhance social inclusivity. These interventions may include eco-labels, traceability certifications, sustainability filters on e-commerce platforms, recommender systems optimized for low-impact products, or influencer-led sustainability campaigns. Together, such digital signals can shift not only individual choices but also wider market demand, ultimately influencing production and supply chain practices (Thøgersen et al., 2019; Sunstein, 2020).

Research Context and Background

Sustainable consumption literature has consistently noted the attitude–behavior gap, where consumers often voice a preference for environmentally responsible options but fail to follow through in practice. This gap is particularly visible in emerging economies such as India, where competing priorities—price sensitivity, limited availability of eco-friendly products, and uncertainty about the credibility of green claims—limit sustainable action (Joshi & Rahman, 2015; White et al., 2019). The rise of digital platforms, however, offers new tools to reduce this gap. Behavioral science has shown that interventions such as framing effects, nudges, or the use of defaults can shift decisions in meaningful ways, especially when linked to credible product information (Thaler & Sunstein, 2008; Benartzi et al., 2017). For example, an e-commerce platform that makes sustainable options the default or prominently highlights verified eco-labels can significantly improve adoption rates. In addition, trust remains a decisive factor in digital contexts. The risk of greenwashing, where companies exaggerate or misrepresent sustainability claims, continues to undermine credibility. Therefore, strategies that integrate transparent communication and third-party verified sustainability indicators are critical to ensuring long-term consumer confidence (Delmas & Burbano, 2011).

Opportunities in Digital Transformation

The intersection of digitalization and sustainability opens up new possibilities for data-driven interventions. Artificial intelligence, recommender systems, and predictive analytics enable businesses to deliver personalized sustainability nudges, making it easier for consumers to align their behavior with their values (Davenport et al., 2020; Jannach et al., 2021). Moreover, recent advances in causal inference methods and statistical modelling allow researchers to evaluate the real impact of these digital nudges on consumer behavior. Techniques such as Bayesian hierarchical modelling, uplift modelling, and Difference-in-Differences (DiD) designs help establish not only correlations but also causal effects, providing stronger evidence for decision-making (Imbens & Rubin, 2015; Hill et al., 2020). Despite these advances, much of the existing research remains focused on consumer intentions rather than actual outcomes, and studies in India often lack integration across multiple data sources. There is a shortage of frameworks that bring together survey responses, transaction-level insights, and product-level Life Cycle Assessment (LCA) data to measure how digital interventions translate into tangible environmental and social impacts (Vanclay et al., 2019; Sala et al., 2021). This study aims to close that gap by using a comprehensive, statistically rigorous, and contextually grounded approach.

Conceptualizing Sustainable Digital Consumerism

This study positions sustainable digital consumerism as a multidimensional construct requiring three key pillars:

1. *Measurement*: Development of interpretable, validated indices of sustainable choice that are applicable across multiple product categories.
2. *Causal Evidence*: Application of robust statistical and econometric tools to determine how digital interventions change actual consumer behavior.

3. *Deployment Pathways*: Integration of sustainability outcomes (emissions avoided, water savings, waste reduction) with traditional marketing KPIs (conversion rates, ROI, loyalty).

By linking micro-level consumer responses with macro-level sustainability performance, the study demonstrates how digital sustainability strategies can serve as both a moral imperative and a competitive advantage (Porter & Kramer, 2019).

Bridging the Attitude–Behavior Gap

The gap between what consumers say and what they do remains one of the central challenges in sustainable consumption. Prior evidence shows that online nudges, such as default filters for sustainable options, real-time feedback on environmental savings, and personalized product recommendations, can shift decision-making significantly (Allcott & Rogers, 2014; Carlsson et al., 2021). Yet, consumer skepticism regarding exaggerated sustainability claims continues to present barriers. The present research directly addresses this by embedding verified LCA data and social impact indicators into the empirical design, ensuring that digital interventions rest on credible and transparent information (Delmas & Burbano, 2011).

Research Contributions

This paper contributes to scholarship and practice in three distinct ways:

1. *Development of the Sustainable-Consumerism-Index (SCI)*: A composite metric combining consumer perceptions, verified product sustainability attributes, and social impact indicators. Validated through exploratory factor analysis, the SCI provides a reliable measure of consumer readiness for sustainable adoption.
2. *Rigorous Analytical Framework*: By combining Propensity Score Matching, Difference-in-Differences, Bayesian hierarchical regression, and Structural Equation Modelling, the study produces robust causal evidence of how digital sustainability interventions influence consumer behavior (Imbens & Rubin, 2015; Pearl & Mackenzie, 2018).
3. *Practical Deployment Strategies*: The study demonstrates how recommender algorithms, sustainability filters, and IoT-enabled product traceability can improve sustainable conversions without undermining profitability (Wamba et al., 2020; Kache & Seuring, 2017).

Data and Methodological Integration

The study draws on four integrated datasets:

- Primary surveys with 600 urban and peri-urban consumers
- Aggregated e-commerce transaction data
- LCA metrics from verified public and commercial databases
- Social media engagement data capturing responses to sustainability messaging

Monte Carlo simulations are further used to project macro-level environmental outcomes, such as annual CO₂ savings, water conservation, and waste reduction. This methodological integration ensures both reliability and practical relevance, linking micro-level consumer decisions with macro-level sustainability gains.

Alignment with SDGs

The study's contributions align closely with the United Nations Sustainable Development Goals, reinforcing both academic and practical relevance. Specifically, it advances SDG 12 (Responsible Consumption and Production) by promoting consumer adoption of sustainable digital choices, thereby embedding environmentally responsible behavior directly into everyday purchasing decisions. It further supports SDG 9 (Industry, Innovation, and Infrastructure) through the use of advanced digital infrastructures, such as recommender systems, IoT-enabled traceability, and big data analytics, to drive scalable and innovative pathways for sustainability in commerce. Finally, the research contributes to SDG 13 (Climate Action) by providing robust statistical evidence that quantifies the environmental outcomes of sustainable consumer behavior, including measurable reductions in carbon emissions, water usage, and waste generation. Together, these contributions highlight how sustainable digital consumerism can serve as a bridge between technological innovation, responsible market practices, and climate-responsive strategies for inclusive growth.

Literature Review

The rise of digital platforms has reshaped consumer behavior, offering both opportunities and barriers for advancing sustainability. While eco-labels, digital nudges, and social media campaigns can promote greener choices, gaps in trust, affordability, and actual behavior remain. Against this backdrop, recent studies provide critical insights into the drivers of sustainable digital consumerism, few of which are listed here as follows:

1. *Wang, Zhang, Yin, and Zhang (2022)* highlighted the enduring attitude–behavior gap in sustainable consumption. They showed that consumer confidence in their ability to act sustainably, together with clear intention-setting, plays a decisive role in converting pro-environmental attitudes into actual choices. This underscores the relevance of embedding behavioral self-efficacy into frameworks for sustainable digital consumerism.
2. *Chen et al. (2021)* advanced this discourse through a meta-analysis of determinants of green purchase behavior. Their findings revealed that favorable attitudes, social influence, and consumers' belief in their effectiveness consistently drive sustainable purchase intentions. Such results provide the statistical backbone for constructing multidimensional indices such as the Sustainable Consumerism Index (SCI).
3. *Magnier, Riviere, and Roux (2022)* demonstrated that the design and visual clarity of eco-labels in online retail significantly affect consumer responses. Labels with simple layouts increased trust and purchase intention, revealing the importance of effective information architecture in digital interventions.
4. Building on this, *Li and Xie (2022)* emphasized that interactive digital features, such as zoom-in inspection options, foster consumer confidence in sustainability claims. Their research suggests that user interface design can serve as a subtle yet powerful nudge for encouraging green product adoption.
5. *De Marchi, Banterle, and Stranieri (2024)* reviewed eco-label practices in the food sector, pointing out that standardization and verification substantially improve consumer confidence. Their work supports the inclusion of trustworthiness as a key dimension in SCI and emphasizes consistency in digital communication strategies.
6. Similarly, *Sousa-Pinto et al. (2024)* found that eco-labels achieve the strongest outcomes when applied at a category-wide and harmonized level, rather than through fragmented initiatives. Their findings advocate for scaling sustainability efforts across platforms to achieve broader impact.
7. *Nyilasy, Gangadharbatla, and Paladino (2021)* examined the negative effects of greenwashing and reported that unverified claims diminish consumer trust and obstruct sustainable purchase behavior. Their insights highlight the necessity of incorporating credibility checks and verification tools within digital marketing for sustainability.
8. *Anisimova and Vrontis (2024)* investigated blockchain-enabled food traceability, demonstrating that transparent provenance enhances trust and purchase intention for sustainable and organic goods. Their findings support the integration of Internet of Things (IoT) and blockchain solutions into consumer-facing platforms to strengthen credibility.
9. *Zhou and Li (2024)* extended this perspective by showing that traceability systems mitigate consumers' perceived risks, thereby increasing their likelihood of adopting eco-friendly options. This evidence validates the experimental inclusion of traceability badges within digital commerce strategies.
10. *Testa, Miroshnychenko, and Hansen (2023)* reviewed green marketing strategies and found that genuine alignment between organizational practices and sustainability claims is critical for credibility. Their recommendations provide guidance for linking marketing KPIs with environmental performance indicators within the SCI framework.
11. In parallel, *Shareef, Mukerji, Dwivedi, Rana, and Islam (2022)* reported that green-focused social media activities significantly influence consumer behavior by building engagement and trust. Their findings affirm the strategic role of ESG-aligned storytelling on digital platforms.
12. *Iglesias, Markovic, and Rialp (2024)* also underscored the influence of sustainability narratives on social media, showing that such messages foster deeper brand loyalty and longer-term consumer commitment. These findings extend the managerial case for integrating sustainability messaging into digital CRM strategies.
13. *Gupta and Singh (2021)* explored green apparel consumption in India and observed that affordability, knowledge, and social norms are major enablers of sustainable purchase decisions. Their results highlight affordability and social responsibility as vital constructs in SCI, particularly relevant to developing economies.
14. *Mukherjee and Kapoor (2024)* investigated the green marketing mix and confirmed that tailoring product, price, and promotion strategies to sustainability considerations significantly boosts consumer intention to purchase. This evidence validates the role of managerial decision-making in embedding sustainability into marketing practices.
15. *Mirsch, Lehrer, Jung, and Wölfl (2025)* provided a systematic review of digital nudging, identifying interventions such as defaults, framing, and social proof as especially effective in online contexts. Their work offers a clear taxonomy that can inform the experimental design of this study.

16. Further advancing the technological aspect, *Felfernig, Friedrich, Jannach, and Zanker (2023)* examined sustainability-oriented recommender systems and showed that multi-objective algorithms can prioritize eco-friendly products without compromising personalization. Their findings directly support the inclusion of algorithmic interventions in sustainable digital consumerism.
17. On the analytics side, *Wamba, Queiroz, and Trinchera (2024)* demonstrated that big data analytics capabilities significantly enhance firms' sustainability performance across economic, social, and environmental dimensions. Their study justifies the deployment of SEM, Bayesian models, and machine learning for robust analysis in this research.
18. *Del Giudice, Scuotto, and Papa (2023)* emphasized that digital transformation enables firms to pursue "sustainability ambidexterity," balancing profitability with environmental responsibility. Their insights underline the managerial imperative of embedding SCI into strategic business models.
19. From an Indian generational lens, *Kautish and Sharma (2019)* revealed that millennial consumers display strong environmental values and identity-driven motivations, making them highly receptive to green products. This validates the inclusion of environmental concern as a key SCI dimension.
20. Finally, *White, Habib, and Hardisty (2019)* synthesized behavioral science insights and recommended scalable nudging strategies such as credible information, simplified defaults, and continuous feedback. Their framework aligns with SCI's behavioral architecture and provides actionable guidance for digital sustainability interventions.

Objectives of the Study

1. To develop a Sustainable Consumerism Index (SCI) for Indian digital consumers by integrating survey, transaction, and life-cycle data.
2. To examine the causal impact of digital sustainability interventions (eco-labels, recommender filters, influencer campaigns) on actual purchase behavior using advanced econometric and machine learning models.
3. To quantify the environmental and social impacts of digital consumer decisions through statistical integration of Life Cycle Assessment (LCA) indicators.
4. To evaluate the scalability of sustainable digital consumerism strategies for Indian e-commerce platforms using simulation-based projections.

Hypotheses of the study

This study outlines the following hypotheses to assess how metadata, validation methods, and search strategies contribute to improving research ideas and outcomes

Hypothesis-1

H₀₁: There is no significant difference in the feasibility of research ideas generated with metadata compared to those generated without metadata. Vs

H₁₁: Research ideas generated with metadata show significantly higher feasibility than those generated without metadata.

Hypothesis-2

H₀₂: Automatic validation during idea selection does not significantly improve the quality of research ideas compared to selection without validation. Vs

H₁₂: Automatic validation during idea selection significantly improves the quality of research ideas compared to selection without validation.

Hypothesis-3

H₀₃: The hybrid search strategy does not significantly outperform database-only searches in identifying relevant primary studies. Vs

H₁₃: The hybrid search strategy significantly outperforms database-only searches in identifying relevant primary studies.

Materials and Methods

This study employed a rigorous, mixed-method explanatory design to statistically model sustainable digital consumerism in the Indian market context. The methodological framework was structured to capture both attitudinal and behavioral dimensions of sustainability-oriented digital consumption and to establish causal evidence regarding

the effectiveness of data-driven interventions. The design integrated primary survey responses, experimental stimuli, transaction-level e-commerce data, life cycle assessment (LCA) metrics, and social media analytics. By combining econometric models with advanced statistical learning techniques, the methodology ensured both internal validity and external applicability.

Research Design

The research followed a sequential, four-phase methodological structure: (1) construct development through exploratory and confirmatory statistical analysis, (2) survey instrument design and experimental mock-up creation, (3) data collection from primary and secondary sources, and (4) multi-level statistical modelling and simulation of outcomes. This explanatory framework enabled not only descriptive understanding but also inferential and predictive modelling of consumer behavior in digital ecosystems.

Study Population and Sampling

The primary survey targeted urban and peri-urban Indian consumers, reflecting the demographic most exposed to digital commerce platforms. A stratified random sampling approach was applied to ensure representation across gender, age groups, income categories, and geographic tiers (Tier 1, Tier 2, and Tier 3 cities). The final sample size for the primary survey consisted of 600 respondents. The sample size was determined to ensure adequate statistical power for multivariate analyses, including Structural Equation Modelling and causal inference techniques. A sample of 600 respondents exceeds commonly recommended thresholds for stable parameter estimation in SEM and provides sufficient power ($\alpha = 0.05$, $\beta = 0.80$) to detect meaningful effects across multiple latent constructs and covariates.

Data Sources:

Four complementary datasets were used to ensure robustness and triangulation:

Primary Survey Data: Structured questionnaires measured consumer demographics, digital consumption patterns, attitudes toward sustainability, willingness to pay, and trust in eco-labels and certifications. Five-point Likert scales were applied to capture perceptions and behavioral intentions.

Experimental Stimuli: Mock product listings, designed to simulate e-commerce interfaces, were employed in an A/B format. Respondents were randomly exposed to either standard listings or listings enhanced with sustainability cues (eco-labels, carbon footprint tags, traceability links). Their purchase intention, click-through likelihood, and choice preference were recorded.

Secondary E-Commerce Data: Aggregated transaction data from two leading Indian platforms provided sales distributions of sustainable versus conventional products over a three-year period (2021–2023). This dataset allowed alignment between stated preferences and actual purchasing outcomes.

Environmental and Social Indicators: LCA-based product impact metrics for CO₂ emissions, water use, and waste generation were integrated with social responsibility indices (e.g., fair-trade, local community benefit tags). These indicators provided quantitative bases for linking micro-level behavior with macro-level sustainability impacts.

Mitigation of Internal Biases: To mitigate internal biases arising from both primary and secondary data sources, several procedural and statistical safeguards were implemented. For primary data collection, stratified random sampling ensured balanced representation across gender, age groups, income categories, and urban–peri-urban regions, thereby reducing selection bias. Standardized questionnaire items adapted from validated scales were employed to minimize measurement bias. Regarding secondary datasets, only aggregated and anonymized e-commerce transaction data and LCA-indicators from verified sources were used, limiting reporting and confidentiality biases. During analysis, PSM and DiD-techniques were applied to control for self-selection and confounding effects, strengthening internal validity and causal interpretation.

Measurement Constructs: The core construct was the Sustainable Consumerism Index (SCI), developed through exploratory factor analysis (EFA). Variables included environmental concern, trust in sustainability claims, affordability considerations, convenience in accessing sustainable alternatives, and perceived social impact. Items loading above 0.6 were retained, and Cronbach's alpha values above 0.8 confirmed internal consistency. Confirmatory factor analysis (CFA) validated dimensionality and model fit, with goodness-of-fit indices meeting conventional thresholds (CFI > 0.95, RMSEA < 0.05).

Analytical Framework: *The data analysis proceeded in multiple stages, each aligned with a statistical objective:*

Descriptive and Reliability Analysis: Initial descriptive statistics profiled consumer attitudes and behaviors. Reliability checks ensured stability of scales, while correlation matrices identified Multicollinearity risks.

Bayesian Hierarchical Regression: To capture heterogeneity across socio-demographic strata and product categories, Bayesian logistic regression models were estimated using Hamiltonian Monte Carlo sampling. Posterior distributions provided robust estimates of sustainable purchase probabilities while accounting for uncertainty and regional variance.

Structural Equation Modelling (SEM): SEM tested causal pathways between attitudes, intentions, and behavior, and evaluated the mediating role of trust and digital interventions. Path coefficients and indirect effects provided evidence for the attitude–behavior gap and the role of sustainability cues in bridging it.

Propensity Score Matching (PSM): To mitigate selection bias in exposure to interventions, treated (exposed to sustainability cues) and control (unexposed) groups were matched on socio-demographic variables. Balance diagnostics (standardized mean differences < 0.1) confirmed matching adequacy.

Difference-in-Differences (DiD): Pre-post intervention outcomes were compared across treatment and control groups to estimate causal effects. Robust standard errors were applied to account for potential clustering.

Machine Learning Models: Random Forest and XGBoost classifiers were used to predict sustainable purchase likelihood. Feature importance analysis ranked predictors, highlighting the relative contribution of SCI, eco-label presence, and affordability. Uplift modelling identified consumer subgroups most responsive to sustainability nudges.

Monte Carlo Simulations: To extrapolate national-level outcomes, simulations were conducted under scenarios of 10%, 30%, and 50% adoption of sustainable digital interventions. Environmental indicators (CO₂ savings, water conservation, waste reduction) were modelled across 10,000 iterations to generate confidence intervals.

Ethical Considerations:

Informed consent was obtained from all participants prior to data collection, and participation was voluntary and anonymous. No personally identifiable information was collected, and the study involved minimal risk to participants. The questionnaire was originally developed in English and administered in the same language. For transparency and reviewer reference, the English version of the questionnaire is provided as Appendix C.

Software and Statistical Tools

Data processing and analysis employed a combination of tools: IBM SPSS v26 for descriptive statistics and EFA, R (*brms*, *lavaan*, *MatchIt* packages) for Bayesian modelling, SEM, and PSM, and Python (*scikit-learn*, *XGBoost*) for machine learning. Monte Carlo simulations were implemented in R using custom scripts. Reliability and reproducibility were prioritized by archiving scripts and anonymized datasets on open science platforms.

Methodological Strengths

This integrated methodological framework combined psychometric measurement, econometric modelling, and computational simulations to comprehensively evaluate *sustainable digital consumerism*. The triangulation of primary, behavioral, and environmental data enhanced construct validity, while advanced causal inference tools ensured internal validity. The multi-level approach allowed both micro-level consumer responses and macro-level sustainability outcomes to be quantified, aligning directly with the study's objective of bridging the attitude-behavior gap in the Indian digital marketplace.

Result and Analysis

The results of this study are presented based on a comprehensive integration of primary survey responses (n = 600), secondary e-commerce transaction data, Life Cycle Assessment (LCA) metrics, and social media analytics. Advanced statistical and machine learning techniques implemented through IBM SPSS v26.0, R (v4.3.2), and Python (*scikit-learn*) were applied to uncover patterns, test hypotheses, and quantify the impact of digital sustainability interventions. The analysis is structured to evaluate both behavioral outcomes and environmental implications, providing actionable insights for digital marketers, policymakers, and sustainability advocates.

Descriptive and Reliability Analysis:

The descriptive statistics reveal a generally positive inclination among Indian digital consumers toward sustainable purchasing. Environmental concern scored the highest mean (4.10), indicating strong awareness of carbon footprints, eco-friendly packaging, and climate impact, which aligns with the research objective of identifying key drivers of

sustainable behavior. Social responsibility (mean = 3.94) and trust in sustainability claims (mean = 3.86) suggest that consumers value ethical practices and verified eco-labels when making online purchase decisions. In contrast, convenience (mean = 3.48) and affordability (mean = 3.39) scored relatively lower, highlighting practical barriers in accessing sustainable products or willingness to pay a premium. Overall, the results suggest that while attitudinal factors strongly favor sustainability, logistical and economic constraints may limit actual purchase behavior. These insights support targeted interventions through digital nudges and marketing strategies, directly contributing to SDG 12 (Responsible Consumption) and SDG 13 (Climate Action).

Table 1: Descriptive Analysis (n=600)

Variable	Category	Frequency	Percentage (%)
Age	18–25	120	20
	26–35	210	35
	36–45	150	25
	46+	120	20
Gender	Male	312	52
	Female	276	46
	Other	12	2
Education	High School	90	15
	Graduate	270	45
	Postgraduate	180	30
	Others	60	10
Monthly Income (₹)	< 20,000	60	10
	20,001–50,000	180	30
	50,001–1,00,000	240	40
	> 1,00,000	120	20

Source: Primary survey data collected by the authors (2025)

Descriptive statistics indicate that respondents are moderately to highly aware of sustainable practices, with Environmental Concern scoring the highest mean (4.12), consistent with prior studies emphasizing environmental awareness as the key driver of sustainable purchasing [22][23]. Affordability had the lowest mean (3.42), highlighting price sensitivity in Indian digital consumers, aligning with the study objective of evaluating the role of economic factors in sustainable choices.

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Table 2: Sustainable Consumerism Variables (Likert scale 1–5)

Dimension	Mean	Std. Dev	Min	Max
Environmental Concern	4.12	0.68	2	5
Social Responsibility	3.95	0.71	2	5
Trust in Sustainability Claims	3.87	0.74	1	5
Convenience	3.56	0.81	1	5
Affordability	3.42	0.85	1	5

Source: Primary survey data collected by the authors (2025)

Reliability Analysis: Reliability analysis was performed to examine the internal consistency of the Sustainable Consumerism Index (SCI) dimensions. Cronbach's alpha was calculated for all latent constructs, with a threshold of 0.70 considered acceptable for social science research.

Table 3: Cronbach's Alpha Results

SCI Dimension	Number of Items	Cronbach's Alpha
Environmental Concern	5	0.85
Social Responsibility	4	0.83
Trust in Sustainability Claims	4	0.81
Convenience	3	0.79
Affordability	3	0.77
Overall SCI Index	19	0.87

Source: Primary survey data collected by the authors (2025)

Cronbach's alpha values above 0.75 for all dimensions confirm strong internal consistency, while the overall SCI score of 0.87 demonstrates high reliability in measuring sustainable digital consumer behavior. This validates the study's aim of creating a robust multidimensional tool and ensures its applicability for comparing behavior across demographics, product categories, and regions.

Sustainable Consumerism Index (SCI) Construction

Exploratory Factor Analysis (EFA) with Varimax rotation revealed five core dimensions of sustainable digital consumer behavior: Environmental Concern, Social Responsibility, Trust in Sustainability Claims, Convenience, and Affordability. Sampling adequacy was high (KMO = 0.803), and Bartlett's Test of Sphericity was significant ($\chi^2 = 2,105.42$, $p < 0.001$), confirming data suitability.

Table 4: Factor Loadings and Reliability of Sustainable Consumerism Index (SCI) Components

Dimension	Indicators	Loading Range	Variance Explained (%)
Environmental Concern	Awareness of carbon footprint, preference for low-impact packaging	0.71–0.84	21.3
Social Responsibility	Support for local communities, fair-trade preference	0.68–0.81	18.2
Trust in Sustainability Claims	Confidence in brand transparency and third-party certification	0.72–0.86	16.4
Convenience	Ease of finding sustainable alternatives online	0.65–0.79	13.9
Affordability	Willingness to pay $\leq 15\%$ premium for sustainable products	0.61–0.74	11.8

Source: Primary survey of 600 urban and peri-urban Indian consumers, 2025; adapted scales from Dunlap et al., 2000 – New Ecological Paradigm (NEP) scale. <https://doi.org/10.1111/0022-4537.00176>

Interpretation: The Sustainable Consumerism Index (SCI) demonstrates strong validity and reliability across five factors - environmental concern, social responsibility, trust, convenience, and affordability - explaining 81.6% of variance. The highest contribution came from environmental concern, aligning with the first research objective of developing a robust measurement tool. The high Cronbach's Alpha (0.87) ensures consistency, confirming SCI as a dependable instrument for future policy and research. These results directly support H₁₁, proving that metadata-driven, multidimensional constructs are superior in capturing feasibility compared to one-dimensional frameworks. Thus, H₀₁ is rejected, affirming SCI as an empirically grounded index that can guide e-commerce platforms and policymakers in advancing SDG 12 (responsible consumption).

Bayesian Hierarchical Regression

Bayesian logistic regression quantified the probability of sustainable purchases, controlling for demographics, region, and product categories.

Table 5: Posterior Odds Ratios (OR) and 95% Credible Intervals (Bayesian Logistic Regression)

Predictor	OR	95% CrI
Presence of Eco-Label	1.34	[1.21, 1.49]
Carbon Footprint Tag	1.27	[1.14, 1.43]
Sustainability Influencer	1.22	[1.10, 1.37]
SCI Score (per SD)	1.46	[1.32, 1.63]
Price Premium (per 10% increment)	0.91	[0.85, 0.97]

Source: Integrated dataset combining primary surveys, e-commerce transaction data, and LCA metrics; analyzed in R v4.3.2 using brms package. LCA data reference: Ecoinvent Database, 2023. <https://www.ecoinvent.org/>

Interpretation: Bayesian estimates highlight that eco-labels, carbon footprint tags, and higher SCI scores significantly raise purchase probability, while higher price premiums reduce it. Notably, a one-standard deviation increase in SCI boosts purchase odds by 46%, underlining the second research objective of validating digital cues as behavioral drivers. This reinforces the importance of automatic validation mechanisms, which improve decision quality and

consumer confidence. Consequently, the results strongly favor H_{12} and lead to rejection of H_{02} , proving that validation during idea selection enhances both quality and adoption rates. This finding has practical implications for e-commerce ecosystems seeking to embed reliable cues that foster trust and consumer alignment with SDG 13 (climate action).

Structural Equation Modelling (SEM)

In the present study, SEM assessed hypothesized pathways linking attitudes, digital interventions, and purchase behavior.

Table 6: Structural Equation Modelling (SEM) Fit and Path Coefficients

Relationship	β	p-value
Environmental Concern → Purchase Int.	0.48	<0.001
Trust in Claims → Purchase Int.	0.32	<0.01
Purchase Int. → Actual Purchase	0.59	<0.001
Digital Intervention → Actual Purchase	0.27	<0.05

Source: Primary survey and experimental digital interventions; SEM implemented in lavaan (R v4.3.2). Reference: Rosseel, Y. (2012). <https://www.jstatsoft.org/article/view/v048i02>

Model Fit: $\chi^2/df = 2.14$, CFI = 0.961, RMSEA = 0.044

Interpretation: The SEM model validates significant pathways between environmental concern, trust in sustainability claims, purchase intention, and actual purchase behavior. Purchase intention serves as a strong mediator ($\beta = 0.59$), while digital interventions independently increase actual purchases. These findings fulfil the third research objective of assessing causal mediation through digital strategies. Excellent fit indices (CFI = 0.961, RMSEA = 0.044) confirm model robustness. Results clearly support H_{12} and reject H_{02} , reinforcing the argument that validated digital cues enhance purchase quality. Beyond statistical evidence, these pathways align with SDG-12, emphasizing that digital nudges can strengthen sustainable consumerism, offering a scalable policy framework for retailers and governments alike.

Propensity-Score-Matching (PSM)

Matching consumers exposed versus unexposed to interventions achieved balanced covariates (SMD < 0.1). The Average Treatment Effect on Treated (ATT) showed a +19.4 percentage point increase in sustainable purchase likelihood ($p < 0.01$).

Table 7: Propensity Score Matching (PSM) Results

Statistic	Value
Balance Check (all covariates)	
ATT (sustainable purchase ↑)	+19.4 percentage points ($p < 0.01$)

Source: Survey and e-commerce transaction data; PSM applied using MatchIt package in R v4.3.2. Reference: Ho et al., 2011. <https://www.jstatsoft.org/article/view/v042i08>

Interpretation: The PSM analysis demonstrates a 19.4% higher probability of sustainable purchases among exposed groups compared to matched controls, with balanced covariates ($|SMD| < 0.1$). This finding eliminates potential selection bias and empirically proves the effectiveness of interventions. It directly addresses the fourth research objective of testing hybrid strategy effectiveness. Results align with H_{13} , confirming that interventions combining metadata and validation are superior to database-only exposure. Consequently, H_{03} is rejected, highlighting that hybrid strategies have practical significance in guiding consumer behavior. This evidence strengthens arguments for industry

adoption of integrated digital approaches that not only improve purchase quality but also accelerate global targets under SDG-12 and SDG-13.

Difference-in-Differences (DiD) Analysis

DiD is a statistical approach that measures the effect of an intervention by comparing changes in outcomes over time between a group exposed to the intervention and a group not exposed. It is used to separate the actual impact of the intervention from other external factors that may influence both groups equally.

Table 8: Difference-in-Differences (DiD) Analysis of Purchase Rates

Group	Pre (%)	Post (%)	Change (%)
Treated	34.5	52.3	17.8
Control	33.8	35.1	1.3
Net DiD Effect			16.5

Source: Pre- and post-intervention transaction data from partner e-commerce platforms; DiD analysis in R.

Interpretation: The DiD analysis shows a net effect of +16.5% in sustainable purchase rates for intervention groups compared to control. This causal design strengthens the argument for digital strategies, meeting the objective of evaluating experimental-level policy impacts. The significant difference validates H_{13} and rejects H_{03} , proving hybrid interventions outperform conventional, non-digital approaches. These results further indicate that targeted nudges can create long-term behavioral shifts, a finding highly relevant for both corporate strategy and public policy. By confirming the measurable causal impact of hybrid models, the study aligns with SDG 12 (responsible production/consumption) and provides evidence-based insights for policymakers seeking scalable sustainability interventions.

Machine Learning Classification

The Random Forest classifier serves as a powerful tool to identify key drivers of sustainable purchasing and segment consumers by sustainability preferences.

Table 9: Random Forest Model Feature Importance

Feature	Contribution (%)
SCI Score	34
Eco-Label Presence	22
Trust in Brand	18
Carbon Tag Visibility	14
Price Premium	12
Model Accuracy: 86%	AUC: 0.91

Source: Combined survey, transaction, and LCA data; Python (scikit-learn) Random Forest classifier. Reference: Pedregosa et al., 2011. <https://scikit-learn.org/>

Interpretation: The Random Forest model highlights SCI score (34%) and eco-label presence (22%) as the most influential predictors, with an AUC of 0.91 confirming high predictive accuracy. These findings support building predictive frameworks for sustainable consumer behavior. The model demonstrates that metadata-driven features outperform traditional predictors like price premiums, thereby supporting H_{11} , H_{12} , and H_{13} simultaneously. By rejecting all null hypotheses, the study underscores that hybrid, validated, and data-enriched approaches significantly

outperform conventional models. Beyond methodological robustness, the high predictive performance ensures practical applications in e-commerce algorithms, advancing evidence-based strategies aligned with SDG 12.

Environmental Impact Simulation

Monte Carlo simulation is a computational method that employs repeated random sampling to evaluate potential outcomes in complex systems. In this study, it is applied to quantify uncertainty and assess the reliability of the research idea generation and selection processes.

Table 10: Monte Carlo Simulation of Environmental Benefits

Indicator	Annual Impact (95% CI)
CO ₂ e Reduction	5.3 Mt (4.7–5.8 Mt)
Water Savings	1.9 billion litres
Waste Diverted	260,000 tonnes

Source: Aggregated LCA data and national e-commerce projections; Monte Carlo simulation in R v4.3.2. Reference: Metropolis & Ulam, 1949. <https://doi.org/10.1080/01621459.1949.10483310>

Interpretation: Monte Carlo simulations indicate that applying interventions to 30% of transactions could reduce CO₂ emissions by 5.3 Mt, save 1.9 billion liters of water, and divert 260,000 tons of waste annually. These findings link individual consumer choices to broader environmental outcomes, supporting the study objective of connecting micro-level behavior with macro sustainability impacts. The results confirm H₁₃ and reject H₀₃, demonstrating that hybrid digital interventions effectively enhance ecological performance. By providing measurable benefits, the study highlights the potential of integrated strategies to advance SDG 12 (Responsible Consumption) and SDG 13 (Climate Action), emphasizing their value for sustainable market transformation and multi-stakeholder engagement.

Discussion

Overview of Key Findings

The present study contributes meaningfully to the expanding body of research on sustainable digital consumerism by examining how consumer behavior within digital platforms is shaped through the interaction of awareness, trust, and technology-enabled interventions. The findings demonstrate that sustainable purchasing decisions are not solely value-driven but are significantly mediated by consumers' exposure to sustainability information, credibility of digital platforms, and the design of digital choice architectures. This observation aligns with earlier empirical evidence suggesting that environmental awareness and digital literacy jointly influence green purchase behavior, particularly in emerging market contexts where information asymmetry and trust deficits are prevalent (*Papadas et al., 2019; Yadav & Pathak, 2020; Gupta & Gentry, 2020*). Consistent with prior studies, the results indicate that digital marketing strategies—such as eco-label visibility, sustainability messaging, and transparent communication—play a critical role in narrowing the well-documented attitude–behavior gap in sustainable consumption (*Tripathi & Patel, 2019; Sarkar & Kundu, 2021*). While consumers may express strong pro-environmental attitudes, actual purchasing behavior improves significantly when sustainability cues are embedded directly within the digital purchasing environment. This supports earlier findings that sustainability-oriented nudges, when delivered at the point of decision-making, are more effective than post-purchase awareness campaigns (*Park & Kim, 2022; Majer et al., 2022*). A key contribution of this study lies in demonstrating the effectiveness of AI-driven recommendation systems integrated with sustainability prompts. The empirical evidence suggests that algorithmic personalization, when aligned with environmental objectives, increases the likelihood of green product selection without adversely affecting user engagement or platform performance. This finding corroborates recent research highlighting the potential of recommender systems to guide consumers toward low-impact choices by subtly reshaping default options and recommendation rankings (*Felfernig et al., 2023; Valencia-Arias et al., 2024*). Importantly, unlike earlier studies that focused primarily on technological efficiency, the present research integrates consumer psychology with algorithmic decision-making, offering a more holistic understanding of sustainable digital persuasion mechanisms (*Luo et al., 2021; Kumar et al., 2023*). Trust emerges as a central moderating factor in sustainable digital consumerism. The results indicate that consumers are more responsive to sustainability interventions when platforms provide verifiable information, such as certified eco-labels, traceability indicators, or third-party validation. This finding is consistent with prior research on greenwashing,

which cautions that exaggerated or ambiguous sustainability claims can erode consumer trust and reduce long-term engagement (Nyilasy et al., 2021). By integrating credible environmental-impact indicators into digital interfaces, platforms can mitigate skepticism and foster sustained behavioral change (Hsiao & Chen, 2022; Xu et al., 2022). From a sustainability governance perspective, the findings reinforce the role of digital commerce platforms as active enablers of SDG-12 (*Responsible-Consumption-and-Production*). While earlier literature has largely emphasized regulatory frameworks and macro-level policy interventions, this study advances micro-level evidence showing how individual consumer decisions can be influenced through data-driven digital architectures (Camilleri, 2020; Tan et al., 2021). Furthermore, the integration of predictive analytics and causal modelling strengthens the argument that sustainability-oriented digital interventions can generate measurable environmental outcomes, thereby supporting SDG-13 (*Climate-Action*) through reduced emissions, waste, and resource consumption (Wang et al., 2020; Bhattacharya & Dey, 2024). Overall, the study extends existing scholarship by moving beyond intention-based models toward outcome-oriented evaluation of sustainable digital consumerism. By combining behavioral insights, advanced statistical modelling, and real-world digital interventions, the research demonstrates that sustainability and digital profitability need not be mutually exclusive. Instead, strategically designed digital ecosystems can align consumer convenience, business objectives, and environmental responsibility, offering scalable pathways for sustainable growth in rapidly digitalizing economies.

Consumer Behavior in Sustainable E-commerce

Sustainable-consumer-behavior within digital-marketplaces continues to be characterized by a pronounced attitude-behavior gap, wherein favorable attitudes toward sustainability do not consistently translate into actual purchasing decisions, a pattern well documented in prior research (Gupta & Gentry, 2020; Sarkar & Kundu, 2021; Tripathi & Patel, 2019). The present study not only confirms the persistence of this gap but also demonstrates that strategically designed digital nudges-such as eco-labels, carbon-footprint-calculators, sustainability-badges, and algorithmically-prioritized green-recommendations-can significantly attenuate this disconnect by embedding sustainability cues directly into the decision-making interface. These findings are consistent with evidence suggesting that visual and informational sustainability signals enhance consumer trust and perceived credibility in online environments, thereby increasing the likelihood of green purchases (Hsiao & Chen, 2022; Majer et al., 2022). Moreover, the results align with behavioral and social influence theories, which emphasize the role of social norms, peer visibility, and contextual cues in shaping sustainable consumption, particularly in digitally mediated settings (Papadas et al., 2019; Park & Kim, 2022). A critical insight emerging from this study is the mediating role of consumer trust in the relationship between sustainability claims and purchase intention; consistent with prior literature on greenwashing, unverified or ambiguous claims tend to weaken consumer confidence, whereas transparent, data-backed sustainability indicators strengthen engagement and conversion outcomes (Nyilasy et al., 2021; Xu et al., 2022). Additionally, the findings highlight important contextual and cultural nuances, as Indian consumers exhibit heightened price sensitivity relative to their counterparts in developed markets, reinforcing earlier observations that economic considerations remain a dominant constraint on sustainable consumption in emerging economies (Yadav & Pathak, 2020; Sheth, 2020). Collectively, these results suggest that effective sustainable e-commerce strategies must balance affordability, credibility, and intelligent digital design to translate pro-environmental attitudes into measurable behavioral change. Table-11 presents a comparative synthesis of how digital strategies influence consumer behavior across studies.

Table-11. Influence of Digital Strategies on Sustainable Consumer Behavior

Digital Strategy	Impact Observed in Prior Literature (APA in-text)	Findings from the present Study
Eco-labels & certifications	Enhance consumer trust and positively influence sustainable purchase decisions by improving credibility and information clarity (Hsiao & Chen, 2022; Majer et al., 2022).	Strong positive effect on green purchase intention and conversion rates.
Social influence cues	Social norms, peer visibility, and contextual nudges significantly moderate sustainable purchase intentions in digital environments (Papadas et al., 2019; Park & Kim, 2022).	Significant mediating role between sustainability awareness and actual purchase behavior.

Price sensitivity	Acts as a major barrier to sustainable consumption in developing and price-sensitive markets, particularly in emerging economies (Yadav & Pathak, 2020; Sheth, 2020).	Strong barrier effect, especially among low- and middle-income consumer segments.
Transparency metrics	Transparent, verifiable sustainability information reduces skepticism and mitigates greenwashing concerns, thereby enhancing trust (Nyilasy et al., 2021; Xu et al., 2022).	Substantial improvement in consumer trust and engagement levels.
AI-driven personalization	Algorithmic recommender systems aligned with sustainability objectives can guide consumers toward eco-friendly choices, though prior evidence reports mixed effectiveness depending on design (Felfernig et al., 2023; Valencia-Arias et al., 2024).	Strong enabling effect, with higher likelihood of sustainable product selection.

Source: Authors' synthesis based on primary survey results and analysis of peer-reviewed literature.

Digital Marketing, AI, and Personalization

The findings highlight digital marketing and artificial intelligence as pivotal mechanisms in advancing sustainable consumption within e-commerce ecosystems, particularly through AI-driven recommender-systems that incorporate environmental criteria into personalization algorithms. Consistent with recent literature, the study demonstrates that sustainability-aware recommender systems can effectively nudge consumers toward greener alternatives by reshaping choice architectures and default recommendations, thereby reinforcing the role of digital innovation in operationalizing SDG-9 (*Industry-Innovation-and-Infrastructure*) (Felfernig et al., 2023; Valencia-Arias et al., 2024; Kumar et al., 2023). Unlike traditional informational campaigns, AI-enabled personalization enables real-time, context-sensitive sustainability cues that align with individual preferences, increasing both relevance and behavioral impact. However, the results also reveal important ethical tensions associated with data-intensive personalization. While consumers generally responded favorably to tailored sustainability prompts, excessive or opaque data usage heightened concerns related to privacy, surveillance, and perceived manipulation, echoing broader concerns in the literature on responsible digital marketing and consumer autonomy (Xu et al., 2022; Nguyen et al., 2022). These findings reinforce the argument that sustainable digital strategies must be guided by transparent data governance and ethical AI-principles to preserve long-term consumer trust. Furthermore, the study shows that digital sustainability marketing is most effective when it resonates with consumers' values, lifestyles, and identity aspirations rather than relying solely on factual or environmental-impact information. This aligns with value-driven and identity-based marketing research, which emphasizes that emotional engagement and self-concept alignment are critical drivers of sustainable behavior in digital contexts (Papadas et al., 2019; Gupta & Gentry, 2020; Luo et al., 2021). Collectively, the evidence suggests that responsible AI-enabled personalization-when ethically designed and value-aligned-can serve as a powerful catalyst for sustainable digital consumerism, balancing technological innovation with consumer trust and social legitimacy.

Supply chain and technological innovations

Beyond consumer-psychology, the study also provides strong evidence that supply-chain-transparency plays a decisive role in shaping sustainable consumer trust. Blockchain-enabled traceability systems offer credible verification of eco-claims, reinforcing prior research on the governance potential of digital supply chains and transparency-driven trust formation (Zhou et al., 2022; Tan et al., 2021; Wang et al., 2020). Green logistics innovations, including carbon-neutral delivery options and recyclable packaging, were similarly found to strengthen consumer loyalty, corroborating studies that identify logistics performance as a critical determinant of sustainable e-commerce outcomes (Wang et al., 2020; Bhattacharya & Dey, 2024; Rosenbusch et al., 2023). Importantly, these interventions directly support the alignment of digital commerce with SDG-13 (*Climate-Action*), given the substantial carbon footprint associated with online retail operations. The study also highlights the growing relevance of circular economy strategies, such as digital resale platforms and repair-oriented services, echoing evidence that consumers increasingly participate in circular business models when enabled by accessible and trustworthy digital infrastructures (Bhattacharya & Dey, 2024; Islam & Meier, 2023; Martins et al., 2023). Collectively, these findings indicate that technological innovations extend

beyond operational efficiency to redefine consumers as active co-creators of sustainability within digitally mediated supply chains.

Theoretical and policy implications

The findings significantly advance theoretical debates on sustainable consumption by demonstrating that digital ecosystems function as active mediators of consumer decision-making rather than passive transaction environments. Classical behavioral frameworks, including the *Theory-of-Planned-Behavior* and the *Value-Belief-Norm-model*, gain renewed explanatory power when situated within algorithmically curated digital contexts, where recommender systems, platform design, and information architecture shape both intentions and realized behavior (Ajzen, 1991; Stern, 2000; Tan et al., 2021). This integration confirms that technological infrastructures increasingly condition how values and norms are translated into sustainable action. From a policy perspective, the results underscore the urgency of stronger regulatory oversight of eco-labeling standards, digital advertising claims, and algorithmic transparency to mitigate greenwashing and restore consumer trust (Nyilasy et al., 2021; Majer et al., 2022). Furthermore, the study highlights the strategic role of public-private partnerships in scaling AI-enabled sustainability nudges across digital platforms, enabling coordinated action between regulators, technology firms, and market actors. Such collaborations not only amplify behavioral impact but also operationalize SDG-17 (*Partnerships-for-the-Goals*) by aligning digital innovation with collective sustainability objectives (Dwivedi et al., 2021; Luo et al., 2021).

Summary

This research investigates sustainable digital consumerism in India, focusing on how digital interventions shape environmentally and socially responsible purchasing. With rising smartphone use, affordable internet, and digital payments like UPI, online commerce has expanded rapidly. While this growth offers opportunities to promote sustainable consumption, it can also reinforce unsustainable habits if sustainability is not embedded in consumer choices. The study integrates primary surveys, e-commerce transactions, LCA-data, and social media analytics to assess the impact of digital nudges. A key contribution is the SCI, a composite metric capturing environmental awareness, trust in sustainability claims, social responsibility, convenience, and affordability. Validated via EFA with high reliability (*Cronbach's Alpha = 0.87*), the SCI highlights environmental concern as the strongest dimension and provides a standardized tool to track sustainable consumer behavior across categories and regions. To evaluate the effectiveness of digital interventions, the research applied advanced statistical and machine learning methods. Bayesian hierarchical regression assessed the probability of sustainable purchases, considering demographic, regional, and product-level variations. Findings revealed that interventions such as eco-labels, carbon footprint tags, and influencer-led campaigns significantly increased purchase likelihood, whereas higher price premiums reduced adoption. SEM validated the causal pathways, confirming that environmental concern and trust drive purchase intentions, which subsequently influence actual behavior. Direct exposure to digital nudges also significantly impacted purchasing decisions, demonstrating the effectiveness of these interventions in real-world digital environments. The study further employed PSM and DiD analyses to address potential selection biases and estimate the causal impact of interventions. PSM results indicated a 19.4 percentage point increase in sustainable purchase probability for consumers exposed to interventions, while DiD analysis showed a net effect of 16.5 percentage points compared to the control group. Machine learning models, including RF and XGBoost, identified SCI-scores and eco-label presence as the most influential predictors of sustainable purchasing, achieving 86% model accuracy and an AUC of 0.91. These findings highlight the potential of AI-driven segmentation and personalized nudging in promoting sustainable consumption. Beyond behavioral-outcomes, the research assessed environmental implications using *Monte-Carlo-simulations*. Scaling sustainability interventions to 30% of national e-commerce transactions could lead to annual reductions of 5.3 million tonnes of CO₂e, savings of 1.9 billion liters of water, and the diversion of 260,000 tonnes of waste from landfills. These results align with SDG-12 (*Responsible-Consumption-and-Production*), SDG-13 (*Climate-Action*), and SDG-9 (*Industry-Innovation-and-Infrastructure*), demonstrating that digital sustainability interventions can achieve significant environmental and social benefits while supporting commercial objectives.

Overall, the study bridges the gap between consumer-intentions and actual-sustainable-behavior by integrating behavioral-science, AI-driven personalization, and credible sustainability information into digital-commerce. It offers a validated measurement tool (SCI), a robust analytical-framework, and actionable insights for e-commerce platforms, policymakers, and sustainability advocates. By linking individual decision-making to broader environmental impacts, the research establishes a scalable blueprint for promoting sustainable digital consumerism in emerging economies.

Conclusion

This study confirms that digital interventions can significantly enhance sustainable consumer behavior in India. Eco-labels, carbon-footprint indicators, sustainability filters, and influencer-led campaigns effectively increase both purchase intentions and actual buying behavior. Key drivers such as trust in sustainability claims, transparency, and social responsibility amplify the impact of these interventions, while price sensitivity remains a notable barrier that can be mitigated through targeted nudges and personalized recommendations. Behavioral science and AI-driven tools play a critical role in bridging the attitude–behavior gap. Platforms that integrate clear sustainability information with machine learning-based personalization can efficiently target consumer segments most responsive to eco-friendly products. Beyond consumer behavior, scaling these interventions offers measurable environmental benefits, including reductions in carbon emissions, water usage, and waste generation. These outcomes directly support SDG-12 (*Responsible-Consumption-and-Production*), SDG-13 (*Climate-Action*), and SDG-9 (*Industry-Innovation-and-Infrastructure*). Overall, the study provides a validated framework, combining the Sustainable Consumerism Index and advanced analytics, to embed sustainability into digital ecosystems effectively, demonstrating that responsible consumption can be both achievable and commercially viable.

To ensure robustness in interpretive conclusions, potential internal biases associated with qualitative insights were addressed through systematic triangulation and validation. Perceptual and attitudinal responses obtained from the primary survey were cross-verified against experimentally observed behavioral outcomes and secondary transaction-level data, reducing reliance on self-reported measures alone. Qualitative interpretations were considered only when consistent directional patterns were supported by quantitative evidence from Structural Equation Modelling, Bayesian posterior estimates, and causal inference techniques. This integrative approach minimized subjective inference bias and ensured that the study’s conclusions are evidence-driven, statistically grounded, and internally consistent.

Recommendations

The results of this research highlight key actionable measures that digital platforms and policymakers can adopt to foster sustainable consumer choices effectively:

1. *Integrate Sustainability Features on Platforms:* E-commerce platforms should embed eco-labels, carbon-footprint indicators, and sustainability filters to nudge consumers toward low-impact products.
2. *Enhance Trust and Transparency:* Standardize third-party certifications and clear sustainability reporting to reduce greenwashing and improve consumer confidence.
3. *Leverage Personalization and AI:* Use machine learning and AI-driven recommender systems to identify and target consumers most responsive to sustainability cues.
4. *Incentivize Adoption:* Implement reward programs, dynamic pricing, or discounts to offset price sensitivity and encourage eco-friendly purchases.
5. *Promote Consumer Awareness:* Educate consumers about environmental and social impacts of products to reinforce the effectiveness of digital interventions.
6. *Support Policy Alignment:* Encourage regulatory frameworks and incentives that promote sustainable digital marketing practices and accountability.

Future Scope of the study

Future research can focus on longitudinal studies to assess the persistence of sustainable digital behavior over time. Integrating real-time IoT and product traceability data with AI-driven recommender systems can enhance consumer trust and engagement. Comparative studies across urban, peri-urban, and rural populations will provide insights into regional adoption patterns. Gamification, AR/VR experiences, and social engagement tools could further strengthen sustainable consumption. Large-scale collaborations among policymakers, e-commerce platforms, and NGOs can maximize both environmental and social impact. Finally, expanding the framework to cross-border digital markets could offer lessons for global sustainable digital consumerism.

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Abbreviations:

SDC	: SUSTAINABLE DIGITAL CONSUMERISM
UPI	: UNIFIED PAYMENTS INTERFACE
SDGs	: SUSTAINABLE DEVELOPMENT GOALS
LCA	: LIFE CYCLE ASSESSMENT
SCI	: SUSTAINABLE CONSUMERISM INDEX
EFA	: EXPLORATORY FACTOR ANALYSIS
CFA	: CONFIRMATORY FACTOR ANALYSIS
KMO	: KAISER-MEYER-OLKIN Measure of Sampling Adequacy
DiD	: DIFFERENCE-IN-DIFFERENCES
PSM	: PROPENSITY SCORE MATCHING
AI	: ARTIFICIAL INTELLIGENCE
SEM	: STRUCTURAL EQUATION MODELLING
RF	: RANDOM FOREST
ATT	: AVERAGE TREATMENT EFFECT ON TREATED

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