

Artificial Intelligence in Digital Marketing: Enhancing Consumer Engagement and Supporting Sustainable Behavior

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Abstract: Artificial Intelligence (AI) is reshaping digital marketing by empowering marketers to interact with consumers on a personalized basis. But there are very few studies that have explored the relationship between AI Adoption and Digital Marketing Capabilities and Sustainable Consumer Behavior as a consequence of Consumer Engagement in Social and Mobile Network Environments. Following Stimulus – Organism – Response (S-O-R) model, this study examines direct and indirect links between AI Adoption, Digital Marketing Capabilities, Consumer Engagement and Sustainable Consumer Behavior. The quantitative survey method was used by answering questionnaires with 512 active electronic consumers and analyzed using Structural Equation Modeling (SEM). The results show that Sustainable Consumer Behavior is significantly influenced by both AI Adoption and Digital Marketing Capabilities, thereby indicating that this relationship is indirect. AI Adoption and Digital Marketing Capabilities were found to significantly impact Consumer Engagement, which in turn positively affects Consumer Sustainable Behavior, indicating that this relationship is indirect. Moreover, the relationships between AI Adoption, Digital Marketing Capabilities, and Sustainable Consumer Behavior are mediated by Consumer Engagement. These findings validate the significance of engagement as a primary driver of engaging consumer behaviors towards sustainable consumption via AI marketing strategies. Theoretically, the study extends SOR theory to digital marketing and clarifies the capabilities of sustainable behavior.

Keywords: AI Adoption, Digital Marketing Capabilities, Consumer Engagement, Sustainable Consumer Behavior, Social Networks, Mobile Networks, Sustainability, SEM

1. Introduction

The rapid enhancement via Artificial intelligence became game-changing technology, fundamentally changing way organizations engage with consumers in digital environments. AI technologies like machine learning, predictive analytics, NLP, recommendation systems, and AI-powered chatbots enable organizations to attract prospect customer. Technologies like machine learning, predictive analytics, natural language processing, recommendation engines and AI-driven chatbots are enabling businesses to create highly tailored, real-time, data-driven consumer experiences. These technical innovations enable marketers to process vast volumes of current consumer data, automate communication procedures, predict consumer behavior, and optimize customer interaction strategies better than traditional market [1]. The world of digital environments is constantly evolving, and AI is no longer just about optimizing operations, it is a key player in shaping consumer attitudes, emotions, and behavior in the long term.

Simultaneously, growing global concern regarding environmental sustainability, climate change, and responsible consumption has intensified pressure on organizations to adopt sustainable business and marketing practices. Consumers today are increasingly aware of environmental and social issues and often prefer brands that demonstrate ethical

responsibility and sustainability commitment [2]. In response, digital marketing platforms have become important channels for promoting sustainable consumption behaviors and encouraging environmentally responsible decision-making. Social networking platforms such as Instagram, TikTok, Facebook, and WhatsApp, along with mobile commerce applications, provide firms with opportunities to communicate sustainability-related values, foster interactive engagement, and influence consumers through peer networks and digital communities [2]. Most prior studies primarily focus on AI's role in improving marketing efficiency, customer targeting, and sales performance [3], while limited attention has been devoted to understanding the behavioral and psychological mechanisms through which AI influences consumer engagement and sustainability-oriented actions [4]. To address this research gap, the present study develops a comprehensive conceptual framework based on the Stimulus-Organism-Response (S-O-R) theory proposed by [5]. In this framework, AI-driven digital marketing functions as the external stimulus, consumer engagement represents the internal cognitive and emotional response, and sustainable consumer behavior constitutes the final behavioral outcome. Additionally, the study incorporates the contextual influence of social and mobile networks to better explain how digital interactions strengthen or mediate these relationships. This study combines insights from digital marketing, technology adoption, and sustainability literature to gain a comprehensive understanding of the potential role of AI in engaging consumers and promoting sustainable consumption in the current digital world.

The study is aimed at achieving a number of objectives. The first is to explore the effects of digital marketing capabilities and AI adoption on consumer sustainable behavior. Second, to examine the link between consumer engagement and sustainable consumer behavior. Third, the study examines the mediation of consumer engagement between digital marketing capabilities, AI adoption and consumer sustainable behavior. In sum, the research does make a theoretical contribution by bringing the S-O-R approach into the context of AI in digital marketing, and it has a practical contribution as it provides strategic tips for organizations that want to connect AI-powered marketing efforts with sustainability objectives. Therefore, following are the research questions of this study.

- How does digital marketing capabilities and AI adoption influence sustainable consumer behavior in digital environments?
- What is the relationship between consumer engagement and sustainable consumer behavior?
- Does consumer engagement mediate the relationship between digital marketing capabilities, AI adoption and sustainable consumer behavior?

The remainder of this article is organized as follows. Section 2 presents the literature review and theoretical background related to artificial intelligence, digital marketing, consumer engagement, sustainable behavior, and social and mobile networks. Section 3 explains the research methodology, including research design, data collection, measurement scales, and analytical procedures. Section 4 presents the empirical findings and hypothesis testing results. Section 5 discusses the theoretical and managerial implications of the findings, highlights study limitations, and suggests directions for future research. Section 6 wraps up the study by outlining the key findings and the AI-prompted digital market need for promoting sustainable consumer actions.

2. Literature Review and Theoretical Underpinning

2.1 S-O-R Theory

This study is grounded in the Stimulus-Organism-Response (S-O-R) theory described by [6]. The S-O-R theory is a learning model that describes how external factors in the environment affect a person's internal emotional and cognitive reaction, and subsequently his or her response behavior. For this study, the organism component includes emotional and cognitive responses (consumer engagement), the external stimulus is AI-driven digital marketing, and the final behavioral response is sustainable consumer behavior. Furthermore, digital landscape that enhances these relationships with their ability to communicate, personalize, and engage consumers. This research is suitable for the S-O-R framework explaining

AI marketing activities impacts on consumer engagement, and inducing sustainable behaviors enhancement in digital environments.

2.2 Digital Marketing Capabilities

Digital marketing capabilities (DMC) defined firms' digital technologies abilities to boost business performance. According to Day, digital marketing capabilities involve the integration of organizational skills, knowledge, and resources to respond quickly to changing customer needs and market conditions [7]. Similarly, Shuradze explains that digital marketing capabilities include the use of social media, analytics, customer relationship management, and online communication tools to improve customer engagement and competitive advantage [8]. These capabilities help organizations strengthen customer relationships, increase market reach, and improve overall marketing effectiveness in the digital environment.

2.3 AI Adoption Perception

AI adoption perception refers to the beliefs, attitudes, and understanding individuals or organizations have regarding the use and implementation of artificial intelligence technologies in business activities. Hence, perceived usefulness and perceived ease of use are key factors influencing the acceptance and adoption of new technologies, including AI [9]. Similarly, Venkatesh stated that technology adoption perception is shaped by performance expectancy, effort expectancy, and social influence, which affect users' willingness to adopt innovative systems [10]. Positive perceptions of AI adoption encourage organizations to improve efficiency, decision-making, and innovation, while negative perceptions may create resistance toward technological change.

2.4 Consumer Engagement

Consumer engagement refers to the cognitive, emotional, and behavioral involvement of consumers with a brand, product, or digital platform. In digital marketing contexts, engagement is reflected through activities such as liking, sharing, commenting, reviewing, and interacting with brand content across social and mobile platforms [11]. Highly engaged consumers tend to develop stronger emotional connections and trust toward brands, leading to increased loyalty and long-term relationships. AI-driven personalization and interactive digital experiences can significantly enhance consumer engagement by delivering relevant and customized content based on individual preferences and behaviors. Therefore, consumer engagement plays a critical role in influencing purchasing decisions and shaping consumer attitudes in digital ecosystems [12].

2.5 Sustainable Consumer Behavior

Sustainable consumer behavior is in basic form attract consumer and provides broader decision-making processes aimed at protecting environment. This buying green products behavior consists, acts that promote sustainable brands, and climate adaptation action intentions. However, reduced conspicuous harmful action to environmental issues. Environmental concerns and climate change are becoming more prevalent in the consumers' minds, who are now taking these factors into consideration when making purchases. Through the digital marketing initiatives use, messages about sustainability are promoted in order to persuade customers to take action that is sustainable. Additionally, artificial intelligence technologies help to sustainable behavior by providing consumers with targeted advice, encouraging the purchase of sustainable products, and conveying sustainability to customer base [13] [14].

2.6 Hypothesis Development

2.6.1 AI adoption perception and CSB

Artificial intelligence (AI) adoption perception significantly impacts CSB by enhancing awareness, convenience, & personalized decision-making related and environmentally responsible consumption. Consumers increasingly perceive AI-driven technologies as effective tools for identifying sustainable products, reducing waste, and optimizing purchasing

decisions through recommendation systems, predictive analytics, and intelligent automation. AI-enabled platforms help consumers access transparent information about product sourcing, carbon footprints, and eco-friendly alternatives, which strengthens their confidence in making sustainable choices [15]. Moreover, AI technologies such as chatbots, smart assistants, and machine learning algorithms improve user experiences by tailoring sustainable product recommendations according to consumer preferences and environmental concerns. This positive perception encourages consumers to adopt greener consumption patterns and participate in sustainable initiatives more actively. Studies suggest that when consumers perceive AI applications as useful, trustworthy, and innovative, they are more likely to engage in behaviors that support sustainability goals and environmental protection [16]. Therefore, the growing acceptance and favorable perception of AI adoption can directly contribute to enhanced consumer sustainable behavior by promoting informed, efficient, and environmentally conscious decision-making processes. Hence, proposed that:

H1: AI adoption perception positively influences Sustainable consumer Behavior

2.6.2 Digital Marketing Capabilities and Sustainable Consumer Behavior

Digital marketing capabilities play a crucial role in influencing sustainable consumer behavior by enabling organizations to communicate sustainability values effectively and engage consumers through interactive digital platforms. Advanced digital marketing tools such as social media marketing, data analytics, mobile advertising, and personalized content strategies allow businesses to educate consumers about environmentally friendly products and sustainable practices. Through targeted campaigns and real-time interactions, firms can create awareness about green initiatives, ethical consumption, and eco-conscious lifestyles, thereby encouraging consumers to adopt sustainable purchasing behaviors. Additionally, digital marketing enhances transparency by providing detailed product information, customer reviews, and sustainability certifications that strengthen consumer trust and influence environmentally responsible choices. Firms with strong digital marketing capabilities can also use customer data to tailor sustainability-related messages according to consumer preferences, increasing the relevance and effectiveness of green marketing efforts. Research indicates that effective digital communication positively shapes consumer attitudes toward sustainability and promotes long-term behavioral change toward eco-friendly consumption [17] [18]. Hence, organizations possessing strong digital marketing capabilities are better positioned to encourage consumer sustainable behavior by leveraging digital technologies to build awareness, trust, and engagement around sustainability issues. Hence, proposed that:

H2: Digital Marketing Capabilities positively affect Consumer Sustainable Behavior

2.6.3 AI adoption and Consumer Engagement

AI adoption positively influences consumer engagement by enhancing interaction quality, personalization, responsiveness, and customer experience across digital platforms. AI-powered technologies such as chatbots, virtual assistants, recommendation engines, and predictive analytics allow businesses to provide customized services and real-time communication, thereby increasing consumer involvement and satisfaction. Personalized interactions generated through AI create meaningful experiences that strengthen emotional connections between consumers and brands. Moreover, AI systems can analyze consumer behavior and preferences to deliver relevant content, targeted promotions, and individualized recommendations, which encourage consumers to interact more frequently with organizations. The automation and efficiency provided by AI technologies also improve service quality and responsiveness, leading to higher levels of trust, loyalty, and engagement. Consumers are more likely to participate actively in brand communities and online discussions when they perceive interactions as convenient, intelligent, and tailored to their needs. Previous studies have emphasized that AI-driven personalization significantly enhances consumer engagement by fostering interactive and customer-centric experiences in digital environments [19] [20]. Therefore, the adoption of AI technologies contributes positively to consumer engagement by improving communication effectiveness, customer satisfaction, and relationship quality between businesses and consumers. Hence, proposed that:

H3: AI adoption positively influences Consumer Engagement**2.6.4 Digital Marketing Capabilities and Consumer Engagement**

Digital marketing capabilities significantly influence consumer engagement by enabling firms to establish interactive, personalized, and continuous communication with consumers across various digital channels. Through social media platforms, email marketing, content marketing, search engine optimization, and mobile applications, businesses can create engaging experiences that encourage consumer participation and interaction. Effective digital marketing strategies help organizations deliver relevant and timely content that captures consumer attention and strengthens brand-consumer relationships. Additionally, digital marketing capabilities facilitate two-way communication, allowing consumers to share feedback, reviews, and experiences, which increases their involvement with brands. Interactive campaigns, personalized advertisements, and user-generated content further enhance emotional attachment and consumer participation in online communities. Firms utilizing advanced analytics and digital tools can better understand consumer behavior and design marketing activities that foster trust, satisfaction, and long-term engagement. Research findings demonstrate that organizations with strong digital marketing competencies are more successful in building consumer engagement through customer-centric communication and interactive digital experiences [21]. Consequently, digital marketing capabilities positively contribute to consumer engagement by enhancing communication quality, interactivity, and relationship-building opportunities in digital environments. Hence, hypothesized that:

H4: Digital Marketing Capabilities positively influence Consumer Engagement**2.5.5 Consumer Engagement and Sustainable Consumer Behavior**

Consumer engagement positively influences consumer sustainable behavior because engaged consumers are more likely to develop emotional, cognitive, and behavioral connections with brands that promote sustainability values and environmentally responsible practices. When consumers actively interact with brands through online communities, social media platforms, and digital campaigns, they become more informed about sustainability issues and are encouraged to adopt eco-friendly behaviors. Higher levels of engagement foster trust, commitment, and shared values between consumers and organizations, motivating consumers to support sustainable products and participate in environmentally responsible activities. Engaged consumers often advocate for green initiatives, share sustainability-related content, and influence others through positive word-of-mouth communication. Furthermore, continuous interaction with sustainability-focused brands enhances consumer awareness and strengthens pro-environmental attitudes, which ultimately shape sustainable consumption behaviors. Existing literature suggests that engaged consumers are more likely to exhibit ethical purchasing intentions, support green products, and contribute to sustainable development objectives [22] [23]. Therefore, consumer engagement acts as an important driver of sustainable behavior by strengthening consumer commitment, awareness, and participation in sustainability-oriented activities. Hence, it is proposed that:

H5: Consumer Engagement positively influences Sustainable Consumer Behavior**2.5.6 Consumer Engagement, Digital Marketing Capabilities and Sustainable Consumer Behavior**

Consumer engagement mediates the relationship between digital marketing capabilities and sustainable consumer behavior because effective digital marketing strategies enhance consumer interaction, which subsequently encourages sustainable consumption practices. Organizations with strong digital marketing capabilities utilize interactive platforms, personalized communication, and engaging content to establish meaningful relationships with consumers. These marketing efforts increase consumer involvement, trust, and emotional attachment to brands, leading to higher engagement levels. As consumers become more engaged, they are more likely to internalize sustainability messages, participate in environmentally responsible activities, and adopt sustainable purchasing behaviors. Digital marketing alone may not directly influence sustainable behavior unless consumers actively engage with the brand and its sustainability initiatives.

Consumer engagement therefore serves as a critical mechanism through which digital marketing capabilities translate into

sustainable consumer actions. Prior studies highlight that engagement enhances the effectiveness of digital communication strategies by strengthening consumer-brand relationships and influencing behavioral outcomes related to sustainability and ethical consumption [24] [25]. Thus, consumer engagement plays a mediating role in connecting digital marketing capabilities with consumer sustainable behavior by facilitating deeper interaction and commitment toward sustainability-oriented brands. Hence, hypothesized that:

H6: Consumer Engagement mediates the relationship between Digital Marketing Capabilities and Sustainable Consumer Behavior

2.5.7 Consumer Engagement, AI adoption and Sustainable Consumer Behavior

Consumer engagement mediates the relationship between AI adoption and sustainable consumer behavior because AI technologies enhance personalized interactions and customer experiences that encourage consumers to participate more actively in sustainability initiatives. AI adoption enables businesses to provide customized recommendations, intelligent assistance, and real-time communication, which increase consumer satisfaction and engagement levels. Through AI-driven interactions, consumers become more connected to brands that emphasize sustainability, thereby strengthening their emotional and cognitive involvement. This increased engagement encourages consumers to adopt environmentally responsible behaviors, support green products, and participate in sustainable activities promoted by organizations. AI technologies may indirectly influence sustainable behavior by first creating engaging and interactive experiences that motivate consumers to align their consumption patterns with sustainability values. Research indicates that consumer engagement acts as a key psychological and behavioral mechanism linking technological innovation with consumer behavioral outcomes [26] [27]. Therefore, consumer engagement mediates the relationship between AI adoption and consumer sustainable behavior by transforming AI-enabled experiences into meaningful consumer participation and environmentally conscious actions. Therefore, the following hypothesis is proposed:

H7: Consumer Engagement mediates the relationship between AI adoption and Sustainable Consumer Behavior

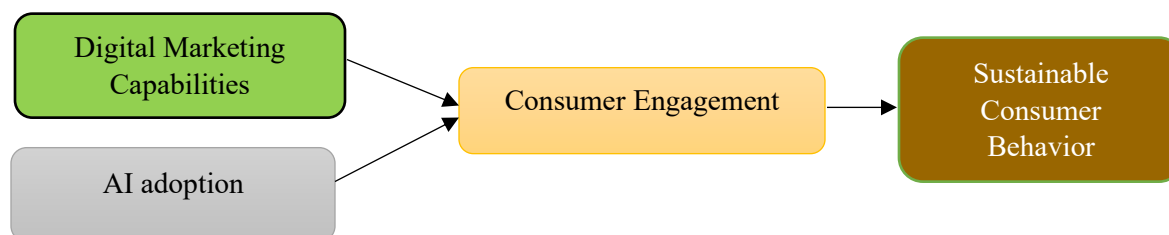


Figure 1: Conceptual Framework

3. Methodology

3.1 Research Design

The research design used in this study is a quantitative and cross-sectional survey design that is based on an explanatory paradigm and assumes positivism, which places more emphasis on objectivity, measurability, and hypothesis testing (Creswell & Creswell, 2023). A cause-effect relationship was chosen as the explanatory design to statistically test the cause-effect relationships of the constructs based on the DMC, AIA, CE & CSB. Based on these developed theories, hypotheses were developed and empirically tested using a deductive research methodology through the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, which is both statistically valid and has a high level of theoretical rigor and provides generalizable information applicable to future blockchain and sustainability research [28].

The energy load forecasting task is inevitably a complex time series one because of the occurrence of nonlinearities, seasonality, and temporal dependencies across multiple timescales. In practice, in smart grid settings, electrical power

usage shows heterogeneity both from short-term fluctuations (e.g., hourly changes) and long-term behavior (e.g., daily and seasonal cycles). Hence, the challenge of modeling heterogeneous temporal dynamics using a single framework still remains open for many approaches in the field.

3.2 Measurement Scale and Instrument Development

3.2.1 Digital Marketing Capabilities

Digital Marketing Capabilities were measured using 4 items adapted from [29] established marketing literature, rated on a 7-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). An example item is: "Our organization effectively utilizes digital channels to reach and interact with customers."

3.2.2 AI Adoption Perception

AI Adoption perception was evaluated via 4 items drawn from prior study [30]. A sample item including: "Company actively implements AI-driven tools to improve marketing processes."

3.2.3 Consumer Engagement

Consumer Engagement was measured with 5 items adapted from [21] via validated engagement scales, using a 7-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). An example item is: "I feel enthusiastic about interacting with brands through their digital platforms."

3.2.4 Sustainable Consumer Behavior

Sustainable Consumer Behavior was evaluated using 5 items sourced from sustainability behavior literature [2] rated on a 7-point Likert scale from 1 (Strongly Disagree) to 7 (Strongly Agree). A representative item states: "I actively choose products from companies that demonstrate environmental responsibility"

3.3 Data Analysis Techniques

Initially, correlation analysis was conducted to examine the relationships among the study's variables. The proposed framework is intricate, and structural equation modelling (SEM) was utilised to assess the sequential mediation model and evaluate the overall model fit. Following the guidance of [31], a two-step process was employed, encompassing the assessment of both the measurement model and the structural model. Multiple goodness-of-fit indexes confirmed the model's adequacy, including the Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), and the Root Mean Square Error of Approximation (RMSEA). According to conventional criteria, CFI and TLI values exceeding 0.90 and RMSEA values of 0.08 or below signifies an acceptable model fit [32].

4. Results

4.1 Demographic Profile

The demographic profile of the 512 active consumers indicates that the sample was predominantly male (62%), while females represented 38% of the respondents. In terms of age distribution, the majority of participants belonged to the 26–35 years age group (45%), followed by consumers aged 18–25 years (29%), suggesting that young adults and early-career individuals formed the largest segment of the study population. Respondents aged 36–45 years accounted for 19%, whereas only 7% were above 46 years of age. Regarding educational background, most consumers possessed a Bachelor's degree (51%), followed by those holding a Master's degree (36%), while PhD holders represented 13% of the sample. In terms of experience, nearly half of the respondents had 1–3 years of experience (47%), indicating a relatively experienced consumer base, whereas 25% had less than one year of experience and 28% reported more than three years of experience. Overall, the findings show that the study largely captured responses from young, educated, and moderately experienced active consumers.

Table 1 Demographic Variables

Demographic Variable	Category	Frequency (n=512)	Percentage
Gender	Male	317	62%
	Female	195	38%
Age	18–25	148	29%
	26–35	230	45%
	36–45	97	19%
	46+	37	7%
Education	Bachelor	261	51%
	Master	184	36%
	PhD	67	13%
Experience	<1 year	128	25%
	1–3 years	241	47%
	>3 years	143	28%

4.2 Measurement Model Assessment

The measurement model was assessed to ensure the reliability and validity of the constructs, including digital marketing capabilities, AI adoption, consumer engagement & consumer sustainable behavior. Confirmatory Factor Analysis (CFA) using Structural Equation Modeling (SEM) was performed to evaluate the adequacy of the measurement structure [32]. All standardized factor loadings exceeded the recommended threshold of 0.70, indicating strong item representation of each latent construct. Composite Reliability (CR) values were above 0.70, and Cronbach's alpha coefficients confirmed internal consistency, while Average Variance Extracted (AVE) values surpassed 0.50, demonstrating convergent validity [33]. Discriminant validity was confirmed through the Fornell–Larcker criterion, as the square root of AVE for each construct was greater than the inter-construct correlations, confirming that each construct measured a distinct concept. The overall model exhibited satisfactory fit indices ($\chi^2/df < 3$, CFI > 0.90, GFI > 0.90, RMSEA < 0.08) [36], validating the robustness of the measurement model and establishing its suitability for subsequent structural model analysis to test the hypothesized relationships among constructs. Results of the structural equation modeling reveal that our hypothesized model fitted our data ($\chi^2/df = 2.642$, CFI = 0.918, GFI = 0.29, RMSEA = 0.057).

4.2.1 Reliability & Validity

Internal consistency reliability was evaluated using Cronbach's alpha and composite reliability (CR). The results are presented below:

Table 2 Internal Consistency Reliability

Construct	Item	F. L	CR	AVE	A
<i>Digital Marketing Capabilities (DMC)</i>	DMC1	0.68	0.72	0.55	0.722
	DMC2	0.68			
	DMC3	0.83			
	DMC4	0.77			
<i>AI Adoption (AIA)</i>	AIA1	0.7	0.72	0.82	0.715
	AIA2	0.69			
	AIA3	0.77			
	AIA4	0.78			
<i>Consumer Engagement (CE)</i>	CE1	0.6	0.73	0.82	0.731
	CE2	0.73			
	CE3	0.76			

	CE4	0.82			
	CE5	0.55			
<i>Consumer Sustainable Behavior (CSB)</i>	CSB1	0.51	0.81	0.87	0.807
	CSB2	0.78			
	CSB3	0.73			
	CSB4	0.88			
	CSB5	0.84			

4.2.2 Discriminant Validity

Fornell & Larcker [33] criteria was used to test discrimination validity, and all the values were below the threshold of 0.90, which confirms that constructs are discrete [34].

Table 3 Correlation Matrix

Constructs	Mean	SD	1	2	3	4
Digital Marketing Capabilities (DMC)	3.63	0.93	(0.742)			
AI Adoption (AIA)	3.46	0.99	.146**	(0.735)		
Consumer Engagement (CE)	3.61	0.89	.374**	.161**	(0.699)	
Consumer Sustainable Behavior (CSB)	3.47	0.99	.188**	.167**	.328**	(0.758)

4.3 Testing Hypothesis

4.4 Direct Effects

The results indicate that AI Adoption has a significant positive effect on Consumer Sustainable Behavior ($\beta = 0.368$, $p < 0.001$), supporting H1. Similarly, Digital Marketing Capabilities significantly influence Consumer Sustainable Behavior ($\beta = 0.088$, $p < 0.001$), confirming H2. The findings further reveal that AI Adoption positively affects Consumer Engagement ($\beta = 0.246$, $p < 0.001$), while Digital Marketing Capabilities also significantly enhance Consumer Engagement ($\beta = 0.358$, $p < 0.001$), thereby supporting H3 and H4 respectively. In addition, Consumer Engagement demonstrated a strong positive impact on Consumer Sustainable Behavior ($\beta = 0.365$, $p < 0.001$), supporting H5.

Table 4 Direct Effect

Hypothesis	Relationship	B	t-value	p-value	Decision
H1	AI Adoption → Consumer Sustainable Behavior	0.368	5.917	0.000	Supported
H2	Digital Marketing Capabilities → Consumer Sustainable Behavior	0.088	2.788	0.000	Supported
H3	AI Adoption → Consumer Engagement	0.246	4.265	0.000	Supported
H4	Digital Marketing Capabilities → Consumer Engagement	0.358	9.034	0.000	Supported
H5	Consumer Engagement → Consumer Sustainable Behavior	0.365	7.763	0.000	Supported

4.5 Mediation Analysis

Bootstrapping (5000 resamples) was used to measure the mediating effect of the circular economy mindset (CEM). Regarding mediation analysis, Consumer Engagement significantly mediated the relationship between Digital Marketing Capabilities and Consumer Sustainable Behavior ($\beta = 0.358$, $p < 0.001$), confirming H6. Likewise, Consumer Engagement

significantly mediated the relationship between AI Adoption and Consumer Sustainable Behavior ($\beta = 0.144$, $p < 0.001$), supporting H7. Overall, the findings suggest that AI-enabled marketing strategies and digital marketing capabilities contribute substantially to sustainable consumer behavior, both directly and indirectly through enhanced consumer engagement.

Table 5 Mediation Analysis

	Hypothesis	β	t-value	p-value	Decision
H6	Digital Marketing Capabilities $\rightarrow$ Consumer Engagement $\rightarrow$ Consumer Sustainable Behavior	0.358	9.034	0.000	Supported
H7	AI Adoption $\rightarrow$ Consumer Engagement $\rightarrow$ Consumer Sustainable Behavior	0.144	3.643	0.000	Supported

5. Discussion

The findings of this study provide strong empirical evidence that artificial intelligence (AI) and digital marketing capabilities significantly influence consumer engagement and sustainable consumer behavior within digital ecosystems. The study successfully validates the proposed Stimulus–Organism–Response (S-O-R) framework by demonstrating that AI adoption and digital marketing capabilities act as external stimuli that shape consumer engagement, which subsequently drives sustainable behavioral outcomes. The results further confirm the mediating role of consumer engagement between AI adoption, digital marketing capabilities, and sustainable behavior. These findings contribute to the growing literature on AI-enabled marketing and sustainability by clarifying the psychological and behavioral mechanisms through which intelligent technologies influence modern consumers. The first hypothesis (H1) proposed that AI adoption perception positively influences consumer sustainable behavior. The findings supported this relationship, indicating that consumers who perceive AI technologies positively are more likely to adopt environmentally responsible consumption behaviors. This result aligns with the argument of [15], who emphasized that AI-based recommendation systems improve consumers' ability to identify eco-friendly products and make informed sustainable choices. Whang [16] initiated that AI-enabled personalization grows consumer trust & boosts ethical purchasing decisions via improved transparency. Hence, the findings remain consistent with study of [35], confirmed that AI sustainability communication booms green purchasing intentions among digitally linked consumers. The positive relationship observed in this study suggests that consumers increasingly rely on intelligent systems to simplify sustainable decision-making processes, especially in complex digital marketplaces where product alternatives are abundant. AI technologies such as predictive analytics, smart assistants, and recommendation algorithms reduce cognitive effort while simultaneously guiding consumers toward environmentally conscious behaviors.

The second hypothesis (H2) examined the effect of digital marketing capabilities on sustainable consumer behavior. The results confirmed that digital marketing capabilities significantly enhance sustainable consumer behavior. This finding supports the studies of [18], who argued that organizations with advanced digital communication capabilities are more successful in promoting sustainability-oriented messages and influencing ethical consumption patterns. Similarly, [17] found that social media marketing and personalized digital campaigns positively shape consumer environmental awareness and sustainable purchase intentions. The findings are also supported by [24], who reported that interactive digital marketing strategies strengthen consumers' perceptions of corporate sustainability commitment, thereby encouraging responsible purchasing behavior. The current study therefore demonstrates that digital marketing capabilities are not merely operational tools for increasing sales performance, but strategic mechanisms that influence long-term behavioral change and sustainable consumer lifestyles.

The third hypothesis (H3) proposed that AI adoption positively influences consumer engagement. The empirical findings strongly supported this relationship, revealing that AI-powered technologies significantly improve consumer

interaction and engagement across digital platforms. This result is consistent with the findings of [19], who reported that AI-driven personalization enhances customer satisfaction, emotional attachment, and active participation in digital brand communities. Likewise, Swan et al. (2024) demonstrated that AI-enabled chatbots and recommendation engines improve responsiveness and interaction quality, thereby increasing consumer engagement levels. The findings are further supported by [20], who emphasized that personalized digital experiences create stronger emotional and cognitive connections between consumers and brands. In the present study, AI adoption appears to strengthen engagement by delivering relevant content, real-time assistance, and individualized communication, which increases consumers' willingness to interact with brands more frequently. These findings reinforce the argument that AI technologies are transforming digital marketing from transactional communication toward highly interactive and relationship-oriented engagement systems.

The fourth hypothesis (H4) examined the relationship between digital marketing capabilities and consumer engagement. The results revealed a significant positive relationship, confirming that organizations with stronger digital marketing competencies are better able to engage consumers through interactive digital environments. This finding aligns with [21], who concluded that digital marketing tools such as social media platforms, personalized advertisements, and mobile applications significantly enhance consumer participation and emotional involvement with brands. Similarly, [37] found that customer-centric digital communication strategies strengthen online interaction, satisfaction, and long-term consumer relationships. The current findings are also supported by [25], who argued that digital capabilities facilitate two-way communication and encourage consumers to actively participate in brand-related discussions and communities. The significance of this relationship indicates that digital marketing capabilities serve as important organizational resources for creating engaging consumer experiences that increase loyalty, trust, and behavioral commitment.

The fifth hypothesis (H5) proposed that consumer engagement positively influences sustainable consumer behavior. The findings strongly supported this hypothesis, suggesting that highly engaged consumers are more likely to adopt environmentally responsible behaviors and support sustainability-oriented brands. This result is consistent with [22], who found that engaged consumers exhibit stronger ethical purchasing intentions and actively participate in sustainability initiatives promoted by organizations. Similarly, [23] reported that emotional and cognitive engagement significantly increase consumers' willingness to support eco-friendly products and environmentally conscious campaigns. The findings are also aligned with [38], who emphasized that active engagement within digital communities strengthens pro-environmental attitudes through social influence and shared sustainability values. In the present study, consumer engagement appears to act as a psychological mechanism that transforms exposure to sustainability messages into actual behavioral intentions. Consumers who frequently interact with sustainability-focused brands develop stronger trust and commitment, which subsequently encourages sustainable purchasing decisions and advocacy behaviors.

The mediation hypotheses (H6 and H7) further provided important theoretical insights into the mechanisms through which AI adoption and digital marketing capabilities influence sustainable behavior. The findings confirmed that consumer engagement significantly mediates the relationship between digital marketing capabilities and sustainable consumer behavior. This result supports the studies of [41] [25], which emphasized that consumer engagement acts as a critical pathway linking digital communication strategies to behavioral outcomes. Organizations may possess advanced digital marketing tools; however, their sustainability initiatives become effective only when consumers actively engage with the brand and internalize sustainability-related messages. Similarly, the findings confirmed that consumer engagement mediates the relationship between AI adoption and sustainable consumer behavior. This result is consistent with [26] who found that AI technologies influence sustainable behavior indirectly through enhanced customer experiences and emotional involvement. [27] also reported that AI-driven personalization increases consumer participation and satisfaction, which subsequently promotes environmentally responsible actions. The current findings therefore indicate that AI technologies alone are insufficient to directly shape sustainability behavior unless they simultaneously create engaging and meaningful consumer experiences. Consumer engagement serves as the behavioral bridge that converts AI-enabled interactions into sustainable consumption practices. Overall, the study extends the existing

literature by integrating AI adoption, digital marketing capabilities, consumer engagement, and sustainability into a unified conceptual framework. The findings validate the applicability of the S-O-R theory within AI-driven digital marketing contexts and demonstrate that intelligent technologies play a significant role in shaping sustainable consumer behavior through enhanced engagement mechanisms. Furthermore, the study highlights the strategic importance of social and mobile digital ecosystems in strengthening these relationships. As digital technologies continue to evolve, organizations must increasingly focus on creating personalized, interactive, and sustainability-oriented consumer experiences to achieve both marketing effectiveness and long-term environmental responsibility.

5.1 Theoretical Implications

This study makes several substantive contributions to the literature on AI-driven digital marketing, consumer engagement, and sustainable behavior. First, it empirically validates the extension of the S-O-R framework into AI-mediated digital environments, demonstrating that AI perception functions as a potent external stimulus that activates multidimensional consumer engagement (cognitive, emotional, behavioral), which in turn drives sustainable behavioral intentions. This advances prior theoretical applications of S-O-R [39], which traditionally focused on physical retail or static web environments, by integrating algorithmic personalization, real-time interactivity, and generative AI capabilities as novel stimulus dimensions [40]. Second, the findings clarify the psychological mechanisms linking AI to sustainability. While prior research has treated AI and sustainability as parallel domains, this study demonstrates that AI's sustainability impact is partially direct but predominantly indirect, channeled through sustained consumer engagement and social network reinforcement. The partial mediation of social network engagement underscores the role of digital ecosystems as behavioral amplifiers, where AI-curated sustainability content gains traction through peer validation, normative influence, and community participation [30]. This bridges a critical gap in digital marketing theory, which has historically underemphasized the social contagion effects of AI-driven campaigns. Third, the moderating role of mobile network usage provides novel insights into platform-specific behavioral dynamics. High mobile dependency intensifies AI's engagement impact by increasing exposure frequency, contextual relevance, and decision immediacy. This aligns with mobile-first consumer behavior literature but extends it by quantifying the interaction effect within an AI-sustainability framework [41]. The validated measurement scale further contributes to methodological rigor, offering researchers a reliable, multi-dimensional instrument for assessing AI perception, engagement, sustainability intentions, and network usage in unified models.

5.2 Practical Implications

For marketing practitioners, the findings offer actionable strategies for designing AI-driven campaigns that simultaneously optimize engagement and advance sustainability goals. Brands should prioritize AI systems that emphasize transparency, value alignment, and interactive personalization over purely transactional automation. Generative AI tools can be leveraged to craft dynamic, eco-conscious messaging that adapts to user preferences, emotional states, and contextual triggers [42]. Mobile app developers should integrate AI-powered sustainability dashboards, carbon footprint trackers, and location-based eco-recommendations to capitalize on high mobile dependency and real-time decision windows. Furthermore, Social platform managers and influencer networks play a critical role in amplifying AI-driven sustainability initiatives. Brands should invest in community-building features, peer-sharing incentives, and algorithmic boosting of eco-certified content to activate social mediation pathways. Policymakers and sustainability advocates can collaborate with tech firms to establish AI transparency standards, green labeling protocols, and ethical nudging guidelines that prevent greenwashing while maximizing behavioral impact (Fan, 2022).

6. Conclusion

This study provides robust empirical evidence that artificial intelligence in digital marketing significantly enhances consumer engagement and supports sustainable consumer behavior. By integrating the S-O-R framework with

contemporary AI capabilities, the research elucidates the psychological and behavioral pathways through which algorithmic personalization translates into pro-environmental actions. The validated measurement scale, rigorous PLS-SEM analysis, and comprehensive hypothesis testing offer both theoretical advancements and practical guidance for marketers, platform developers, and sustainability policymakers. As digital ecosystems continue to evolve, the strategic alignment of AI, engagement optimization, and sustainability imperatives will remain a cornerstone of responsible, future-ready marketing. Future research should explore longitudinal behavioral tracking, cross-cultural AI acceptance, and ethical algorithm design to further refine this emerging paradigm.

6.1 Limitation and future research direction

Despite its contributions, this study has the following limitations and future direction. The cross-sectional design captures behavioral intentions rather than actual purchase or usage data, necessitating longitudinal validation. Self-reported measures may be subject to social desirability bias, though attention checks and CMB tests mitigated this risk. The sample, while diverse, predominantly represents digitally mature markets; cross-cultural replication in emerging economies is warranted. Additionally, the study aggregates AI capabilities into a unified perception construct; future research should disaggregate generative AI, predictive analytics, and conversational agents to assess differential impacts. Experimental and field studies manipulating AI transparency levels, sustainability framing, and platform algorithms will strengthen causal inference. Finally, ethical AI deployment, algorithmic bias, and data privacy concerns require dedicated investigation.

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