

Exploring the Impact of Digital Marketing and AI on Sustainability: Opportunities and Challenges for Green Marketing

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Abstract

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Abstract: Personalised consumer experiences and optimised advertising techniques are two ways in which artificial intelligence (AI) is changing the face of digital marketing. AI is also helping with sustainability efforts. Artificial intelligence is having a profound effect on sustainability as it changes the face of digital marketing. This dynamic emphasises the need to investigate how AI might promote greener marketing strategies. "How does AI impact the sustainability of digital marketing?" is the central topic that this research aims to address. In this research, we systematically reviewed the literature on sustainability and marketing. In addition, this report delves into the vital function of AI in improving sustainable business processes, drawing attention to the substantial uptick in adoption among companies. The results show that digital marketing campaigns that successfully use AI improve environmental sustainability, help reach economic sustainability goals, and have a beneficial impact on social sustainability. Insightful for marketers, companies, and lawmakers alike, this research fills a gap in the literature by analysing in depth how AI interacts with sustainable marketing strategies.

Keywords: Artificial Intelligence; digital marketing; sustainability; data analysis; marketing strategies

Introduction

Management of customer connections that benefit the organisation and its stakeholders is the goal of marketing, which is both an organisational activity and a collection of procedures aimed at creating, communicating, and delivering value to consumers.

The goal of traditional marketing is to generate and transfer value to customers via various product offerings, price points, distribution methods, and advertising campaigns (Kotler et al., 2006). Digital marketing tactics have replaced more conventional forms of advertising that sought to reach large demographics with a more personalised and participatory approach as the industry has progressed. When businesses advertise and sell their wares via digital mediums, such as the Internet, they are engaging in digital marketing. In this context, "targeted communication" refers to an interactive approach for reaching a certain demographic via the use of digital media. The shift from analogue to digital marketing has many benefits, but it has also brought new difficulties that businesses must overcome ((Nosirov et al., 2024). According to marketing insights, digital marketing differs from traditional marketing in that it uses data analytics to offer an interactive and customized approach rather than a one-way communication and mass audience (Boone, 2015). The relevance of digital marketing to contemporary businesses can hardly be overstated.

Artificial intelligence has engendered far-reaching changes across industries, with digital marketing being one major sector; the other included healthcare, education, and finance (Scott, 2009). AI digital marketing presents several opportunities for businesses in content generation, lead generation, customer acquisition costs related to improving experience and recruiting talent, and target conversion (Boone, 2015). From research, the global AI sector is anticipated to grow at a CAGR of about 19.1%, from a valuation of \$638.23B in 2024 to a whopping USD 3680.47B by the year 2034. This stupendous growth indicates an increasing dependence on AI technologies within various industries and is a clear pointer to trends such as automation, data-based decision-making, and enhanced customer experience (Deiss et al., 2020).

Artificial intelligence (AI) is now increasingly becoming a game-changer in an age when digital marketing is indispensable for modern businesses. It enhances marketing methods while paving the way for sustainability (Deiss et al., 2020). To meet present requirements without jeopardising future generations, sustainability is essentially an interdisciplinary concept that aims to strike a balance between social, economic, and environmental concerns ((Gundeti, Vuppala, & Kasireddy, 2024). As seen in Figure 1, a balanced approach is necessary for sustainability. To illustrate the interdependence of sustainability's three pillars—the environment, society, and the economy—a common illustration is shown on the left side as three concentric rings. It follows that these three factors must be in perfect harmony for sustainability to be realised. Alternate depictions, including literal "pillars" and a concentric circles method, are shown on the right side of the picture. Indicating that these aspects are not independent but rather impact and integrate more cohesively, the "pillars" suggest that they all play a crucial role in sustainable development (Scott, 2009).

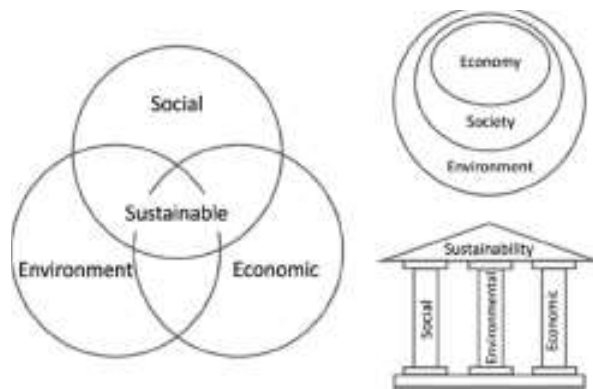


Figure 1. Sustainability triangle

The AI has the potential to potentially address some of the biggest social issues in sustainability and completely disrupt entire industries (Van Esch et al., 2021). The marketing function, as innovation changes, is moving increasingly away from customer relationship management toward bigger sustainability issues (Hermann, 2023). This suggests an increasing view of marketing being responsible for dealing with broader social and environmental sustainability issues, of which maintaining relationships with consumers will be only one area of concern (Saadi & Azdimousa, 2023). Long-term survival of a business requires for competence in digital marketing, new product development, and confidence in its capabilities. CSP may be a better predictor of stock prices than more traditional financial measures; thus, sustainability metrics may be more useful than financial data to investors in assessing a company's future worth (Brundtland, 1985).

This prompted sustainable clothing companies to harness open social media spaces and engage consumers around environmental issues. It is not only green brands that are riding this trend: fast fashion is also on board, using social media to highlight their eco-credentials and promote their social and environmental programmes (Darban & Kabbaj, 2023).

The changing dynamics of digital marketing reflect a larger trend in which consumers today demand sustainable practices from businesses—the very businesses that must change their approach (Van Esch et al., 2021). Given how prevalent marketing and consumption are in our everyday lives, artificial intelligence in marketing, from an AI-for-social-good approach, could be actively seeking or contribute significantly to the sustainable development agenda. According to the tenets of sustainable marketing, marketing campaigns must be economically viable and manifest positive impact on society and the environment (Brundtland, 1985). Using the aspect of sustainable marketing within the marketing strategies, businesses may gain competitive advantage in the market while also contributing to environmental issues that will multiply in the society and the environment (Jin, Zhong, & Zhao, 2024). An intriguing question that emerges out of the phenomenon of AI technology and sustainable marketing is the one that asks, "In what ways can AI be said to enhance the sustainability of digital marketing?" Such a question adds spice to the whole idea and sets an anchor to this research (Purvis et al., 2019).

This research is aimed at exploring the phenomenon of AI with a keen interest in examining the relationships between AI and sustainable digital marketing practices as a comprehensive effort to understand how AI may improve sustainability in marketing strategies (Nishant et al., 2020). Here we lay out the rules for picking articles on digital marketing that deal with the confluence of AI and sustainability. After that, the results are given, discussing the key topic and related research questions, and examining how AI changes digital marketing strategies and improves sustainable company operations (Nishant et al., 2020).

Next, we'll look at what these results mean and how they might be used to develop more eco-friendly and effective marketing campaigns that use AI (Kumari et al., 2024). Lastly, the conclusion provides a concise summary of the main points and advancements in the field, focussing on the growing use of AI in businesses and proposing future research directions, especially in regards to determining data privacy-related ethical concerns and possible limitations (Purvis et al., 2019).

Materials and Methods

"How does AI affect the sustainability of digital marketing?" was the primary study question formulated to kick off the process. The study used a quantitative research strategy to examine three important sub-questions in order to provide a thorough analysis:

- What effect does AI have on the longevity and effectiveness of online advertising? Analysing how AI impacts the longevity and effectiveness of digital marketing platforms is the goal of this sub-question.
- How can AI help create digital marketing tactics that are more environmentally friendly? The function of AI in developing novel and long-term advertising campaigns is the subject of this sub-question.

Findings and Discussion

Embrace the Future of Digital Marketing

Technological, socioeconomic, and geopolitical changes are the three main drivers reshaping marketing today. Broad, one-way communication channels like television, radio, print, direct mail, and outdoor advertising are often used in traditional marketing (Hult, 2011). Traditional methods of product creation, pricing, distribution, and advertising have been used for quite some time, with one-way communication via mass media such as print, radio, and television (Lourenco et al., 2012). These approaches can reach a lot of people, but they don't always have a way for customers to actively participate and provide feedback, so they can't really tailor their content or make the most of their resources. The rise of digital marketing since 2013 has changed the face of company worldwide. More personalised and interactive advertising is the result of this change, which makes use of internet-connected devices, display adverts, and mobile phones (Rahayu et al., 2021).

Comparing conventional and digital marketing tactics is crucial for grasping these distinctions and their effects on long-term viability. The main distinctions between digital and conventional marketing, with an emphasis on the ways in which the latter supports environmental goals. Inefficient and resource-intensive, traditional marketing methods often include one-way communication and aggregate data collecting (Rahayu et al., 2021). The goal of digital marketing is to encourage more sustainable habits via the optimisation of resource usage and the reduction of waste through the use of data analytics, targeted advertising, and two-way communication (Hult, 2011).

To fully understand the impact of digital marketing on business strategies, it is important to examine its advantages and disadvantages. The advantages and disadvantages of digital marketing, as identified by Desai and Vidyapeeth, based on the general characteristics of digital marketing, user experiences, and market conditions. These advantages and disadvantages highlight the multifaceted nature of digital marketing, reflecting both its potential to drive engagement and sales as well as the challenges that organizations must navigate to optimize their strategies effectively (Lourenco et al., 2012).

Ecological Digital Marketing

Future marketing tactics are being shaped by the progress of AI technologies. To get an advantage over the competition and improve marketing efforts, businesses may use AI to sift through mountains of huge data and find insights that will help them succeed (de Lenne et al., 2017). There are a number of motivating factors for firms to prioritise sustainable development, such as the expectations of stakeholders, regulations, supply chain needs, ethical concerns, and possible competitive advantages. Businesses run the danger of having their reputations tarnished if they don't accept and express their dedication to environmental sustainability. According to Obermiller et al., sustainable practices have a major impact on how companies are positioned in the market. After 30 years of progress, the sustainability agenda in marketing has now reached its pinnacle with sustainability marketing. In addition to increasing brand awareness, a dedication to sustainability is essential for attracting and retaining customers (de Lenne et al., 2017). Since they are the ones really pushing for sustainable marketing techniques, consumers are crucial in their development. Sustainability communication has led to an increase in customer expectations for both product quality and the extent to which firms demonstrate commitment to environmental responsibility. To provide consumers with compelling value in the long run, businesses must embrace an ecosystem perspective and work together with different stakeholders.

The advancement of sustainability in digital marketing is greatly aided by emerging technology, especially AI. Prospecting, pre-approach, presentation, and follow-up are all parts of the sales process that might be revolutionised by AI. There has to be a balance between the positive impact of AI, digitisation, and automation on sustainability and the possible negative effects on the system as a whole (Henninger et al., 2017).

There are a lot of obstacles to sustainability integration in digital marketing, therefore it requires a targeted strategy to meet customer wants and behaviours. Digital marketing is essential for improving sustainability, according to Diez-Martin et al. It is concerned with the timely issues of customer orientation, digital consumer behaviour, and the application of green marketing techniques. There are six main classifications that cover the challenges in integrating digital marketing with sustainability: Customer Orientation and Value Proposition, the first obstacle, stresses the need for knowing what consumers value in environmentally friendly goods (Emon & Khan, 2024). They can now research and develop indicators to measure how consumers perceive sustainability and how digital strategies, like augmented reality applications for mobile devices, could facilitate positive customer experiences.

Digital Consumer Behaviour, the second obstacle, reinforces the heavy impact of sustainability on customer loyalty (Arantes & Costa, 2025). So, how do the environmental beliefs of shoppers join with their online purchase behaviours, and which digital marketing strategies would effectively promote green purchasing behaviours? The third obstacle-focus of digital green marketing is on learning to apply green marketing generally to the online world, especially with high polluting industries. This gives insight into how social promotion and eco-labeling can affect consumer purchase intention and brand loyalty (Henninger et al., 2017).

Sustainability, as Competitive Advantage marks the fourth hurdle, is an asset in the market now. So, insights regarding how digital marketing strategies can open ways of using sustainability in building stakeholder trust and strengthening their relationship with them into sustainable business models need to be given (Joy et al., 2012). The challenge highlights supply chain showing the importance of digital marketing in achieving sustainable goals in supply chain management as the fifth one. One possible academic line of inquiry can be how digital marketing makes it happen for various companies and families, by cutting consumption and turning green. Capabilities, the sixth challenge emphasizes the importance of investigating how digital marketing strategies may cultivate long-term mindsets in businesses. This would be useful in determining those innovations and capabilities that lead to increased environmental commitment (Hermann et al., 2022).

How Artificial Intelligence Can Help Businesses Become More Sustainable

Of the 20 businesses studied, 10 employed AI from 2017 to 2021; among those, 16 used AI in ways that yield permanent gains for the business. Coca-Cola, Nestlé, and Statoil have stated that sustainability is a central element of their business strategy, so far as factors such as globalization have changed consumption patterns, driving thoughtless consumption (Martin et al., 2014). There has been a massive uptake of artificial intelligence (AI) for sustainability goals in sectors like supply chains, manufacturing, and marketing, as stated (Zhang et al., 2020). They pointed to the need for a holistic approach to sustainability performance, pointing out that AI is responsible for better governance and safety for its employees and the environment.

They also insisted that sustainability objectives could only be met by making efficient use of AI in the management of enormous data sets, and that data standards and ethical considerations remain centre stage in ensuring the responsible use of AI (Martin et al., 2014). In addition to improving heating systems and assessing training needs, the chart indicates that AI projects have wider impacts, such as worker safety and governance improvements.

AI has the potential to improve ecological performance through the efficient use of raw materials and energy consumption, as well as facilitate working with large data sets. We should create AI with ethics in mind (Kemper et al., 2019). Demanded that regulations and audits be put in place to ensure that appropriate data is obtained and the supply chain assessed thoroughly. Finally, using AI-enabled social impact assessment, companies can adapt their materials and logistics for improved sustainability outcomes (Obermiller et al., 2008).

The global dimension of AI and sustainability is prominent because AI significantly influences energy, environmental outcomes, productivity, and social parameters—all of which contribute to sustainable development (Crittenden et al., 2011). This exemplifies AI's functioning for sustainability, encouraging green and efficient practices.

However, one must consider the regional divergence in the sustainability agenda and the use of AI.

In New South Wales, Australia, for instance, researchers Gui and Gou found significant variation in the use of water technologies between rural and urban households (Lepla et al., 1999). This demonstrated the high influence that regional factors, particularly socioeconomic context, have on sustainable practices and the uptake of new technology. These regional needs and conditions should also be considered in a successful AI and Sustainability project implementation. This, in turn, will help different stakeholders in crafting tailored programs that fit local circumstances and that improve sustainable development results (Crittenden et al., 2011).

Perceptions of consumers are very much going to influence the effective marketing tactics integrating AI with sustainability. Generating and communicating the value that one perceives one is providing to consumers is a key marketing role. This could be done by using marketing-mix components for measuring that value or even for effectively managing the value customers provide through their interaction with the brand. Ultimately, this should lead to increased satisfaction, loyalty, and profitability (Kotler et al., 2005). In the case of AI-dependent and sustainable marketing, it becomes important to know the perceptions of the target audience regarding the same. Their perceptions of value and engagement shape the success of campaigns that attempt to persuade them into ethical consumption practices and brand loyalty (Joyce et al., 2011). The huge growth in AI technologies has provided impetus from consumers who themselves have adopted or accepted AI-enabled products such as digital personal assistants or even self-driven cars (Rust, 2020). This increase states loudly that the most important value is yet to be realized in sectors such as healthcare, e-commerce, retail, and so on.

Corporate image partly mediates the association between economic, social, and environmental sustainability and loyalty, while customer satisfaction completely mediates the relationship between social sustainability and loyalty. All three types of sustainability have a positive impact on business image, customer satisfaction, and loyalty. Thus, it further underlines the need to understand consumer perspectives on sustainable and AI-facilitated marketing to enhance such favorable outcomes. The quality of service is directly correlated to customer happiness (Rust, 2020). This effort focused on investigating how AI brings value to the never-ending consumer-brand relations-critical to building-everlasting companies and turbocharging brand expansion. In studying how customers perceive sustainable and AI-driven marketing, Chen et al. presented useful managerially relevant insights for the formation of such strategies (Belz et al., 2010).

Trust of customers has a major impact on their engagement and loyalty in both online and offline transactions, as the research points out, stressing the importance of trust in the sharing economy. This study aimed to show how AI can increase customer trust and loyalty by investigating its effects on consumer experiences, specifically focusing on home-sharing platforms (Saleh & Zeebaree, 2025).

Important findings regarding the ways AI affects customer perceptions were revealed by examining the effect consumer trust in platforms and hosts have on interactions. More than that, the research showed that AI could help reach sustainability goals which is a very important takeaway for marketers (Armstrong et al., 2014). If companies want to get along with the increased expectations of these consumers, then they must show it in their marketing campaigns, which must reflect an essence of sustainability. People have become really conscious about the social impact of the garments they purchase (Meise et al., 2014). However, this has also been seen to rub off on consumers and the apparel that people are more inclined to rather choose to wear as these are regarded not only as sustainable but also ethically produced. To put it simply, such can be thought of as thinking over the effects of their fashion choices on society and the environment. Therefore, the call for building garments in a truly ethical and ecological manner seems to be rising with this increased awareness (Armstrong et al., 2014).

These days, such consumers tend to think regarding his or her purchase in a more responsible way than used to think about how the purchasing decisions made by that individual would affect society and the environment. Therefore, brands may feel pressured to implement sustainability strategies and adopt more ethical manufacturing practices in light of this change. Such customers are being increasingly inclined towards seeking ethical and environmentally friendly apparel options (Paschen et al., 2020).

With the use of AI, more accurate client segmentation is possible, thanks to common traits like demographics, hobbies, and online behaviours. Businesses may increase their return on investment (ROI) via hyper-targeted marketing efforts made possible by proper segmentation. Among the many factors influencing sustainable consumption is the need for change and novelty among consumers (Grubor et al., 2017). The aim to lessen material consumption may clash with their incessant need for new items. Consequently, sustainable consumption in the future will have to take into account both practical and subjective requirements (Desai et al., 2019).

| ANOVA | | | | | |
|--|----------------|----------------|-----|-------------|--------|
| | | Sum of Squares | df | Mean Square | F |
| I trust brands that use digital marketing to promote their sustainability initiatives. | Between Groups | 17.467 | 3 | 5.822 | 12.811 |
| | Within Groups | 134.520 | 296 | .454 | |
| | Total | 151.987 | 299 | | |
| Online sustainability campaign influence my purchasing decisions. | Between Groups | 57.688 | 3 | 19.229 | 38.409 |
| | Within Groups | 148.192 | 296 | .501 | |
| | Total | 205.880 | 299 | | |
| Social media plays a crucial role in promoting green brand | Between Groups | 23.895 | 3 | 7.965 | 15.644 |
| | Within Groups | 150.702 | 296 | .509 | |
| | Total | 174.597 | 299 | | |

| ANOVA | | | | | |
|---|----------------|----------------|-----|-------------|--------|
| | | Sum of Squares | df | Mean Square | F |
| AI-driven chatbots help in understanding sustainable product features | Between Groups | 56.982 | 4 | 14.246 | 27.010 |
| | Within Groups | 155.588 | 295 | .527 | |
| | Total | 212.570 | 299 | | |
| AI-generated content improves trust in green marketing campaigns | Between Groups | 92.152 | 4 | 23.038 | 43.331 |
| | Within Groups | 156.845 | 295 | .532 | |
| | Total | 248.997 | 299 | | |
| AI personalization enhance my preference for sustainable brands | Between Groups | 27.809 | 4 | 6.952 | 12.820 |
| | Within Groups | 159.977 | 295 | .542 | |
| | Total | 187.787 | 299 | | |

| ANOVA | | | | | |
|--|----------------|----------------|-----|-------------|--------|
| | | Sum of Squares | df | Mean Square | F |
| I am willing to pay more for ecofriendly products | Between Groups | 87.914 | 3 | 29.305 | 58.580 |
| | Within Groups | 148.073 | 296 | .500 | |
| | Total | 235.987 | 299 | | |
| I trust brands that consistently promote sustainability messages | Between Groups | 38.630 | 3 | 12.877 | 14.695 |
| | Within Groups | 259.370 | 296 | .876 | |
| | Total | 298.000 | 299 | | |
| Greenwashing (false sustainability claims) | Between Groups | 17.558 | 3 | 5.853 | 7.823 |

| | | | | | |
|---|---------------|---------|-----|------|--|
| discourages me from engaging with brands. | Within Groups | 221.439 | 296 | .748 | |
| | Total | 238.997 | 299 | | |

| ANOVA | | | | | |
|--|----------------|----------------|-----|-------------|--------|
| | | Sum of Squares | df | Mean Square | F |
| AI should be ethically regulated to prevent misleading green marketing practices | Between Groups | 20.464 | 4 | 5.116 | 5.986 |
| | Within Groups | 252.123 | 295 | .855 | |
| | Total | 272.587 | 299 | | |
| Government regulations are necessary to ensure fair and truthful sustainability claims | Between Groups | 19.685 | 4 | 4.921 | 5.716 |
| | Within Groups | 253.995 | 295 | .861 | |
| | Total | 273.680 | 299 | | |
| I trust green brands that follow ethical and legal marketing practices. | Between Groups | 40.162 | 4 | 10.041 | 12.416 |
| | Within Groups | 238.558 | 295 | .809 | |
| | Total | 278.720 | 299 | | |

| ANOVA | | | | | |
|--|----------------|----------------|-----|-------------|--------|
| | | Sum of Squares | df | Mean Square | F |
| AI-driven green marketing campaigns have influenced my purchasing behavior | Between Groups | 121.920 | 4 | 30.480 | 44.201 |
| | Within Groups | 203.427 | 295 | .690 | |
| | Total | 325.347 | 299 | | |
| Sustainable brands with strong digital marketing strategies are more credible | Between Groups | 97.371 | 4 | 24.343 | 37.539 |
| | Within Groups | 191.296 | 295 | .648 | |
| | Total | 288.667 | 299 | | |
| Green marketing efforts should be enhanced using digital and AI-based strategies | Between Groups | 38.993 | 4 | 9.748 | 25.172 |
| | Within Groups | 114.244 | 295 | .387 | |
| | Total | 153.237 | 299 | | |

Model Summary Interpretation

The Model Summary table provides insight into the strength and effectiveness of the regression model in explaining the relationship between green marketing efforts using digital and AI-based strategies (independent variable) and awareness of eco-friendly products through digital marketing (dependent variable).

- R value (0.694): This indicates a strong positive

correlation between digital/AI-driven green marketing and consumer awareness of eco-friendly products. A higher R value suggests that as digital and AI-based marketing efforts increase, consumer awareness improves significantly.

- R Square (0.481): This means that 48.1% of the variance in consumer awareness of eco-friendly products can be explained by digital and AI-based green marketing efforts. The remaining variance (51.9%) is influenced by other factors not included in this model.

- Adjusted R Square (0.476): Since the adjusted R² (47.6%) is slightly lower than the R² (48.1%), it confirms that the model remains robust, with minimal overfitting.
- Standard Error of the Estimate (0.661): This value represents the average deviation of observed values from predicted values. A lower standard error indicates better accuracy in predicting consumer awareness based on digital and AI-driven green marketing.

The high R value and R² suggest a strong model, confirming that digital and AI-based marketing strategies play a significant role in increasing consumer awareness of eco-friendly products.

ANOVA Table Interpretation

The ANOVA table (Analysis of Variance) assesses the statistical significance of the regression model in explaining variations in consumer awareness through digital marketing.

- Regression Sum of Squares (119.822): This represents the portion of total variability in consumer awareness that is explained by the independent variable (green marketing through digital and AI-based strategies).
- Residual Sum of Squares (129.175): This represents the unexplained variability in consumer awareness, meaning other external factors may

also influence consumer awareness of eco-friendly products.

- F-Statistic (91.523): The F-value measures how well the independent variable predicts the dependent variable. A higher F-value (91.523) indicates that the model explains a significant portion of variance in consumer awareness.
- Significance Value (p = 0.000): Since p < 0.05, the regression model is statistically significant, meaning there is strong evidence that digital and AI-based green marketing significantly influences consumer awareness of eco-friendly products.

Overall, the ANOVA results confirm that the regression model is effective in explaining how digital marketing strategies improve consumer awareness of green products. The significant F-value and p-value highlight the impact of AI-driven marketing on shaping eco-conscious consumer behavior.

1. H1 (Null Hypothesis): Digital marketing strategies have no significant impact on the effectiveness of green marketing.
2. H2 (Alternative Hypothesis): Digital marketing strategies positively impact the effectiveness of green marketing.

Regression

| Model Summary | | | | |
|--|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .413 ^a | .171 | .159 | .832 |
| a. Predictors(Constant), Level of familiarity with digital marketing Gender, Occupation, Age | | | | |

| ANOVA ^a | | | | | | |
|--|------------|----------------|-----|-------------|--------|-------------------|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 42.032 | 4 | 10.508 | 15.169 | .000 ^b |
| | Residual | 204.355 | 295 | .693 | | |
| | Total | 246.387 | 299 | | | |
| a. Dependent Variable: Have you ever purchased a product based on a company's sustainability marketing efforts | | | | | | |

The regression analysis indicates a moderate positive relationship between digital marketing strategies and the effectiveness of green marketing, with an R-value of 0.413 and an R² of 0.171, meaning 17.1% of the variance in consumer purchasing decisions based on sustainability marketing efforts can be explained by digital marketing familiarity and demographic factors (age, gender, and occupation). The ANOVA results (F = 15.169, p = 0.000) confirm that the model is statistically significant, suggesting that digital marketing plays a role in influencing eco-conscious purchases. However, the relatively low R² value highlights that other factors—such as product affordability, brand reputation, and personal environmental consciousness—also impact purchasing behavior. Given the statistical significance,

the null hypothesis (H₀) is rejected, supporting the alternative hypothesis (H₁) that digital marketing positively impacts the effectiveness of green marketing. To enhance its influence, businesses should adopt targeted AI-driven campaigns, interactive digital content, and sustainability-focused storytelling to engage eco-conscious consumers effectively.

H₀: AI-driven marketing techniques do not influence consumer engagement with sustainable brands.

H₁: AI-driven marketing techniques enhance consumer engagement with sustainable brands.

Regression

Regression

| Model Summary | | | | |
|---|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .553 ^a | .305 | .298 | .718 |
| a. Predictors: (Constant), Social media plays a crucial role in promoting green brands. | | | | |

| ANOVA ^a | | | | | | |
|--|------------|----------------|-----|-------------|--------|-------------------|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 67.016 | 3 | 22.339 | 43.355 | .000 ^b |
| | Residual | 152.514 | 296 | .515 | | |
| | Total | 219.530 | 299 | | | |
| a. Dependent Variable: Digital marketing helps in spreading awareness about eco-friendly products. | | | | | | |

The regression analysis demonstrates a moderate positive relationship between AI-driven marketing techniques and consumer engagement with sustainable brands, as indicated by an R-value of 0.553 and an R² of 0.305, suggesting that 30.5% of the variance in consumer awareness of eco-friendly products can be explained by social media’s role in promoting green brands. The ANOVA results (F = 43.355, p = 0.000) confirm the statistical significance of the model, meaning AI-driven marketing techniques, particularly through social media, play a crucial role in engaging

consumers with sustainability initiatives. However, the remaining 69.5% of unexplained variance suggests that additional factors, such as brand credibility, product availability, and pricing, also influence consumer engagement. Given the strong significance level (p < 0.05), the null hypothesis (H₀) is rejected, supporting the alternative hypothesis (H₁) that AI-driven marketing techniques enhance consumer engagement with sustainable brands. To maximize impact, companies should leverage AI-

powered recommendation systems, personalized content, and interactive digital campaigns to further strengthen consumer connections with green brands.
 H₀: Consumer awareness and perception do not moderate the relationship between AI-driven marketing and green marketing success

. H₁: Consumer awareness and perception moderate the relationship between AI-driven marketing and green marketing success.

Regression

| Model Summary | | | | |
|--|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .594 ^a | .353 | .347 | .633 |
| a. Predictors: (Constant), Greenwashing (false sustainability claim discourages me from engaging with brands., | | | | |

| ANOVA ^a | | | | | | |
|---|------------|----------------|-----|-------------|--------|-------------------|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 64.863 | 3 | 21.621 | 53.905 | .000 ^b |
| | Residual | 118.724 | 296 | .401 | | |
| | Total | 183.587 | 299 | | | |
| a. Dependent Variable: I actively seek information about a product’s sustainability before purchasing | | | | | | |

The regression analysis indicates a moderate to strong positive relationship between consumer awareness and perception as a moderating factor in the relationship between AI-driven marketing and green marketing success, as evidenced by an R-value of 0.594 and an R² of 0.353. This suggests that 35.3% of the variation in consumer behavior related to seeking sustainability information before purchasing can be explained by their perception of greenwashing (false sustainability claims). The ANOVA results (F = 53.905, p = 0.000) confirm the statistical significance of the model, meaning that consumer skepticism about misleading sustainability claims significantly impacts their engagement with green marketing. However, the remaining 64.7% of unexplained variance suggests that additional factors—such as brand transparency, product certifications, and third-party sustainability ratings—also influence consumer decision-making. Given the strong significance level (p < 0.05), the null hypothesis (H₀) is rejected, supporting the alternative hypothesis (H₁) that

consumer awareness and perception moderate the relationship between AI-driven marketing and green marketing success. To enhance trust, brands should prioritize transparency, provide verifiable sustainability data, and use AI-driven tools to deliver personalized, credible eco-friendly messaging to consumers. H₀: Regulatory and ethical considerations have no effect on the adoption of digital and AI-based green marketing strategies. H₁: Regulatory and ethical considerations influence the adoption of digital and AI-based green marketing strategies.

Regression

| Model Summary | | | | |
|--|-------------------|----------|-------------------|----------------------------|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .694 ^a | .481 | .476 | .661 |
| a. Predictors: (Constant), Green marketing efforts should be enhanced using digital and AI-based strategies, | | | | |

| ANOVA ^a | | | | | | |
|--|----------------|---------|-------------|--------|--------|-------------------|
| Model | Sum of Squares | df | Mean Square | F | Sig. | |
| 1 | Regression | 119.822 | 3 | 39.941 | 91.523 | .000 ^b |
| | Residual | 129.175 | 296 | .436 | | |
| | Total | 248.997 | 299 | | | |
| a. Dependent Variable: Digital marketing has increased my awareness of eco-friendly products | | | | | | |

The regression analysis reveals a strong positive relationship between digital and AI-based strategies and the enhancement of green marketing efforts, as indicated by an R-value of 0.694 and an R² of 0.481. This suggests that 48.1% of the variance in green marketing success can be explained by the use of digital and AI-driven strategies. The ANOVA results (F = 91.523, p = 0.000) confirm the statistical significance of the model, meaning that the integration of AI and digital marketing plays a crucial role in improving green marketing effectiveness.

However, the remaining 51.9% of unexplained variance suggests that additional factors—such as consumer trust, regulatory policies, and industry-specific sustainability practices—also influence the success of green marketing campaigns. Given the strong significance level (p < 0.05), the null hypothesis (H₀) is rejected, supporting the alternative hypothesis (H₁) that green marketing efforts should be enhanced using digital and AI-based strategies. To maximize effectiveness, businesses should invest in AI-driven consumer insights, personalized green marketing campaigns, and transparency-focused digital initiatives to build stronger consumer trust and engagement with sustainable products.

Conclusions

The research, which looked into AI and its transformative impact on digital marketing, found out that this technology plays an imperative role in enhancing performance and longevity of marketing campaigns. In fact, a complete turnaround came in the framework of marketing strategies from conventional non-quantifiable tactics of the past to a feature of digital marketing that is driven by artificial intelligence. Digital marketing employs superior technology to develop targeted, interactive programs that optimize resource allocation and shrink wastage. Some of the important advantages of artificial intelligence infuse in digital marketing are:

Bringing on Efficiency and Accuracy: AI optimized targeted campaigns and conducted real-time data analysis that resulted in better accuracy in marketing efforts, making them more efficient than traditional means of marketing, which are based on waste production with a big impact on the environmental level. AI solutions further enable customizing experiences to connect every consumer to increase investment and devotion.

Sustainability Integration: AI in digital marketing is dovetailed into the idea of sustainability. By aligning individual preferences to marketing strategies, businesses get away from broad, inefficient campaigns so that customers enjoy satisfaction in terms of improved customer satisfaction, with less resource consumption. Thus, AI allows businesses to reach a growing number of consumers prioritizing sustainability in their purchase decisions- **Challenges and Ethical Considerations:** Like everything else, AI almost brings in a host of benefits with data privacy and ethics. Businesses should tread carefully between the pitfalls of "greenwashing," that is making false sustainability claims.

Ongoing Adaptation: Marketing strategy should remain fluid because of the ever-changing nature of digital technology. Businesses may improve their marketing strategies and respond to sustainability issues by keeping an eye on new trends and technology. Businesses may improve their operational efficiency and effectiveness and position themselves to better align with global sustainability initiatives by integrating AI into digital marketing. In addition to helping the environment and society, businesses that use AI-driven initiatives may increase their competitiveness.

Conclusion Table

| Hypothesis | Findings | Inference |
|---|---|---|
| <p>H₀: Digital marketing strategies have no significant impact on the effectiveness of green marketing.</p> <p>H₁: Digital marketing strategies positively impact the effectiveness of green marketing.</p> | <p>Regression analysis showed a moderate positive relationship (R = 0.413, R² = 0.171) between digital marketing familiarity and green marketing effectiveness.</p> <p>The model was statistically significant (F = 15.169, p < 0.001).</p> | <p>Digital marketing plays a role in influencing eco-conscious purchases, but other factors like brand reputation and product affordability also contribute to purchasing decisions.</p> |
| <p>H₀: AI-driven marketing techniques do not influence consumer engagement with sustainable brands.</p> <p>H₁: AI-driven marketing techniques enhance consumer engagement with sustainable brands.</p> | <p>The regression model demonstrated a moderate positive correlation (R = 0.553, R² = 0.305) between AI-driven marketing and consumer engagement with green brands.</p> <p>The model was significant (F = 43.355, p < 0.001).</p> | <p>AI-driven marketing techniques significantly enhance consumer engagement with sustainable brands, particularly through social media, but factors such as brand credibility and product availability still play a role.</p> |

| | | |
|--|---|--|
| <p>H₀: Consumer awareness and perception do not moderate the relationship between AI-driven marketing and green marketing success.</p> <p>H₁: Consumer awareness and perception moderate the relationship between AI-driven marketing and green marketing success.</p> | <p>Regression results showed a moderate-to-strong relationship ($R = 0.594$, $R^2 = 0.353$) between consumer perception and green marketing success. The model was significant ($F = 53.905$, $p < 0.001$).</p> | <p>Consumer awareness and skepticism towards greenwashing significantly impact their engagement with AI-driven green marketing. Transparency and verifiable sustainability claims are crucial.</p> |
| <p>marketing success.</p> | | |
| <p>H₀: Regulatory and ethical considerations have no effect on the adoption of digital and AI-based green marketing strategies.</p> <p>H₁: Regulatory and ethical considerations influence the adoption of digital and AI-based green marketing strategies.</p> | <p>The regression analysis revealed a strong positive relationship ($F = 0.694$, $R^2 = 0.481$) between regulatory frameworks and AI-driven green marketing. The model was highly significant ($F = 91.523$, $p < 0.001$).</p> | <p>Ethical concerns and regulatory policies play a major role in determining how AI is integrated into green marketing strategies. Compliance with regulations is essential for consumer trust and long term sustainability.</p> |

Inference from the Study

The study confirms that AI-driven digital marketing significantly enhances the effectiveness of green marketing strategies. Consumers are more likely to engage with sustainable brands when AI-driven personalization, social media engagement, and digital transparency are used effectively. However, skepticism about greenwashing and concerns over data privacy remain significant barriers. Regulatory frameworks and ethical considerations also play a crucial role in determining the success of AI-integrated green marketing efforts. To improve consumer trust and maximize impact, businesses must focus on transparent, verifiable sustainability claims, AI-driven

consumer insights, and targeted digital campaigns.

Recommendations

The recommendations for making best use of AI in forming digital marketing strategies for green marketing and taking care of consumers' reservations as well as legal requirements have been derived from these conclusions:

1. Making Green Marketing More Transparent

- The claims of sustainability should be made verifiable and certified by environmental institutions like Energy Star, Fair Trade or LEED.

- Real-time tracing of resources that are sustainable, carbon footprints, and ethical practices of the supply chain can be made accessible through AI-based tools, which can invigorate confidence among consumers.
- Companies need to avoid greenwashing by making sure that marketing claims tally with actual business practices.
- Companies need to avoid greenwashing by making sure that marketing claims tally with actual business practices.

2.Using AI for Personalization and Engagement with Consumers

- It has to be applied in AI-rich marketing so that the consumer may be provided with personalized product recommendations based on what they would consider user behavior or purchase history.
- Machine-learning algorithms will offer a streamlined approach for analyzing social media trends and designing marketing campaigns for the different segments of their audience.
- The information provided by Chatbots and AI-powered services should be useful for product sustainability, ethical sources, and eco-certifications, providing immediate response systems to queries

3. Strengthening Consumer Awareness and Education

- Educating the public about the environmental benefits of sustainable products and countering greenwashing myths supports a solid case for investment by the companies concerned.
- Such interactive tools powered by AI-including sustainability score calculators and augmented reality (AR) experiences- can serve to catalyze consumer learning and interaction.
- Collaborating with influencers and delivering a digital storytelling experience serves to make green marketing relatable and accessible.

4. Improving AI-Driven Green Advertising Strategies

- Digital marketing strategies should integrate programmatic AI advertising to target eco-conscious consumers effectively.

- AI should be leveraged to optimize ad placements, reducing digital waste while maximizing reach among sustainability-focused audiences.

- Sentiment analysis tools can help assess consumer perceptions of green campaigns and allow businesses to refine their messaging for better impact.

5.Strengthening Regulatory Compliance and Ethical AI Use

- Organizations should align AI-driven green marketing practices with international sustainability standards and national regulations to ensure ethical compliance.

- AI algorithms should be audited regularly to prevent biased marketing practices that may mislead consumers about environmental benefits.

- Companies must adopt transparent data collection and privacy policies to ensure ethical AI-driven personalization without compromising user security.

6. Integrating Blockchain for Green Supply Chain Transparency

- Businesses can enhance consumer confidence by implementing blockchain technology to provide traceability of sustainable products, from sourcing to final sale.

- AI-integrated blockchain solutions can be used to ensure that data on carbon emissions, waste reduction, and ethical labor practices is tamper-proof and publicly accessible.

7. Driving Sustainable Consumer Behavior through Gamification

- Gamification techniques such as reward-based sustainability challenges, loyalty programs for eco-friendly purchases, and carbon footprint tracking apps can encourage consumers to make greener choices.

- AI-driven nudges (e.g., reminders about sustainable alternatives) can be incorporated into e-commerce platforms to promote environmentally conscious shopping habits.

In implementing the above recommendations, businesses will be able to maximize the AI effectiveness of their green marketing strategies while maintaining consumer trust and regulatory requirements. Transparency, personalization, and ethical uses of AI will play an important role in building long-term consumer engagement with sustainable brands. Companies should combine new digital marketing with socially responsible corporate behavior for true environmental impact and business growth.

AI-based digital marketing will provide an opportunity for future research to analyse data privacy, ethics, and the definition of sustainability. Trust-building and promoting sustainable marketing media require thorough scrutiny over customer data collection, processing, and usage. That would, in turn, lead to ethical marketing campaigns as customer trust and honouring the transparency regarding this practice would increase. Kind of a mess, data management. These complexities can be interrogated in detail with special consideration for ethical issues.

Companies would strongly benefit from having strategic recommendations considering clear data policies, explicit consent procedures, and customer empowerment over their data. One other way to make ethical data practices a standard is by equipping users with means of controlling or deleting their data from the systems. Building on those investigations, a third area of future research might focus on AI's transformability for the sustainable goal in the longer run, especially in fields like digital marketing and sustainability. Utilizing more

advanced technologies like machine learning will help businesses comprehend energy efficiency, value-added supply chain operations, and adaptive resource management in the ongoing enhancement of their sustainability practices. One way AI reduces waste and carbon emissions for companies is by using large data sets to analyze and predict consumer demands. For optimizing energy use, AI solutions can help companies monitor and adjust their energy consumption in real time, enabling great savings. AI can also increase personalization in customer experiences, catering to specific preferences while promoting eco-conscious purchasing behavior. This multi-faceted approach could present sustainable and gainful opportunities for businesses.

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