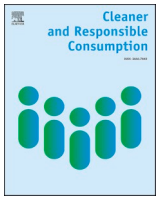
Cleaner and Responsible Consumption 17 (2025) 100269

Contents lists available at ScienceDirect

Cleaner and Responsible Consumption

journal homepage: www.journals.elsevier.com/cleaner-and-responsible-consumption



Exploring AI-enabled green marketing and green intention: An integrated PLS-SEM and NCA approach

Osama Sohaib [a,b,*], Aamna Alshemeili [a], Tariq Bhatti [a]

[a] School of Business, American University of Ras Al Khaimah, Ras Al Khaimah, United Arab Emirates
[b] School of Computer Science, University of Technology Sydney, Sydney, Australia

ARTICLE INFO

Keywords:
AI
Green marketing
Trust
Green intention
NCA

ABSTRACT

As the world becomes more conscious of sustainability issues, businesses are progressively adopting green marketing tactics to attract environmentally aware customers. The emergence of artificial intelligence (AI) has significantly transformed green marketing, opening up novel avenues for promoting sustainable consumption. This study explores various AI-enabled green marketing strategies (AI-enabled strategic, Tactical and Internal green marketing orientation) and their impact on fostering customer trust and satisfaction, ultimately influencing green intention. Data were collected from consumers in the UAE. The research uses an integrated approach, combining Partial Least Squares-Structural Equation Modeling (PLS-SEM) and Necessary Condition Analysis (NCA). The findings from both PLS-SEM and NCA highlight the significance of AI-enabled green marketing, trust, and satisfaction as essential factors for fostering green intention. Additionally, Importance-Performance Map Analysis (IPMA) offers further insights and managerial recommendations for enhancing sustainability practices. This study sheds light on the potential of AI in shaping green marketing strategies and their influence on driving sustainable consumer behavior.

1. Introduction

The emergence of Artificial Intelligence (AI) has engendered a notable transformation across multiple industries, with the marketing sector being no exception. Notably, AI-powered approaches are progressively gaining traction in green marketing, intending to encourage consumers to adopt more sustainable consumption behaviors (Kotler and Armstrong, 2016; Ameen et al., 2022; Baqi et al., 2022). These strategies involve using AI to develop targeted and effective green marketing campaigns and obtain customer sentiment (Kotler and Armstrong, 2016; Ameen et al., 2022). Artificial intelligence (AI) presents an opportunity for businesses to conduct an in-depth analysis of customer behavior patterns, anticipate future purchases, and customize their products and services accordingly, ultimately heightening customer satisfaction and building trust (Kotler and Armstrong, 2016; Baqi et al., 2022).

The practice of green marketing pertains to promoting goods or services that exhibit environmental friendliness or sustainability (Kotler and Armstrong, 2016; Luchs et al., 2010). Such a marketing approach has gained significant momentum recently and is favored by businesses that aim to attract and retain environmentally conscious consumers. Green marketing campaigns typically involve product labeling, eco-friendly packaging, and carbon offset programs (Kotler and Armstrong, 2016). In light of the advent of artificial intelligence (AI), corporations have increasingly implemented advanced and precise green marketing strategies (Kietzmann and Canhoto, 2018). Although AI-assisted strategies for green marketing offer promising benefits, it is crucial to acknowledge that specific customers may need to be made aware or willing to adopt such strategies. To that end, it is incumbent upon businesses to be transparent and convey their sustainable practices and principles to their customers to foster trust and loyalty (Martínez, 2015; Tan et al., 2022). Implementing AI-driven strategies can substantially impact consumer intentions toward sustainable consumption, ultimately positively influencing the environment and society (Baqi et al., 2022; Tan et al., 2022). However, more research must be done on how AI-enabled strategies influence customer intentions toward green products (Ameen et al., 2022; Kietzmann and Canhoto, 2018).

Numerous research efforts explore how artificial intelligence (AI) can enhance the environmental sustainability of various products (Frank, 2021). Likewise, multiple companies are actively developing products that integrate AI to elevate their level of environmental sustainability (Ameen et al., 2022). Surprisingly, the field of business needs

* Corresponding author. School of Business, American University of Ras Al Khaimah, Ras Al Khaimah, United Arab Emirates.
E-mail addresses: osama.sohaib@uts.edu.au, osama.sohaib@aurak.ac.ae (O. Sohaib).

https://doi.org/10.1016/j.clrc.2025.100269
Received 26 July 2023; Received in revised form 14 September 2024; Accepted 20 March 2025
Available online 21 March 2025

studies examining the impact of AI-based improvements that can influence market players' attitudes and behaviors. To bridge this gap in knowledge, this study delves into the consequences of AI-enabled green marketing strategies companies use and their effectiveness in influencing customer purchase intentions toward green products.

This study contributes to the growing body of literature on green marketing by examining the unique role of AI in shaping consumer trust and satisfaction towards eco-friendly products. Unlike traditional green marketing approaches, AI-enabled strategies offer a data-driven, personalized, and real-time mechanism to engage consumers, enhancing their green intention. By integrating AI into marketing strategies, businesses can more effectively build customer trust and align their offerings with sustainability goals, providing both environmental and competitive advantages. This research extends the understanding of AI's potential to influence green consumer behavior, contributing valuable insights into sustainable marketing practices.

The focus of this study is to investigate the effectiveness of different AI-enabled green marketing strategies in promoting sustainable consumption and the importance of building customer trust and satisfaction towards purchasing intention of green products. Our goal is to provide valuable insights into how businesses can leverage AI to encourage sustainable consumption and contribute to creating a more sustainable future. Therefore, this research addresses the following research question: How do various AI-enabled green marketing strategies (AI-enabled strategic, Tactical, and Internal green marketing orientation) impact customer trust and satisfaction, and how do these factors collectively influence green intention among environmentally conscious consumers?

This study makes several key contributions to the field of AI-enabled green marketing. First, while much of the prior research on green marketing has focused on traditional methods, our study offers a novel exploration of AI-driven strategies, including strategic, tactical, and internal green marketing orientations. By integrating Partial Least Squares-Structural Equation Modeling (PLS-SEM) with Necessary Condition Analysis (NCA), this research provides a more robust and nuanced understanding of the relationship between AI-enabled green marketing, customer trust, satisfaction, and green intention. This combined methodology is one of the first applied to this context, offering a comprehensive, data-driven perspective that complements previous studies focused on traditional green marketing approaches. Furthermore, this study employs Importance-Performance Map Analysis (IPMA), adding another layer of insight by offering practical, data-backed recommendations for enhancing green marketing strategies and sustainability practices. By addressing the role of AI in shaping consumer trust and satisfaction, our research contributes to the broader understanding of how businesses can leverage AI to promote sustainable consumption, supporting existing theories around trust and environmental sustainability.

The paper is structured as follows: Initially, it presents a comprehensive review of the literature and theoretical background about green marketing and the influence of AI in marketing, leading to the development of hypotheses. Next, the research methodology is discussed, detailing the approach taken in this study. Subsequently, the results of the PLS-SEM and NCA analyses are presented and thoroughly examined. The findings are discussed in detail, along with their implications. Finally, the study concludes by addressing the research limitations and proposing future directions for further investigation.

2. Literature review

2.1. Green marketing

Previous research has examined the impact of green marketing on consumer behavior, with studies conducted by Chan (2013), Chen (2010), Di Pietro et al. (2013), Kang and Hur (2012), and Slevitch et al. (2013). For example, Han et al. (2009) investigated how attitudes toward green behaviors influence consumers' decision-making regarding eco-friendly choices. Their findings demonstrate that attitudes toward green behaviors positively affect a product's overall image and specific behavioral intentions. Wu and Liu (2022) emphasize the significant impact of green marketing on fostering brand trust and confidence. The researchers discovered that selecting and validating a promotional mix approach that prioritizes ecological preservation and principles is at the core of sustainable advertising. Choi and Ng (2011) and Nyilasy et al. (2014) studies have shown that when customers view a product as eco-friendly or sustainable, it positively impacts their inclination to purchase it. Despite often incurring higher costs, enhancing environmental sustainability improves a company's profitability, as Fraj-Andres et al. (2009) highlighted. As a result, many companies today are actively working to enhance the environmental sustainability of their products, as this not only grants them marketing advantages but also boosts their overall profitability, as Herbas Torrico et al. (2018) noted.

It is worth noting that previous studies on green marketing have mainly concentrated on electronic products and companies producing items like cosmetics, toiletries, and hybrid cars (Ng et al., 2014; Chen, 2010). However, more research has yet to be employed to investigate how AI-enabled green marketing and its associated outcomes (e.g., trust and satisfaction) can impact customer purchasing intentions toward green products.

2.2. AI in marketing

In the existing literature, various applications of AI in marketing have been highlighted. The primary objectives of AI advancements are to save costs and enhance efficiency. Artificial Intelligence (AI) is increasingly significant in green marketing, offering innovative solutions to promote sustainability. AI's predictive capabilities and data-driven insights can optimize green marketing strategies (Rathore, 2018). Alsalhy et al. (2023) proposed an AI-based Smart Driven Marketing Planning Strategy to enhance eco-friendly practices, utilizing dimensional smart marketing to meet AI strategies for creating and promoting sustainable systems. AI is driving a shift from fast fashion to sustainable practices in the fashion industry, providing efficient solutions that balance profitability with environmental consciousness (Rathore, 2019). AI applications in this sector include predictive analytics for efficient production, personalization to enhance product longevity, and virtual fitting rooms to limit wastage. However, while AI offers significant customer advantages, it's crucial to consider green ideology when formulating corporate and marketing strategies to address issues like greenwashing and promote eco-friendly consumption (Baqi et al., 2022).

AI-enhanced products with autonomous environmental benefits positively influence purchase intent, particularly for women and adult-targeted products (Frank, 2020). AI, through its neural networks, attempts to replicate human intelligence. AI incorporates human language, reasoning, and emotions to achieve a more realistic mimicry. Previous studies have explored this integration (Poria et al., 2015). Additionally, AI extracts insights from data, automates business processes, and generates consumer and market insights through program-based algorithms (Davenport et al., 2020). AI's involvement in marketing goes beyond mere integration with traditional strategies and extends into the dynamic realm of digital marketing. Recent studies have revealed that automated systems now play a significant role in shaping the customer journey. For instance, the sophisticated AI-powered Google system determines search rankings, evaluation algorithms dictate review placement, AI-driven chatbots answer customer queries, and social listening engines analyze social media posts to gauge sentiment and gather feedback (Verma & Kenji et al., 2021).

Moreover, AI offers valuable assistance to marketers in segmentation, targeting, and positioning (Huang and Rust, 2018). Leveraging deep learning, marketers can personalize recommendations and programmatic advertising, enabling the discovery of new and innovative products, services, places, and offerings tailored to meet the specific

needs of customers is a key focus in the work of researchers Guo et al. (2017) and Ma and Sun (2020). In addition, as studied by Verma and Yadav (2021), emotive AI algorithms are used to track customers' preferences and dislikes. Furthermore, AI is pivotal in ensuring that curated or newly created content is tailored and relevant to individual customers (Chintalapati and Pandey, 2022; Grewal et al., 2020; Ma and Sun, 2020). Market research is another promising application of AI in marketing (Huang and Rust, 2021).

Artificial Intelligence (AI) is increasingly recognized for its potential in promoting sustainability and green marketing. Green AI aims to develop environmentally friendly and inclusive AI systems, focusing on energy efficiency and accessibility (Bolón-Canedo et al., 2024). AI applications in sustainable marketing, such as chatbots and augmented reality, are growing rapidly (Yadav and Sondhi, 2023). Green marketing strategies, which promote environmental sustainability, have positively impacted consumers' purchasing intentions (Ashoush and Kortam, 2022). However, the environmental impacts of AI solutions themselves must be carefully considered. While AI is seen as a tool to address environmental issues, particularly greenhouse gas emissions, the energy consumption and emissions associated with training large AI models are significant concerns (Ligozat et al., 2021). To fully assess the environmental usefulness of AI services, a comprehensive evaluation of their net environmental impacts, beyond just greenhouse gas emissions, is necessary (Ligozat et al., 2021).

In summary, this work uniquely contributes by exploring AI's transformative impact on green marketing and its critical role in driving consumer behavior toward sustainable choices. It fills a gap in the literature by applying advanced analytical techniques to examine AI-enabled green marketing strategies and their influence on fostering a more environmentally conscious marketplace.

3. Theoretical background and hypotheses development

AI's ability to leverage big data, machine learning algorithms, and predictive analytics enables marketers to develop more precise, data-driven green marketing strategies. These strategies can predict consumer behaviors, preferences, and environmental concerns, allowing real-time adjustments and tailored communication. This level of personalization in AI-enabled green marketing surpasses traditional approaches, which typically employ broader, less targeted tactics. AI's role in automating sentiment analysis and behavior tracking processes makes it invaluable for optimizing eco-friendly campaigns and fostering trust in environmentally conscious consumers.

From a strategic perspective, AI is becoming increasingly important in marketing. Companies like Google, Spotify, and Under Armour utilize AI-driven platforms like Microsoft Cognitive Services, Amazon Lex, Google Assistant, and IBM Watson to enhance performance. These technologies enable businesses to strengthen customer engagement across marketing channels, improve market forecasting, and automate various processes. Consequently, AI has become one of the most influential technologies in business, with its market value expected to grow from $10.1 billion in 2018 to $126 billion by 2025 (Vlačić et al., 2021).

While traditional green marketing primarily relies on general strategies such as eco-labeling and carbon offsetting programs, AI-enabled green marketing offers dynamic, real-time consumer engagement. AI's ability to assess consumer feedback instantaneously and adjust campaigns accordingly significantly improves effectiveness and customer trust. Furthermore, AI can detect consumer sentiment towards green practices, helping businesses avoid greenwashing pitfalls and align more closely with genuine environmental concerns.

According to Connelly et al. (2011), signaling theory is vital in understanding behavior when two parties (individuals or organizations) possess varying information. In this context, the sender, who holds the information, faces the decision of whether and how to communicate or signal it effectively. On the other hand, the receiver must determine how to interpret the conveyed signal. Consequently, signaling theory is significant across diverse management domains, such as strategic management, entrepreneurship, human resource management, and marketing.

Signaling theory suggests that the impact of a signal, such as a product's environmental sustainability, relies on how the receiver perceives and interprets the signal (Connelly et al., 2011). According to the signaling theory proposed by researchers such as Spence (2002) and Connelly et al. (2011), it is believed that when consumers perceive a product as environmentally sustainable, it positively influences their intention to purchase it. This is so that it can signal the trustworthiness of the business providing the products (Herbas Torrico et al., 2018). This is because the environmentally friendly aspects of a product act as a signal that builds consumer trust (Frank, 2021; Martínez and Del Bosque, 2013). This signal increases the customer's perception of product quality (Koller et al., 2011) and motivates them to use the product to express their own values in their social circle (Koller et al., 2011). Consequently, these mechanisms collectively increase the consumers' desire to buy such products (Choi and Ng, 2011; Herbas Torrico et al., 2018).

Signaling theory focuses on how companies communicate information about their products or practices to customers to build trust and reputation. AI tools, equipped with the ability to collect and analyze vast amounts of data from customer interactions, aid in conveying and reinforcing green signals to customers. These tools encompass voice assistants like chatbots, which constantly gather and analyze data. Moreover, the integration of AI and virtual reality, known as virtual transformation, along with image recognition on social media platforms, is gaining momentum in marketing (Chintalapati and Pandey, 2022; Xi and Siau, 2020).

AI-driven environmental sustainability provides an opportunity to enhance appeal among consumers, enabling companies to harness environmental sustainability to connect with consumers from various social backgrounds and increase sales while fostering a healthier environment (Frank, 2021). Therefore, this research posits a higher need for AI-enhanced marketing strategies to signal trustworthiness and satisfaction toward purchasing intentions of green products. Fig. 1 shows the research model. Table 1 presents the description of the factors adopted in this study.

3.1. AI-enabled green marketing

According to Papadasa et al. (2017), Green marketing orientation measures an organization's commitment and dedication to implementing strategic, tactical, and internal processes and activities that aim to create, communicate, and deliver products and/or services with the least possible environmental impact. With the integration of AI-enabled green marketing, organizations can leverage artificial intelligence technologies and tools to enhance their green marketing efforts. These AI-enabled strategies enable companies to analyze and optimize their

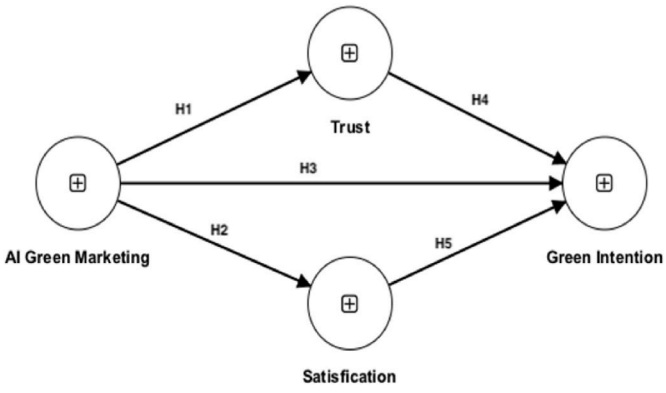


Fig. 1. Research model.

Table 1
Factor description.

Factor	Description	Sources
AI-enabled Green Marketing	**AI-enabled strategic green marketing orientation:** refers to the degree to which organizations incorporate the environmental imperative and utilize artificial intelligence (AI) technology in their strategic marketing decisions. It reflects the organization's ability to integrate AI-driven approaches and techniques to develop and execute environmentally conscious marketing strategies that align with their sustainability goals and objectives. **AI-enabled Tactical green marketing orientation:** refers to the degree to which organizations incorporate environmental values and considerations into their tactical marketing decisions using artificial intelligence technology. This orientation emphasizes the integration of AI capabilities to align marketing activities with sustainability goals and optimize the environmental impact of tactical marketing decisions. **AI-enabled Internal Green Marketing Orientation:** The extent to which all internal stakeholders, empowered by AI technologies, embrace and embody the corporate environmental values, fostering a culture of environmental consciousness and sustainability throughout the organization. It reflects the level of integration of AI-enabled strategies and tools in promoting and implementing environmentally friendly practices and initiatives among employees, managers, and other internal stakeholders.	Papadas et al. (2017)
Trust	An individual's willingness to rely on a business or brand as an exchange partner, based on a sense of confidence and belief in their commitment to environmentally friendly practices.	Martínez (2015)
Satisfaction	The overall sense of pleasure or contentment experienced by a consumer as a result of a green product or service meeting or exceeding their expectations, desires, and needs related to environmental sustainability. It reflects the level of fulfillment and gratification individuals derive from their eco-friendly purchases and the extent to which those purchases align with their environmental values and goals.	Martínez (2015)
Green Intention	Green intentions refer to the likelihood and willingness of individuals to prioritize and purchase green products over conventional products during their purchasing decision-making process. It reflects the probability that individuals will consciously consider and give preference to environmentally friendly products, taking into account their environmental attributes and sustainability aspects.	(Mostafa, 2006; Moslehpour et al., 2022; Ansu-Mensah, 2021; Chekima and Chekima, 2019).

environmental practices, identify sustainable alternatives, personalize communication with consumers, and enhance transparency in their sustainability initiatives. By incorporating AI into their green marketing orientation, organizations can drive positive environmental change while meeting the needs and expectations of eco-conscious consumers.

The interplay of psychological factors can bolster or impede consumers' intentions and actions toward sustainable consumption (Hermann, 2021). In this regard, AI plays a pivotal role by enabling the segmentation and targeting of consumers based on their psychological inclinations toward sustainable offerings, also known as psychological targeting. Marketers can leverage AI to empower individuals to embrace a mindset of consuming better while consuming less (Wiedmann et al., 2020). Essentially, AI in marketing is a supportive tool that aids individuals in making well-informed decisions that align with sustainability goals. Studies have shown that people's environmental concerns increase the likelihood of purchasing green products (Ansu-Mensah, 2021; Kashi, 2020; Mostafa, 2006; Moslehpour et al., 2022; Chekima and Chekima, 2019). Therefore, we hypothesize.

H1. AI-Powered Green Marketing positively influences customer trust.

H2. AI-Powered Green Marketing positively influences customer satisfaction.

H3. AI-Powered Green Marketing positively influences consumer purchasing intentions of green products.

Customer satisfaction and trust are crucial for comprehending consumer behavior (Delgado and Munuera, 2005; Martínez, 2015). When a product demonstrates environmental sustainability, it signifies that its product upholds ethically superior values. Consumers develop positive attitudes and intentions towards such products because they identify with these values and desire to associate themselves with them. Furthermore, consumers seek to signal to others that they also possess these ethically superior values, which can enhance their social relationships (Koller et al., 2011; Martínez and Del Bosque, 2013). Moreover, environmental sustainability plays a crucial role as an indicator of reliability (Martínez and Del Bosque, 2013). This assessment promotes positive attitudes and intentions toward the product (Herbas Torrico et al., 2018; Martínez and Del Bosque, 2013). Tarabieh (2020) and Zhueug et al. (2021) found that green trust significantly influences green purchase intention. Furthermore, research has established that customer satisfaction significantly impacts customer retention and purchase intentions (Ranaweera and Prabhu, 2003; Martínez, 2015). Building upon these findings, we propose the following hypotheses.

H4. Customer trust positively influences consumer purchasing intentions of green products.

H5. Customer satisfaction positively influences consumer purchasing intentions of green products.

4. Methodology

The research methodology employed in this study follows a survey-based approach to assess AI-enabled marketing, trust, satisfaction, and

green intention. Data were collected from consumers living in the UAE. Likert scale-based closed-ended questionnaire consisting of items adapted and modified from previously utilized instruments to ensure measurement scale reliability and validity. AI-enabled marketing was modified from (Papadas et al., 2017). Trust and Satisfaction were adopted and modified from Martínez (2015). Green Intention adopted from (Mostafa, 2006; Moslehpour et al., 2022; Ansu-Mensah, 2021; Chekima and Chekima, 2019). Data was collected via an online survey platform, emphasizing participant anonymity, confidentiality, and voluntary participation. The questionnaire was validated for content validity by subject matter experts, while the reliability was assessed through Cronbach's alpha coefficient. Exploratory factor analysis (EFA) was used to establish construct validity. Partial Least Squares Structural Equation Modeling (PLS-SEM) is used to analyze the data to verify proposed hypotheses. Necessary Condition Analysis (NCA) was performed to identify essential conditions for Green Intention.

5. Data analysis and results

The survey collected demographic details from 240 respondents residing in the UAE, representing various nationalities. 220 were used for analysis after accounting for missing data. A significant portion of the participants identified themselves as local Emiratis (42 %), while other nationalities included Indian (18 %), Pakistani (14 %), UK (10 %), Filipino (8 %), Egyptian (6 %), and various other nationalities comprising the remaining 2 %. Regarding age distribution, the respondents spanned a wide range, with 25 % falling into the 18–25 age group, 40 % in the 26–40 age group, and the remaining 35 % aged 41 and above. Regarding gender, the survey comprised 55 % male participants and 45 % female participants, indicating a relatively balanced representation. As for their green purchasing habits, one question inquired about their frequency of buying environmentally friendly products. Approximately 75 % of the respondents expressed a regular interest in green purchases, 20 % reported occasionally opting for sustainable products, and the remaining 5 % stated they rarely made green purchases.

Partial Least Squares (PLS) Structural Equation Modeling (SEM) was employed to test the hypotheses using SmartPLS version 4. PLS-SEM is commonly used in information systems and business research due to its flexibility. It is suitable for prediction-oriented studies, doesn't require a large sample size, doesn't assume normality or specific distributions, and can handle variables of nominal, ordinal, and interval scales (Hair et al., 2014).

PLS was selected because it enables us to assess measurement model parameters and structural path coefficients simultaneously. Another advantage is that it allows us to evaluate both formative and reflective factors together, as Chin et al. (2003) pointed out.

In our research model, trust, satisfaction, and green intention were treated as reflective indicators since they were considered as outcomes of underlying constructs. On the other hand, AI-enabled Green Marketing was treated as a formative construct because it is multidimensional and encompasses various referent groups, such as strategic, tactical, and internal processes. It's worth noting that formative constructs differ from reflective constructs in that they are not interchangeable. This means that a modification in one indicator does not necessarily imply a corresponding change in the other indicators. For instance, an increase in influence from strategic perspectives could impact individuals' green purchase behavior even without the influence of other sources.

5.1. Reliability and validity assessment

The measurement model was evaluated for its reliability and validity through internal consistency, convergent validity, and discriminant validity. For convergent and discriminant validity, we used two measures. Firstly, we looked at the square root of the average variance extracted (AVE) from the construct's indicators, which should be at least 0.70 and higher than its correlation with other constructs. Secondly, we required item loadings to be at least 0.70, indicating a stronger association with their assigned construct than other constructs. Table 2 presents the values of Cronbach's reliability, composite reliability, and AVE for all constructs, which exceeded the recommended threshold of 0.70. Furthermore, the correlations between variables, as shown in Table 3, were all lower than the square root of each variable's average variance extracted (AVE), indicating sufficient discriminant validity. AI Green Marketing is a formative construct, it was not analyzed in this specific procedure. However, the validity of formative indicators was confirmed through significant outer weights (p-value <0.05). Additionally, the variance inflation factor (VIF) value for formative indicators was below 5, indicating the absence of multicollinearity.

It's important to mention that when using cross-sectional design surveys, there's a possibility of encountering common method bias, especially when the data collection relies solely on perception (Sharma et al., 2009). However, the PLS method is quite robust in estimating data from a composite model population, regardless of whether the measurement model is reflective or formative (Sarstedt et al., 2016). Additionally, Kock (2015) suggests that if all factor level VIFs resulting from a full collinearity test are equal to or lower than 3.3, the model can be considered free of common method bias. Our research found that all factor level VIFs were below 3.3, indicating no bias present in the data.

Furthermore, discriminant validity analysis is conducted using the Heterotrait-monotrait (HTMT) criterion. Henseler et al. (2015) have extensively supported using HTMT-based validity assessment as the preferred variance-based SEM approach. Our examination of the HTMT values for all latent variables revealed that they were below the critical threshold of 0.85, as demonstrated by Henseler et al. (2015). Additionally, to ensure robust results, we employed bootstrapping for HTMT inference, and all the confidence interval values were found to be below 1. These findings demonstrate the establishment of discriminant validity using HTMT.

5.2. Structural model testing

The structural models and hypotheses were tested by examining the significance of the path coefficients and the R^2 variance for the dependent variable. To determine the significance of the pathways in the research, the scientists employed a statistical method known as bootstrapping and a t-statistical test at a 5 % significance level. SmartPLS 4 was utilized for bootstrapping, which estimates standard errors to test the significance of coefficients such as outer weights, outer loadings, and path coefficients. The results of the structural model, including coefficients and corresponding t-values, can be found in Table 4, while Fig. 2 illustrates the coefficients of determination (R^2) for the dependent constructs.

In addition, the Stone-Geisser criterion Q^2 was calculated using the blindfolding method to assess the predictive relevance by measuring the construct cross-validated redundancy (Henseler et al., 2009). In our analysis, the Q^2 values for the 'Green intention' endogenous construct, ranging from 0.32, were all above the threshold value of 0, indicating strong predictive relevance.

The results of the hypothesis testing indicate that all the relationships examined are statistically significant and supported by the data.

Table 2
Reliability and validity assessment.

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Green Intention	0.807	0.886	0.722
Satisfaction	0.719	0.842	0.701
Trust	0.827	0.896	0.743

Table 3
Construct correlation.

	AI Green Marketing	Green Intention	Satisfaction	Trust
AI Green Marketing	1.00	0.835	0.816	0.760
Green Intention	0.835	**0.84**	0.765	0.885
Satisfaction	0.816	0.765	**0.83**	0.650
Trust	0.760	0.885	0.650	**0.86**

Diagonal elements are the square root of AVE.

Table 4
Path testing.

	Mean	Std. deviation (STDEV)	T statistics	P values	Supported?
AI Green Marketing - > Green Intention	0.253	0.111	2.077	0.038	Yes
AI Green Marketing - > Satisfication	0.824	0.044	18.362	0.000	Yes
AI Green Marketing - > Trust	0.786	0.054	14.091	0.000	Yes
Satisfication - > Green Intention	0.185	0.088	2.249	0.025	Yes
Trust - > Green Intention	0.567	0.086	6.749	0.000	Yes

However, we can assess the relative importance of each factor by evaluating the strength of the relationship as indicated by the coefficient values. The R^2 values provide insights into the amount of variance explained by the independent variables in the respective regression models. A higher R^2 value suggests that the included independent variables can account for a larger proportion of the dependent variable's variation.

Among the relationships tested, the strongest factor is the impact of AI Green Marketing on Satisfaction. This relationship has a coefficient of 0.824, indicating a strong positive association. It suggests that when AI Green Marketing strategies are implemented, they significantly impact increasing satisfaction levels. The second most influential factor is the relationship between AI Green Marketing and Trust, with a coefficient of 0.786. This indicates a strong positive relationship, suggesting that AI Green Marketing initiatives contribute to building trust among individuals. The relationship between AI Green Marketing and Green Intention, although still significant, shows a moderate effect with a coefficient of 0.253. This implies that AI Green Marketing moderately influences individuals' intention to purchase green products (Green Intention).

Furthermore, the relationships between Satisfaction and Green Intention and Trust and Green Intention show effects with coefficients of 0.185 and 0.567, respectively. While these relationships are still significant, they indicate a less substantial impact on individuals' green intentions than those involving AI Green Marketing. The relationship between Trust and Green Intention has an R^2 value of 0.57. This means that approximately 57 % of individuals' Green Intention variability can be explained by the variations in Trust towards environmental factors. Similarly, the relationship between Satisfaction and Green Intention has an R^2 value of 0.66. This indicates that approximately 66 % of the variation in individuals' Green Intention can be explained by variations in Satisfaction. Furthermore, the R^2 value of 0.86 for Green Intention implies that approximately 86 % of the variation in Green Intention can be explained collectively by the independent variables considered in the analysis, such as AI Green Marketing, Trust, and Satisfaction.

In summary, the results suggest that AI Green Marketing strongly influences both Satisfaction and Trust, making it an essential factor in promoting positive green product purchase intention, including the direct effect of AI Green Marketing.

5.3. Necessary Condition Analysis (NCA)

NCA provides a unique approach to identifying necessary conditions by examining the absence or insufficiency of specific conditions that might prevent the occurrence of an outcome (Dul, 2016; Dul et al., 2023). It helps researchers better understand causality and necessary conditions, complementing PLS-SEM findings (Richter et al., 2020).

Necessary Condition Analysis (NCA) involves determining a ceiling line on top of the data, representing the minimum requirements for a specific outcome. There are two default ceiling lines: the ceiling envelopment-free disposal hull (CE-FDH) line serves as the boundary that distinguishes the area with observations from the area without any observations. It indicates the constraints the independent variable (X)

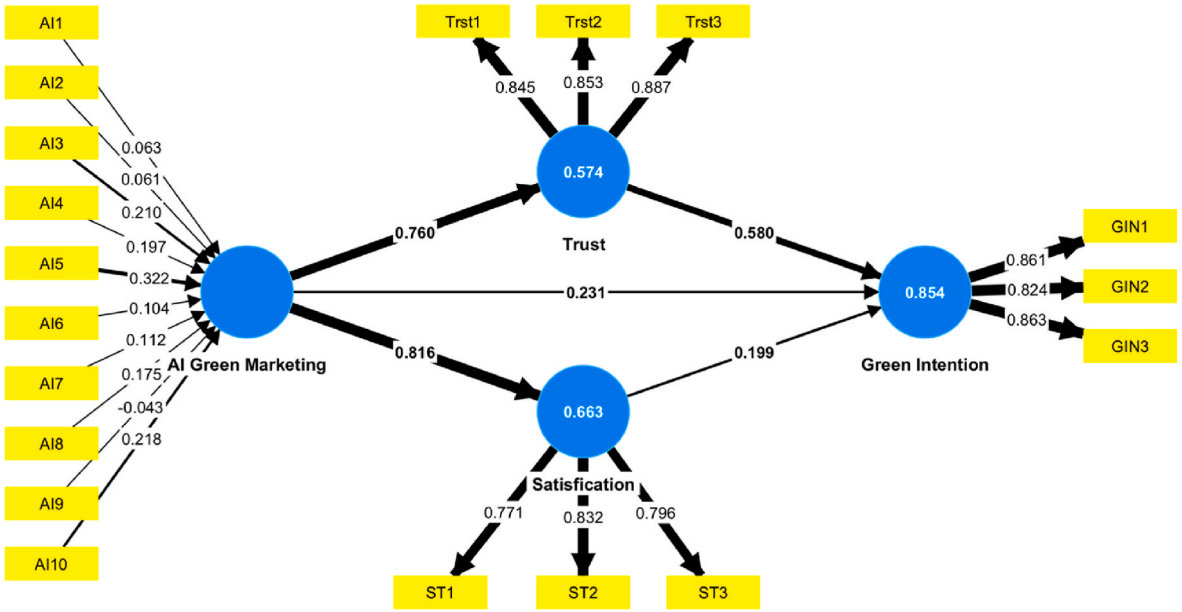


Fig. 2. Path testing.

puts on the dependent variable (Y). When there's a bigger gap between the observations and the line, constraint X has a more significant impact on Y. Additionally, the CE-FDH line shows the minimum level of X needed to reach a specific level of Y. On the other hand, the CR-FDH (ceiling regression - free disposal hull) line is a straight-line estimate of the CE-FDH line. NCA aims to identify necessary conditions by analyzing scatterplots and identifying areas where these conditions may be present. The analysis helps understand the critical factors needed for the desired outcome. Alternatively, the bottleneck table presents the ceiling line results in a tabular format.

Two important Necessary Condition Analysis (NCA) parameters are ceiling accuracy and necessity effect size (d). The ceiling accuracy refers to the degree to which the identified ceiling line accurately represents the minimum conditions required for the outcome. On the other hand, the necessity effect size measures the strength or magnitude of the necessary conditions concerning the outcome. For further details on NCA and these parameters, refer to the works of Dul (2016), Dul et al. (2023) and Richter et al. (2020).

Fig. 3 and Table 5 show the CE-FDH effect size. The NCA effect size results indicate significant relationships between the predictor variables (AI Green Marketing, Satisfaction, and Trust) and the outcome variable (Green Intention). To determine the significance, we employed the percentile bootstrapping procedure with 10,000 subsamples, and the results include 95 % confidence intervals. The effect sizes suggest that these predictor variables substantially impact Green Intention. Trust has the largest effect size among the three predictors, with a value of 0.369. The p-values associated with all three variables are 0.000, indicating strong statistical significance.

Table 6 shows the NCA results for AI Green Marketing as a predictor, revealing that it significantly impacts various outcome variables (Trust, Satisfication and Green Intention). The effect sizes are substantial, with Satisfaction having an effect size of 0.314, Trust at 0.369, and Green Intention at 0.347. All these effect sizes and p-values of 0.000 indicate that the relationships are statistically significant. This demonstrates that AI Green Marketing is a strong predictor for Satisfaction, Trust, and Green Intention, with each outcome variable showing a meaningful and statistically significant association.

Table 7 shows the bottleneck of the CE-FDH in percentile. The values in the table represent the minimum values of the predictor variables required to achieve a certain level of the outcome variable, Green Intention. Figs. 4–6 shows NCA plots. As the levels of Green Intention increase, the minimum requirements for the predictor variables also increase. This indicates that a stronger presence or higher levels of the predictor variables are needed to attain higher levels of Green Intention.

In our model, 'AI-Green Marketing' is modeled as formative

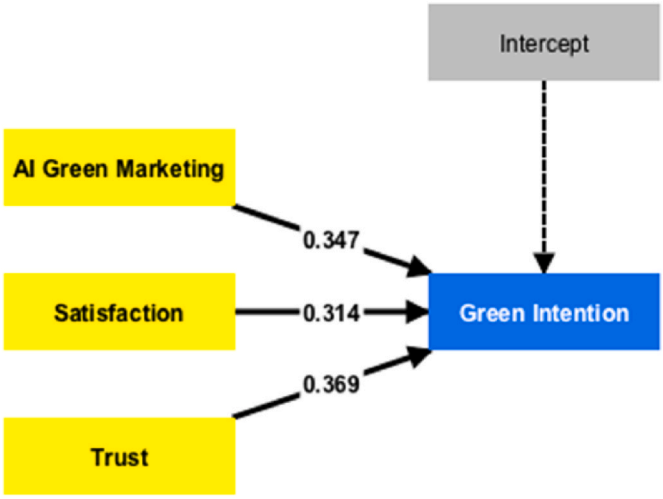


Fig. 3. NCA results.

Table 5
NCA results for Green Intention as an outcome.

	Effect size	95.00 %	p value
AI Green Marketing	0.347	0.158	0.000
Satisfaction	0.314	0.139	0.000
Trust	0.369	0.178	0.000

Note(s): Effect sizes in the range of $0.1 \leq d < 0.35$ are considered medium. For effect sizes of $0.3 \leq d < 0.55$, the effect size is classified as large.

Table 6
NCA results for AI green marketing as a predictor.

Outcome Variable	Effect Size	95 % CI	p-value
Satisfaction	0.314	0.139	0.000
Trust	0.369	0.178	0.000
Green Intention	0.347	0.158	0.000

Table 7
Bottleneck table- CE-FDH (percentage-levels).

	Green Intention	AI Green Marketing	Satisfaction	Trust
0.00 %	−3.82	NN	NN	NN
10.00 %	−3.278	1.02	1.02	1.02
20.00 %	−2.735	1.02	1.02	1.02
30.00 %	−2.193	3.061	3.061	3.061
40.00 %	−1.65	3.061	3.061	3.061
50.00 %	−1.108	4.082	3.061	4.082
60.00 %	−0.566	5.102	6.122	4.082
70.00 %	−0.023	5.102	6.122	4.082
80.00 %	0.519	19.388	19.388	38.776
90.00 %	1.062	64.286	41.837	68.367
100.00 %	1.604	67.347	73.469	76.531

exogenous. Therefore, additional analyses are conducted by utilizing the indicator of the formative construct (Richter et al., 2020). Fig. 7 and Table 8 show the CE-FDH effect size for AI-Green Marketing indicators. To determine the significance, we employed the percentile bootstrapping procedure with 10,000 subsamples, and the results include 95 % confidence intervals.

The result shows that indicator (AI3) has larger effect sizes, indicating stronger associations with Green Intention, while others have moderate to smaller effect sizes. Additionally, the permutation p values suggest the level of statistical significance for each effect size. Specific indicators (A1, A7 and A9) demonstrate moderate relationships with Green Intention, as indicated by their effect sizes and associated confidence intervals. While the remaining indicators (AI2, AI4, AI5, AI6, AI8, AI10) have relatively smaller effect sizes ranging from 0.061 to 0.198, indicating weaker relationships with Green Intention. The permutation p values further indicate the significance of these relationships.

Table 9 shows the bottleneck of the CE-FDH in percentile for the effect size of the formative construct 'AI-Green Marketing' indicators for Green Intention. The table provides insights into the changing minimum requirements of the predictor variables as the level of Green Intention increases. For example, at 30.00 % of Green Intention, AI7 has a minimum requirement of 2.04, and AI9 has a minimum requirement of 1.02. At higher levels of Green Intention, more predictors have minimum values assigned to them. For instance, at 70.00 % of Green Intention, AI4 has a minimum requirement of 5.10, and AI6 has a minimum requirement of 3.06. At 100.00 % of Green Intention, the values for the predictors show the highest minimum requirements. For example, AI5 has a minimum requirement of 60.20, AI6 has a minimum requirement of 43.87, and AI10 has a minimum requirement of 45.91. NN represents not a necessary condition.

The bottleneck Table 10 for AI Green Marketing indicators to Trust, as measured by CE-FDH, illustrates the minimum required levels of each indicator to achieve varying degrees of trust. At lower trust levels (0 %–

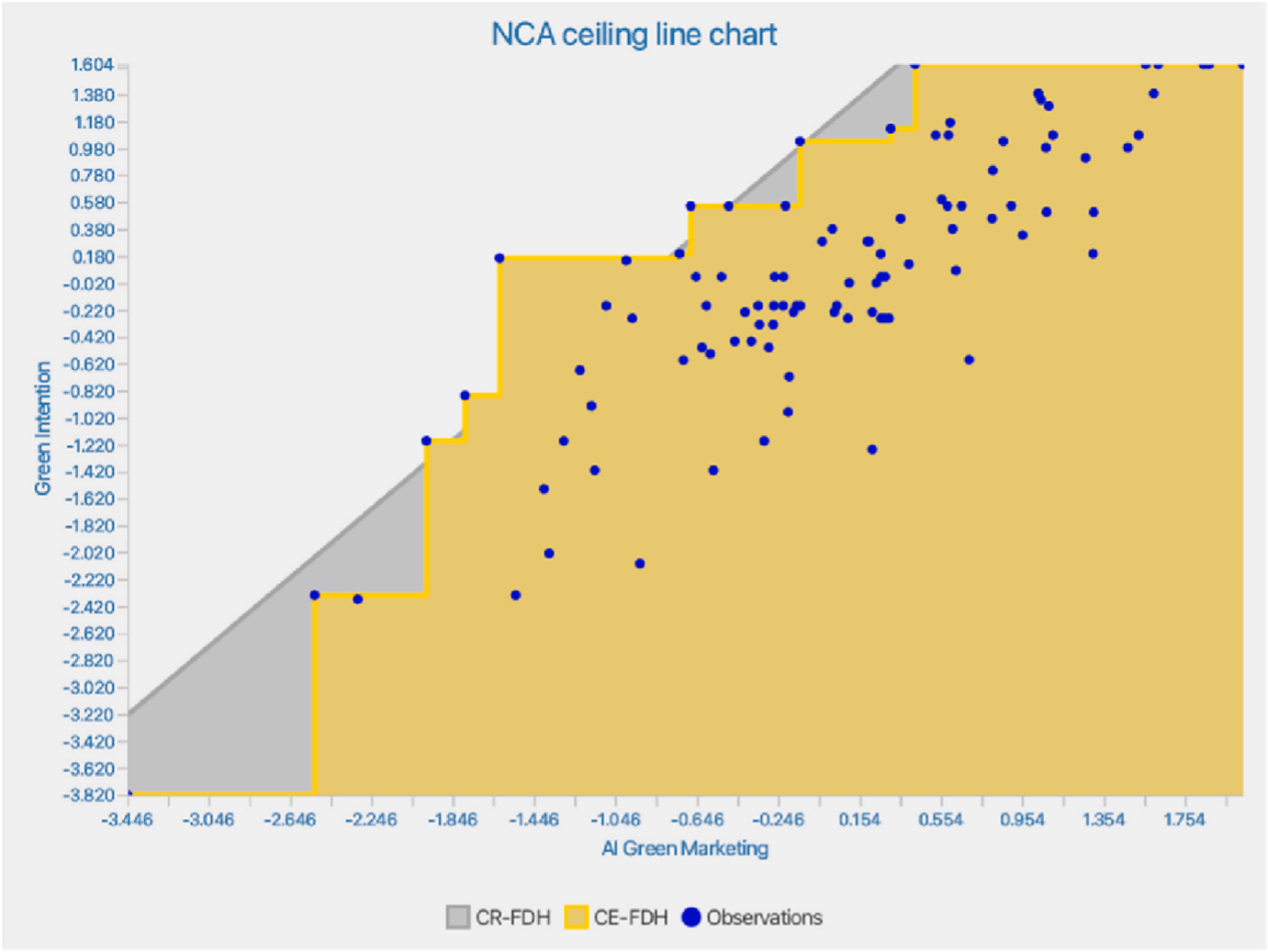


Fig. 4. Nca Plot – AI green marketing – green intention.

70 %), no specific minimum requirements are necessary for any of the indicators, as indicated by "NN" (Not Necessary). However, as trust levels increase to 80 % and above, several indicators become crucial, including AI5, AI7, AI9, and AI10. For instance, at 90 % trust, AI5, AI7, and AI10 require minimum values of 4.000, while AI9 needs 4.000 and AI8 requires 5.000. At the highest trust level of 100 %, the required values for these indicators are consistent, with AI5, AI7, and AI10 needing 4.0 and AI8 and AI9 requiring 5.000. This table highlights how the significance of specific AI Green Marketing indicators increases with the level of trust, emphasizing their role in achieving higher trust outcomes.

Table 11 shows the bottleneck of the CE-FDH and CR-FDH effect size of the formative construct 'AI-Green Marketing' indicators on trust. The findings reveal that certain indicators, specifically AI7, AI9, and AI10, are critically important for fostering and sustaining customer trust. These indicators demand high optimal and robust levels (0.120 for CE-FDH and 0.060 for CR-FDH), underscoring their significant role in effective trust-building strategies. Conversely, indicators such as AI1 and AI8 have moderate requirements (0.080 for CE-FDH and 0.040 for CR-FDH), indicating a moderate influence on trust. AI4, with the lowest values (0.050 for CE-FDH and 0.025 for CR-FDH), exhibits the least impact on trust, though it remains a relevant component of the overall AI marketing strategy. These results highlight the varying effort required for different AI strategies to effectively build and maintain customer trust, providing valuable insights for developing more targeted and efficient AI-driven marketing approaches.

The bottleneck analysis (Table 12) for AI Green Marketing indicators on Satisfaction reveals varying minimum requirements at different satisfaction levels, as determined by the CE-FDH method. At 80 % and above satisfaction levels, indicators such as AI1, AI4, AI5, AI6, AI7, AI8, AI9, and AI10 each require a consistent minimum value of 4.000 to contribute to satisfaction effectively. In contrast, for lower satisfaction levels (from 0 % to 70 %), no specific minimum requirements are identified for these indicators. This indicates that as satisfaction increases, certain AI Green Marketing indicators become crucial in meeting the necessary thresholds to achieve higher satisfaction levels, highlighting their importance in optimizing customer satisfaction strategies.

Table 13 shows the analysis of AI Green Marketing indicators' impact on Satisfaction, using CE-FDH and CR-FDH methods, revealing that most indicators require similar levels of effort to influence satisfaction significantly. Specifically, indicators AI1, AI6, AI7, AI8, AI9, and AI10 each need a minimum value of 0.100 in CE-FDH and 0.050 in CR-FDH. Indicators AI3, AI4, and AI5 have slightly higher requirements of 0.125 for CE-FDH and 0.063 for CR-FDH, indicating a somewhat greater impact on satisfaction. AI2, however, shows no requirement (0.000) in both methods, suggesting it has little to no effect on satisfaction. This pattern highlights that while most indicators are relatively consistent in their influence, a few require higher levels of engagement to impact customer satisfaction significantly.

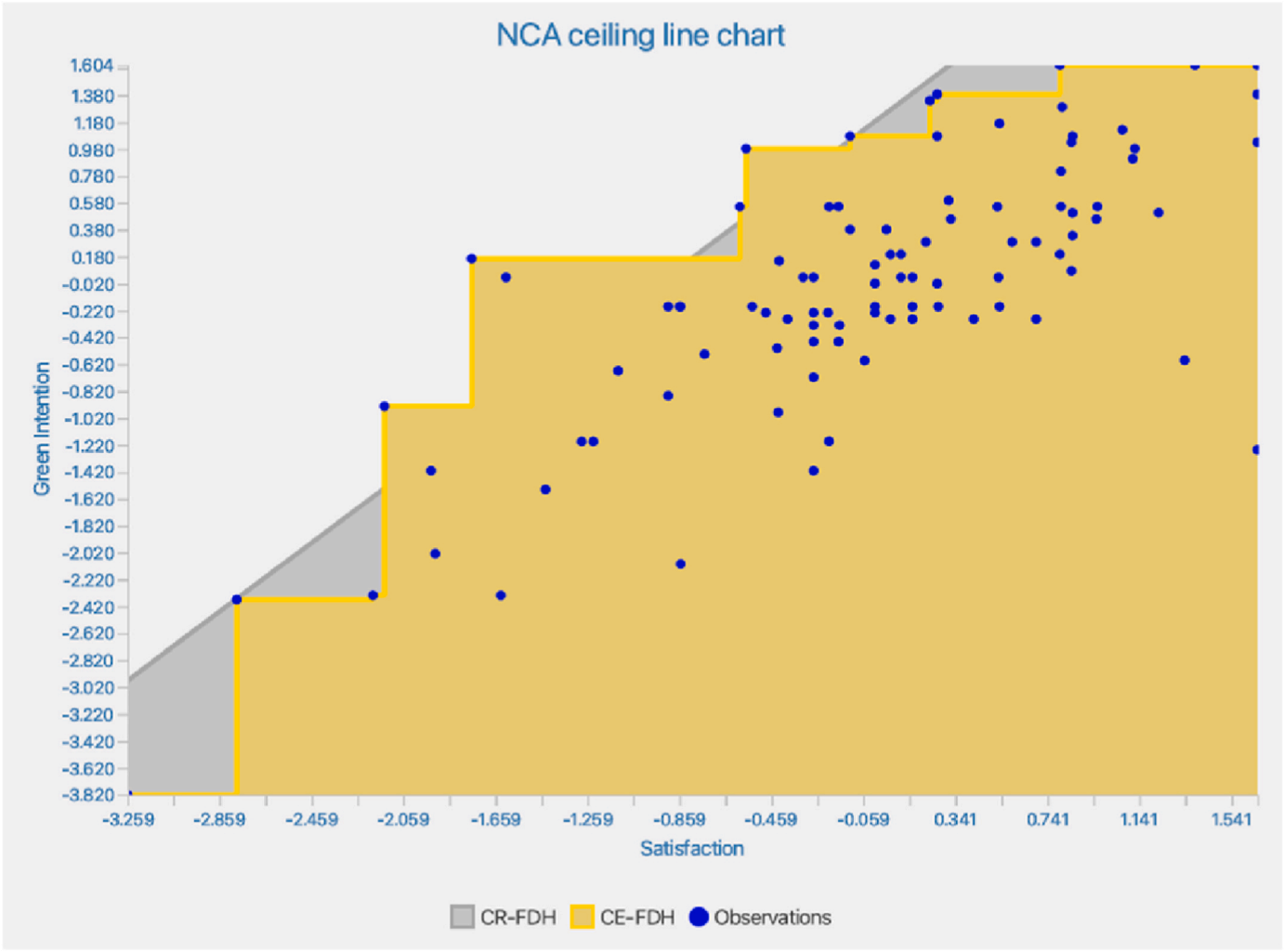


Fig. 5. Nca Plot – satisfaction – green intention.

6. Discussions and implications

The combined use of PLS-SEM and NCA yields results with increased practical value and significant benefits for advancing theorizing and theory testing (Richter et al., 2020). One key advantage is the ability to combine different perspectives on causality, which enhances the understanding of theoretical relationships between constructs. This integration adds value by providing a comprehensive and robust approach to analyzing data and drawing meaningful conclusions. The findings obtained from the combined approach have direct implications and applications in real-world settings, offering actionable insights for decision-making and practical implementation. By leveraging the strengths of both methods, researchers can enhance their theoretical understanding and generate practical knowledge that can contribute to various fields and domains.

The findings of both PLS-SEM and NCA reveal that AI-Green marketing, Trust and Satisfaction are meaningful and significant necessary conditions for Green Intention. PLS-SEM results found that AI Green Marketing has the strongest impact on satisfaction, significantly increasing satisfaction levels. It also contributes to building trust among individuals. The relationship between AI Green Marketing and individuals' intention to purchase green products is moderate. Satisfaction and trust also have but significant impact on green intentions. The independent variables (AI Green Marketing, Trust, and Satisfaction) considered in the analysis explain approximately 86 % of the variation in Green Intention. The NCA results found that all three factors - AI Green Marketing, Satisfaction, and Trust - significantly and positively affect green intention. These effect sizes suggest that all three factors substantially impact green intention. AI Green Marketing, Satisfaction, and Trust are all necessary conditions for Green Intention.

To enhance the analysis further, we conducted Importance-Performance Map Analysis (IPMA) to provide further insights and recommendations for managerial actions. IPMA involves assessing two dimensions, namely performance and importance, which are crucial for prioritizing managerial actions. Performance is evaluated on a scale ranging from 0 to 100. In our PLS path model, conducting an IPMA involves selecting a target construct, such as Green Intention, to examine its performance and importance. Fig. 8 shows the IPMA results. The results reveal the following insights. AI Green Marketing has a significant total effect of 0.835 on Green Intention, performing at a moderate level with a performance rating of 71.953. Satisfaction shows a weaker influence with a total effect of 0.199 and a slightly better performance rating of 73.608 compared to AI Green Marketing. However, Trust emerges as a key factor, exhibiting a substantial total effect of 0.58 and a higher performance rating of 77.272. This indicates that Trust plays a crucial role in driving Green Intention. Consequently, managerial actions that focus on enhancing trust-related factors have the potential to significantly influence individuals' green product purchase intentions (Green Intention).

Similarly, indicators level IPMA was also performed. Fig. 9 shows the results. Among the AI-Green Marketing factors, AI5 exhibited the strongest influence on Green Intention, with a total effect of 0.269. AI10

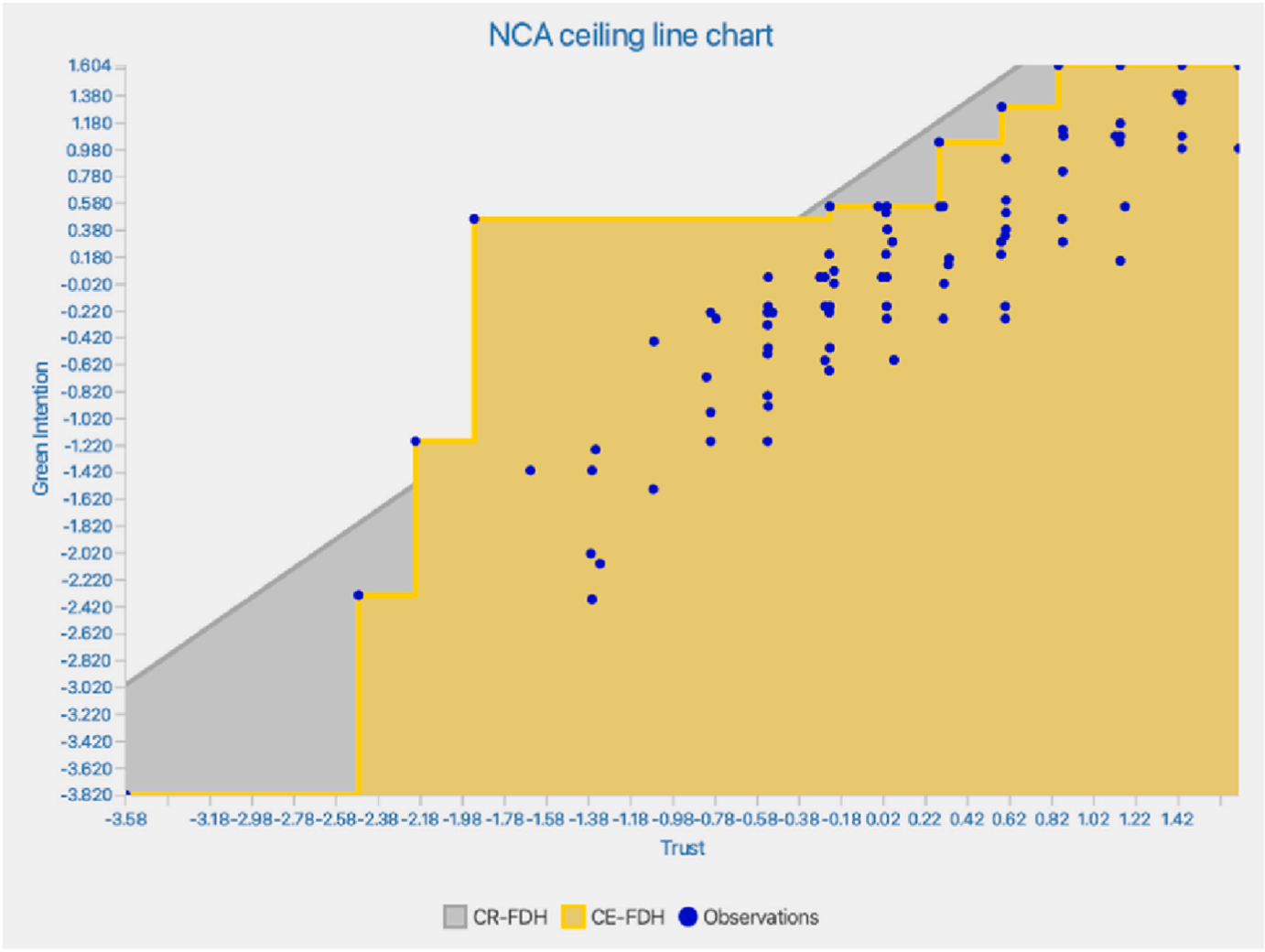


Fig. 6. Nca Plot – trust– green intention.

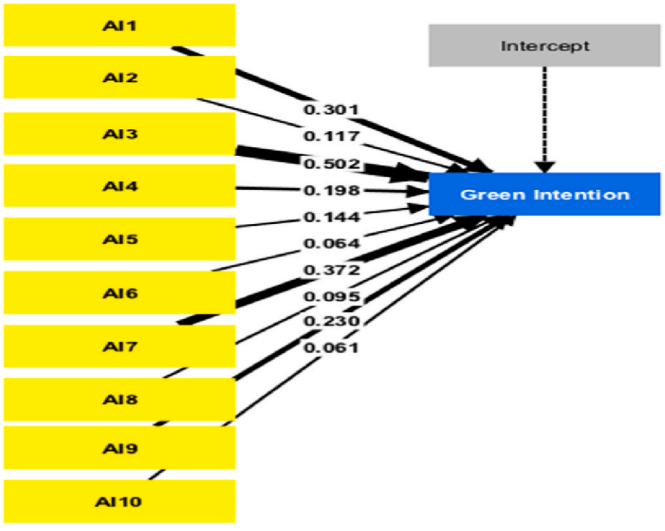


Fig. 7. NCA results of AI Green Marketing indicators.

also had a significant impact, with a total effect of 0.182. Conversely, AI9 had a negative effect, indicating it may hinder Green Intention. Notably, AI4 and ST3 had moderate effects on Green Intention.

Table 8
NCA results of AI Green Marketing indicators.

	Effect size	95.00 %	p value
AI1	0.301	0.339	0.05
AI2	0.117	0.117	0.05
AI3	0.502	0.507	0.04
AI4	0.198	0.115	0.00
AI5	0.144	0.116	0.005
AI6	0.064	0.098	0.21
AI7	0.372	0.259	0.00
AI8	0.095	0.093	0.04
AI9	0.230	0.16	0.001
AI10	0.061	0.074	0.11

Note(s): $0 < d < 0.15$ indicates a small effect size. Effect sizes in the range of $0.1 \leq d < 0.35$ are considered medium. For effect sizes of $0.3 \leq d < 0.55$, the effect size is classified as large. Effect sizes of $d \geq 0.55$ are categorized as very large.

However, AI4 had a lower performance rating, while ST3 demonstrated a higher performance rating. Regarding Trust-related factors, Trst1 emerged as the most influential, with a total effect of 0.23. Trst2 and Trst3 also exhibited notable effects. These findings emphasize the importance of considering AI-related and Trust-related factors when promoting Green Intention. Managers can leverage the insights gained from the IPMA to prioritize their actions and strategies effectively.

Table 14 summarises the relative effects of all three predictors (AI Green Marketing, Satisfaction, and Trust) of the outcome variable

Table 9
Bottleneck table- CE-FDH (percentage-levels) - AI Green Marketing indicators for Green Intention.

	Green Intention	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8	AI9	AI10
0.00 %	−3.82	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
10.00 %	−3.278	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
20.00 %	−2.735	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
30.00 %	−2.193	NN	NN	NN	NN	NN	NN	2.04	NN	1.02	NN
40.00 %	−1.65	NN	NN	NN	NN	NN	NN	2.04	NN	1.02	NN
50.00 %	−1.108	NN	NN	2.04	NN	NN	NN	2.04	NN	3.06	NN
60.00 %	−0.566	1.02	NN	2.04	NN	NN	NN	3.06	NN	3.06	NN
70.00 %	−0.023	1.02	NN	2.04	5.10	NN	NN	3.06	NN	3.06	NN
80.00 %	0.519	23.46	8.16	2.04	20.40	9.184	NN	3.06	NN	3.06	NN
90.00 %	1.062	23.46	8.16	2.04	20.40	9.184	11.22	12.24	11.22	20.40	3.06
100.00 %	1.604	23.46	8.16	2.04	60.20	58.163	43.87	43.87	34.69	20.40	45.91

Table 10
Bottleneck table -CE-FDH (Percentage-Levels) - AI Green Marketing Indicators for Trust.

	Trust	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8	AI9	AI10
0.000 %	2.000	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
10.000 %	2.500	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
20.000 %	3.000	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
30.000 %	3.500	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
40.000 %	4.000	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
50.000 %	4.500	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
60.000 %	5.000	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
70.000 %	5.500	NN	NN	NN	NN	NN	4.000	NN	NN	NN	NN
80.000 %	6.000	NN	NN	NN	NN	NN	4.000	NN	NN	NN	NN
90.000 %	6.500	4.000	4.000	4.000	3.000	4.000	4.000	5.000	4.000	5.000	5.000
100.000 %	7.000	4.000	4.000	4.000	3.000	4.000	4.000	5.000	4.000	5.000	5.000

Table 11
NCA effect size AI Green Marketing Indicators for Trust.

AI Green Marketing Indicators	CE-FDH	CR-FDH
AI1	0.080	0.040
AI2	0.100	0.050
AI3	0.100	0.050
AI4	0.050	0.025
AI5	0.100	0.050
AI6	0.100	0.050
AI7	0.120	0.060
AI8	0.080	0.040
AI9	0.120	0.060
AI10	0.120	0.060

(Green Intention). Based on the comparison of the PLS-SEM, NCA and IPMA, the findings suggest that both Trust and AI Green Marketing play crucial roles in influencing individuals' Green Intentions. Trust is identified as the most influential factor in the NCA analysis. At the same time, AI Green Marketing stands out as the most important factor according to the PLS-SEM and IPMA analysis, while Satisfaction appears to have a relatively lower impact.

Trust is identified as the most critical outcome variable among Satisfaction and Green Intention in the NCA analysis due to its largest effect size of 0.369. This substantial effect size indicates that AI Green Marketing has a stronger and more significant impact on Trust compared to Satisfaction (0.314) and Green Intention (0.347). The statistical significance of Trust, with a p-value of 0.000, underscores the robustness of this relationship, suggesting that the observed effect is highly unlikely to be due to chance. Trust is fundamental in shaping customer relationships, influencing immediate satisfaction, long-term

Table 13
Effect size AI Green Marketing Indicators for Satisfaction.

AI Green Marketing Indicators	CE-FDH	CR-FDH
AI1	0.100	0.050
AI2	0.000	0.000
AI3	0.125	0.063
AI4	0.125	0.063
AI5	0.125	0.063
AI6	0.100	0.050
AI7	0.100	0.050
AI8	0.100	0.050
AI9	0.100	0.050
AI10	0.100	0.050

Table 12
Bottleneck table -CE-FDH (Percentage-Levels) - AI Green Marketing Indicators for Satisfaction.

	Satisfication	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8	AI9	AI10
0.000 %	3.000	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
10.000 %	3.400	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
20.000 %	3.800	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
30.000 %	4.200	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
40.000 %	4.600	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
50.000 %	5.000	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
60.000 %	5.400	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
70.000 %	5.800	NN	NN	NN	NN	NN	NN	NN	NN	NN	NN
80.000 %	6.200	4.000	NN	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
90.000 %	6.600	4.000	NN	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
100.000 %	7.000	4.000	NN	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000

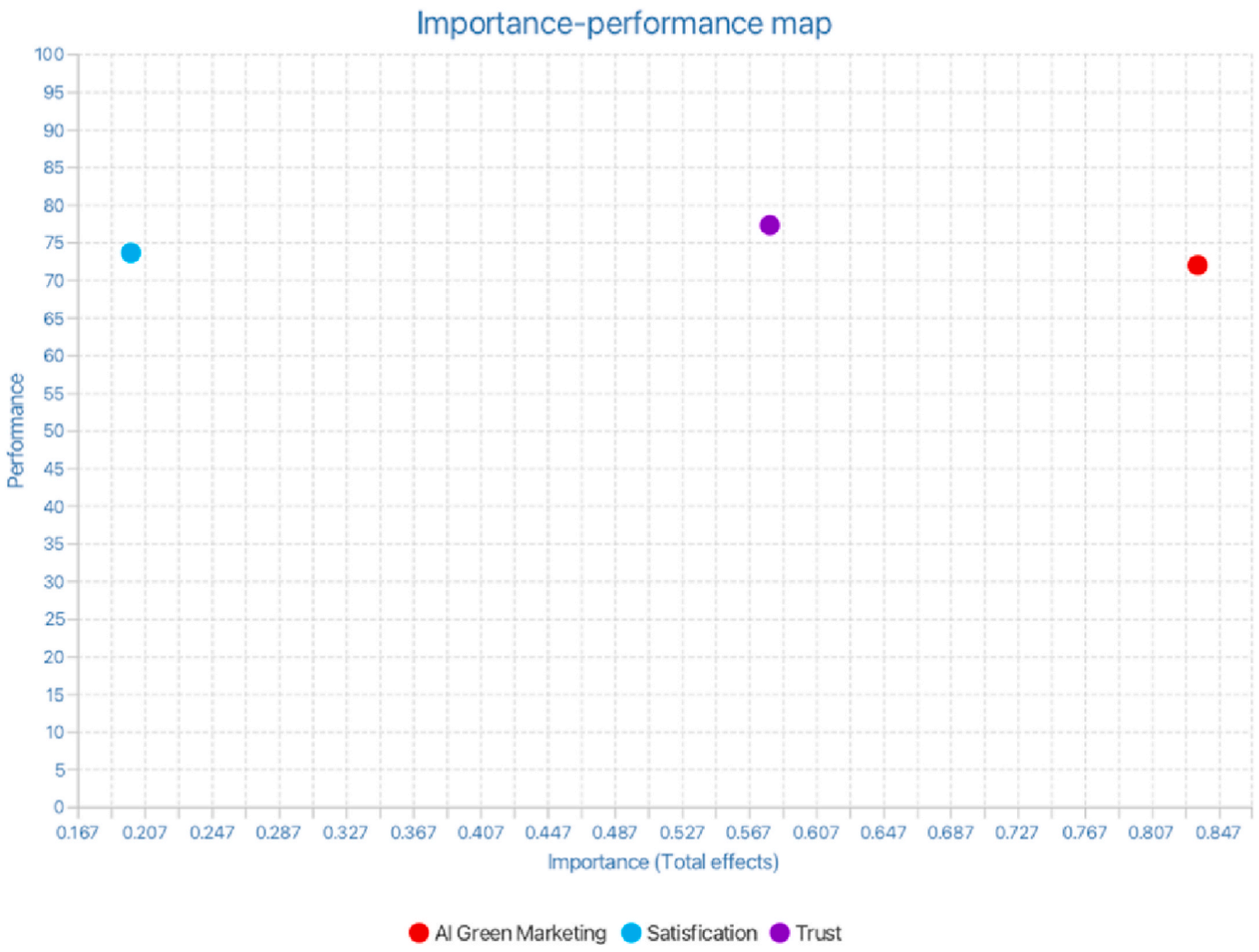


Fig. 8. Importance-performance map analysis (Output: Green Intention).

customer engagement, and loyalty. As such, prioritizing Trust in AI Green Marketing strategies is crucial, as it can lead to enhanced customer satisfaction and stronger Green Intention, ultimately fostering more sustainable and impactful customer interactions.

In the IPMA analysis, AI Green Marketing is the most influential factor concerning the outcome variable Green Intention, with the highest effect size of 0.835. This significant impact underscores the effectiveness of AI-driven marketing strategies in shaping and enhancing consumers' intentions to engage in environmentally friendly behaviors. The substantial influence of AI Green Marketing indicates its strategic importance in promoting sustainable practices among consumers. By leveraging AI technologies for personalized recommendations and targeted campaigns, organizations can effectively drive green consumer behavior, highlighting AI Green Marketing as a critical element in achieving sustainability goals and aligning with environmentally conscious market trends.

Combining these two approaches provides valuable insights for understanding and prioritizing managerial actions to enhance Green Intention. The results highlight the significance of implementing AI Green Marketing strategies to enhance Green Intention among individuals. Organizations can influence customers' intentions to support and purchase green products by focusing on AI-driven marketing initiatives promoting environmental sustainability. Trust-building activities, such as environmental commitments and protection efforts, foster positive perceptions and drive Green Intention. Managers can leverage these insights to prioritize resource allocation and strategic decision-making. Allocating resources toward AI Green Marketing initiatives and trust-building activities can yield substantial returns in influencing consumers' green intentions. Regarding the effects of AI-Green Marketing indicators on Green Intention, Table 15 compares NCA and IPMA analysis.

The NCA analysis shows that AI3 has the largest effect (0.502), followed by AI7 (0.372) and AI9 (0.230). On the other hand, the IPMA analysis indicates that AI5 has the highest total effect on performance (0.269), followed by AI10 (0.182). The rankings of the factors vary between the two analyses, highlighting the different perspectives and emphasis each approach provides.

Considering managerial implications, the NCA analysis emphasizes the relative importance of different factors in explaining the outcome variable (Green Intention). On the other hand, the IPMA analysis provides insights into the actual performance associated with each factor, highlighting which factors contribute more to achieving desired outcomes. Based on the NCA effect, AI3 is the most influential indicator with the highest rank of 1, indicating its strong impact on Green Intention. Following AI3, the indicators AI7, AI1, and AI9 also hold significant positions in the ranking, suggesting their considerable contribution to influencing Green Intention. On the other hand, the IPMA effect ranking sheds light on the indicators' performance in terms of achieving desired outcomes. Interestingly, AI5 secures the top rank, highlighting its strong performance driving green intention. AI10 also

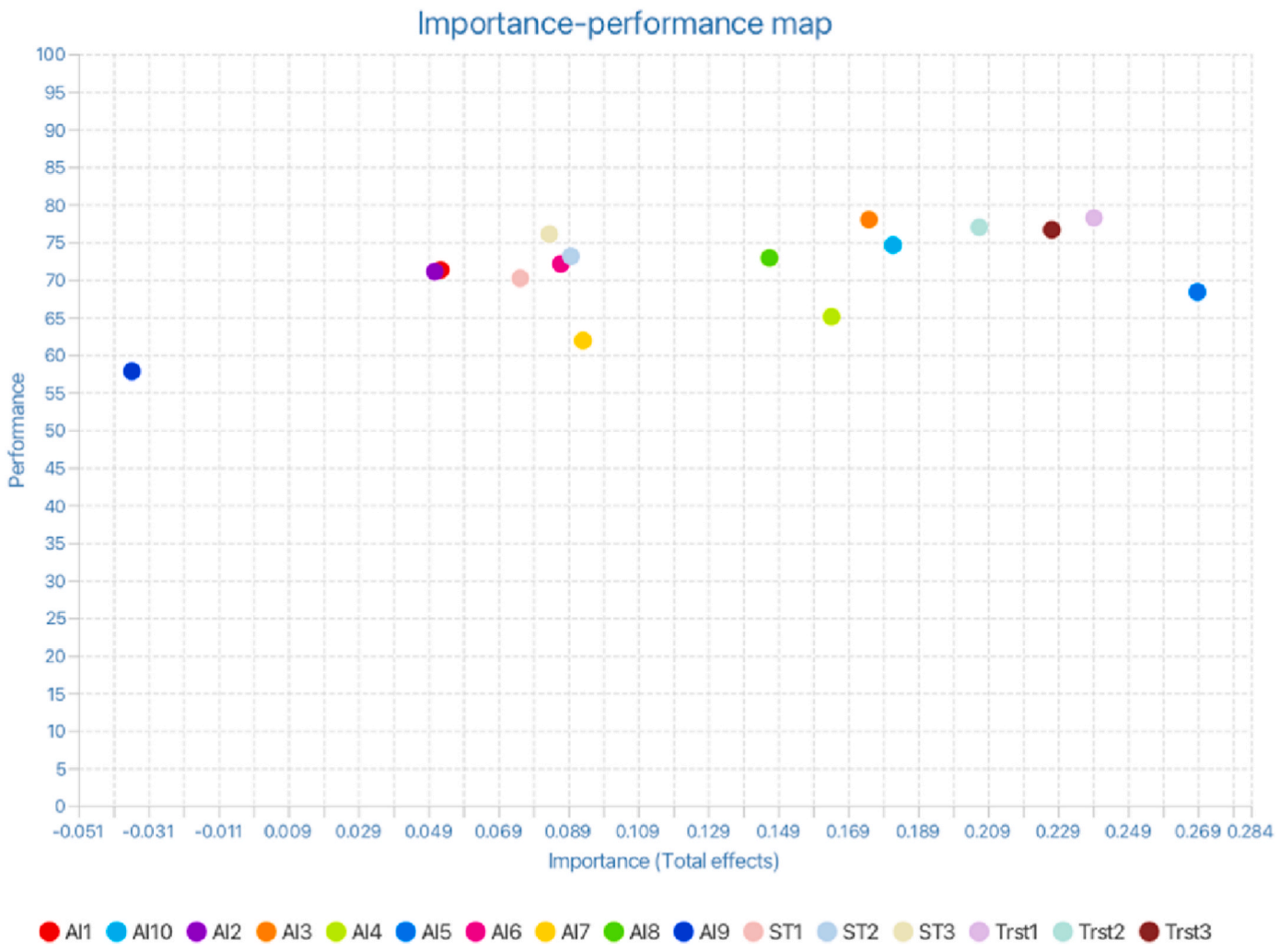


Fig. 9. IPMA (Input: AI Green Marketing indicators; Output: Green Intention).

Table 14
Construct effects comparison of PLS-SEM, NCA and IPMA.

Factors	NCA Effects	PLS-SEM and IPMA Effects	NCA Rank	IPMA Rank PLS-SEM and IPMA
AI Green Marketing	0.347	0.835	2	1
Trust	0.369	0.58	1	2
Satisfaction	0.314	0.199	3	3

Table 15
AI-green marketing indicators effects comparison.

Indicators (AI-Green Marketing)	NCA Effects	IPMA Effects	NCA Rank	IPMA Rank
AI1	0.301	0.052	3	8
AI2	0.117	0.051	7	9
AI3	0.502	0.175	1	3
AI4	0.198	0.164	5	4
AI5	0.144	0.269	6	1
AI6	0.064	0.087	8	7
AI7	0.372	0.093	2	6
AI8	0.095	0.146	9	5
AI9	0.23	−0.036	4	10
AI10	0.061	0.182	10	2

demonstrates a notable performance, obtaining the second rank. However, it is important to note that AI9 ranks at the bottom regarding the IPMA effect, indicating its relatively weaker performance in influencing Green Intention.

Overall, these ranking findings provide valuable guidance for managerial implications. AI3, AI7, AI1, and AI9 are identified as key indicators that significantly impact Green Intention, emphasizing the need for managers to focus their efforts on these factors. Additionally, the performance rankings highlight the effectiveness of AI5 and AI10 in achieving Green Intention, suggesting that managers should prioritize these indicators in their strategic initiatives. Managers can utilize the combined information from both analyses to make informed decisions. They can prioritize their actions based on the relative importance indicated by the NCA analysis and focus on improving performance in areas associated with factors identified by the IPMA analysis. By considering both the influence on Green Intention and the actual performance outcomes, managers can develop comprehensive strategies to enhance green intentions and overall performance.

Our findings are aligned with the signaling theory proposed by researchers (Connelly et al., 2011; Spence, 2002), such that the perceived environmental sustainability of a product is believed to influence purchase intent positively. This is because it signals trustworthiness from the business offering the product (Herbas Torrico et al., 2018). Our findings are also consistent with previous researchers highlighting the product's environmental benefits, which indicate consumer trust (Frank, 2021), improving how customers perceive the product's quality (Martínez and Del Bosque, 2013). It also strengthens their inclination to

associate themselves with the company's values within the social context. (Koller et al., 2011). Tarabieh (2020) and Zheug (2021) found that trust influences green purchase intention significantly. Consequently, the product's environmental benefits increase customers' inclination to purchase green products (Frank, 2021). As people's environmental concerns grow, their attitude towards green products also increases. This, in turn, leads to a higher likelihood of purchasing green products (Ansu-Mensah, 2021; Kashi, 2020; Moslehpour et al., 2022; Chekima and Chekima, 2019).

7. Conclusion and limitations

In conclusion, the growing awareness of sustainability issues in today's world has prompted businesses to adopt green marketing tactics to attract environmentally conscious customers. Artificial intelligence (AI) integration has significantly transformed green marketing practices, offering new opportunities for promoting sustainable consumption. This study explored various AI-enabled green marketing strategies, including strategic, tactical, and internal orientations, and their impact on fostering customer trust and satisfaction, ultimately influencing green intentions.

The findings of this research support the signaling theory proposed by previous researchers, suggesting that the perceived environmental sustainability of a product positively influences purchase intent. Consumers view environmentally sustainable products as indicators of trustworthiness from the businesses offering them, aligning with the notion that environmental benefits positively affect consumer trust and product perception. Trust was a significant factor influencing green purchase intentions. Consequently, as people's environmental concerns grow, so does their likelihood of purchasing green products. In summary, this research sheds light on the powerful influence of AI-enabled green marketing strategies in fostering customer trust and satisfaction, ultimately driving green intentions among consumers. As businesses continue to embrace sustainability and innovation, AI's integration in green marketing will likely play an even more significant role in promoting a more environmentally conscious marketplace.

This study contributes to the growing body of literature on green marketing by examining the unique role of AI in shaping consumer trust and satisfaction towards eco-friendly products. Unlike traditional green marketing approaches, AI-enabled strategies offer a data-driven, personalized, and real-time mechanism to engage consumers, enhancing their green intention. By integrating AI into marketing strategies, businesses can more effectively build customer trust and align their offerings with sustainability goals, providing both environmental and competitive advantages. This research extends the understanding of AI's potential to influence green consumer behavior, contributing valuable insights into sustainable marketing practices.

Despite the valuable insights gained from this study, it has several limitations. Firstly, the data collection was limited to consumers in the UAE, which may restrict the generalizability of the findings to other regions and cultural contexts. Secondly, the study focused exclusively on AI-enabled green marketing strategies, potentially overlooking the influence of other marketing techniques or broader societal factors on green purchase intentions. To enhance the generalizability of the findings, future research should focus on using samples from various countries. Lastly, it is crucial to note that this study solely examined the role of AI-enabled green marketing in influencing consumer trust and satisfaction from the consumer's point of view. For a comprehensive understanding, future research should also consider investigating the impact of AI-enabled green marketing strategies from the companies' perspective, examining how such initiatives contribute to Green Intentions. Future research should incorporate qualitative research methods to explore the factors in greater detail.

CRediT authorship contribution statement

Osama Sohaib: Formal analysis, Investigation, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Aamna Alshemeili:** Conceptualization, Investigation, Methodology. **Tariq Bhatti:** Conceptualization, Resources, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

I would like to affirm that there is no conflict of interest associated with this research article. The work presented in this manuscript is purely academic and has been conducted with the utmost integrity and objectivity. Neither I nor any of the co-authors have any financial or personal relationships with individuals, organizations, or entities that could influence the research design, data interpretation, or the decision to publish this article.

We understand the importance of maintaining transparency and ensuring that potential conflicts of interest are disclosed to uphold the integrity and credibility of scientific research.

We have adhered to the ethical guidelines and standards set forth by the Journal of Retailing and Consumer Services, and we are committed to upholding the principles of academic integrity throughout the publication process.

Appendix A

	Code	Questions
Strategic AI-green marketing orientation	AI1	How much more likely are you to purchase products/services from a company that has a separate department/unit specializing in environmental issues for their organization, incorporating AI-enabled green marketing strategies?
	AI2	How important is it to you that companies participate in environmental business networks, utilizing AI-enabled green marketing techniques?
	AI3	How likely are you to purchase environmentally friendly products/services from a company that invests in R&D programs to create them, supported by AI-enabled green marketing initiatives?
	AI4	How much more likely are you to purchase products/services from a company that targets environmentally-conscious consumers among other target markets, employing AI-enabled green marketing approaches?
Tactical AI-green marketing orientation	AI5	I value companies that utilize AI-enabled green marketing to absorb the extra cost of offering environmentally-friendly products/services.
	AI6	I prefer to purchase products/services that incorporate AI-enabled green marketing strategies, such as using recycled or reusable materials.
	AI7	I prefer companies that prioritize digital communication methods, enabled by AI, for promoting their products/services as they are more eco-friendly.
Internal AI-green marketing orientation	AI8	I prefer to support companies that actively encourage their employees, through AI-enabled green marketing, to use eco-friendly products and services.
	AI9	I trust products from companies that have dedicated environmental committees, utilizing AI-enabled green marketing, to ensure internal audits of their environmental performance.

(*continued on next page*)

(*continued*)

	Code	Questions
	AI10	I tend to choose products from companies that promote eco-friendly behavior through internal environmental prize competitions, coupled with their AI-enabled green marketing strategies.
Trust	Trst1	I believe the environmental commitments of companies are generally reliable.
	Trst2	I believe the environmental arguments of companies are generally trustworthy.
	Trst3	I believe companies are sincere and honest about their environmental protection efforts.
Satisfaction	ST1	The choice of companies/products due to its environmental commitment makes me happy.
	ST2	I consider it is correct to choose the company/product because of its environmental commitment
	ST3	I am satisfied with companies/products because of its environmental performance.
Green Intention	GI1	I plan to purchase environmentally friendly products over conventional products.
	GI2	I will consider buying green products because they are less polluting.
	GI3	I plan to switch to a green version of a product.

Data availability

Data will be made available on request.

References

Alsalhy, M.J., Sharif, H., Haroon, N.H., Mohsin, S.K., Khalid, R., Ali, A., 2023. Integrating AI-based smart-driven marketing to promote sustainable and green systems. In: *2023 International Conference On Emerging Research In Computational Science* (ICERCS). IEEE, pp. 1–6.

Ameen, N., Sharma, G.D., Tarba, S., Rao, A., Chopra, R., 2022. Toward advancing theory on creativity in marketing and artificial intelligence. Psychol. Market. 39 (9), 1802–1825.

Ansu-Mensah, P., 2021. Green product awareness effect on green purchase intentions of university students': an emerging market's perspective. Future Business Journal 7 (1), 1–13.

Ashoush, N., Kortam, W., 2022. The impact of green marketing strategies on consumers' purchasing intention. Bus. Manag. Rev. 13 (2), 263–275.

Baqi, A., Abdeldayem, M.M., Aldulaimi, S.H., 2022. Embedding artificial intelligence and green ideology in formulating corporate and marketing strategies. In: 2022 ASU International Conference in Emerging Technologies for Sustainability and Intelligent Systems (ICETSIS). IEEE, pp. 1–4.

Bolón-Canedo, V., Morán-Fernández, L., Cancela, B., Alonso-Betanzos, A., 2024. A review of green artificial intelligence: towards a more sustainable future. Neurocomputing, 128096.

Chekima, B., Chekima, K., 2019. The impact of human values and knowledge on green products purchase intention. In: Gbadamosi, A. (Ed.), Exploring the Dynamics of Consumerism in Developing Nations. IGI Global, pp. 266–283. https://doi-org.ezproxy.lib.uts.edu.au/10.4018/978-1-5225-7906-9.ch012.

Chen, Y.S., 2010. The drivers of green brand equity: green brand image, green satisfaction and green trust,". J. Bus. Ethics 93 (2), 307–319.

Chin, W.W., Marcolin, B.L., Newsted, P.R., 2003. A partial least squares latent variable modeling approach for measuring interaction effects: results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. Info. Sys. Research 14 (2), 189–217. https://doi.org/10.1287/isre.14.2.189.16018.

Chintalapati, S., Pandey, S.K., 2022. Artificial intelligence in marketing: a systematic literature review. Int. J. Mark. Res. 64 (1), 38–68. https://doi.org/10.1177/14707853211018428.

Choi, S., Ng, A., 2011. Environmental and economic dimensions of sustainability and price effects on consumer responses. J. Bus. Ethics 104 (2), 269e282.

Connelly, B.L., Certo, S.T., Ireland, R.D., Reutzel, C.R., 2011. Signaling theory: a review and assessment. J. Manag. 37 (1), 39e67.

Davenport, T., Guha, A., Grewal, D., Bressgott, T., 2020. How artificial intelligence will change the future of marketing. J. Acad. Market. Sci. 48 (1), 24–42. https://doi.org/10.1007/s11747-019-00696-0.

Delgado, E., Munuera, J.L., 2005. Does brand trust matter to brand equity? J. Prod. Brand Manag. 14 (3), 187–196.

DiPietro, R., Cao, Y., Partlow, C., 2013. Green practices in upscale foodservice operations: customer perceptions and purchase intentions. Int. J. Contemp. Hospit. Manag. 25 (5), 779–796.

Dul, J., 2016. Necessary condition analysis (NCA): logic and methodology of 'necessary but not sufficient' causality.". Organ. Res. Methods 19, 10–52.

Dul, J., Hauff, S., Bouncken, R.B., 2023. Necessary condition analysis (NCA): review of research topics and guidelines for good practice. Rev Manag Sci 17, 683–714. https://doi.org/10.1007/s11846-023-00628-x.

Fraj-Andres, E., Martinez-Salinas, E., Matute-Vallejo, J., 2009. A multidimensional approach to the influence of environmental marketing and orientation on the firm's organizational performance. J. Bus. Ethics 88 (2), 263e286.

Frank, B., 2021. Artificial intelligence-enabled environmental sustainability of products: marketing benefits and their variation by consumer, location, and product types. J. Clean. Prod. 285, 125242.

Grewal, D., Hulland, J., Kopalle, P.K., Karahanna, E., 2020. The future of technology and marketing: a multidisciplinary perspective. J. Acad. Market. Sci. 48 (1), 1–8. https://doi.org/10.1007/s11747-019-00711-4.

Guo, J., Su, Q., Zhang, Q., 2017. Individual creativity during the ideation phase of product innovation: an interactional perspective. Creativ. Innovat. Manag. 26 (1), 31–48. https://doi.org/10.1111/caim.12205.

Hair, F., Marko, J.S., Lucas, H., Volker, G.K., 2014. Partial least squares structural equation modeling (PLS-SEM) an emerging tool in business research. Eur. Bus. Rev. 26 (2), 106–121.

Han, H., Hsu, L.T., Lee, J.S., 2009. Empirical investigation of the roles of attitudes toward green behaviors, overall image, gender and age in hotel customers eco-friendly decision making-process. Int. J. Hospit. Manag. 28 (4), 519–528.

Henseler, J., Ringle, C.M., Sinkovics, R.R., 2009. The use of partial least squares path modeling in international marketing. New Challenges to International Marketing (Advances in International Marketing) 20, 277–319.

Henseler, J., Ringle, C.M., Sarstedt, M., 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J. Acad. Market. Sci. 43 (1), 115–135.

Herbas Torrico, B., Frank, B., Tavera, C.A., 2018. Corporate social responsibility in Bolivia: meanings and consequences. Int. J. Corp. Soc. Responsib. 3 (7), 1e13.

Hermann, E., 2021. Artificial Intelligence in Marketing: Friend or Foe of Sustainable Consumption? AI & SOCIETY, pp. 1–2.

Huang, M.H., Rust, R.T., 2018. Artificial intelligence in service. J. Serv. Res. 21 (2), 155–172. https://doi.org/10.1177/1094670517752459.

Huang, M.H., Rust, R.T., 2021. A framework for collaborative artificial intelligence in marketing. J. Retailing. https://doi.org/10.1016/j.jretai.2021.03.001.

Kang, S., Hur, W.H., 2012. Investigating the antecedents of green brand equity: a sustainable development perspective. Corp. Soc. Responsib. Environ. Manag. 19 (5), 306–316.

Kashi, M.A., 2020. Green purchase intention: a conceptual model of factors influencing green purchase of Iranian consumers. Journal of Islamic Marketing 11 (6), 1389–1403.

Kietzmann, J.H., Canhoto, A.I., 2018. Artificial intelligence in marketing: a bibliographic review. Eur. J. Market. 52 (1/2), 376–398.

Kock, N., 2015. Common method bias in PLS-SEM: a full collinearity assessment approach. Int. J. e-Collaboration 11 (4), 1–10. https://doi.org/10.4018/ijec.2015100101.

Koller, M., Floh, A., Zauner, A., 2011. Further insights into perceived value and consumer loyalty: a "green" perspective. Psychol. Market. 28 (12), 1154e1176.

Kotler, P., Armstrong, G., 2016. Principles of Marketing, sixteenth ed. Pearson.

Luchs, M.G., Naylor, R.W., Irwin, J.R., Raghunathan, R., 2010. The sustainability liability: potential negative effects of ethicality on product preference. J. Market. 74 (5), 18–31.

Ma, L., Sun, B., 2020. Machine learning and AI in marketing— connecting computing power to human insights. Int. J. Res. Market. 37 (3), 481–504. https://doi.org/10.1016/j.ijresmar.2020.04.005.

Martínez, P., 2015. Customer loyalty: exploring its antecedents from a green marketing perspective. Int. J. Contemp. Hosp. Manag. 27 (5), 896–917. https://doi.org/10.1108/IJCHM-03-2014-0115.

Martínez, P., Del Bosque, I.R., 2013. CSR and customer loyalty: the roles of trust, customer identification with the company and satisfaction. Int. J. Hospit. Manag. 35, 89e99.

Moslehpour, M., Chau, K.Y., Du, L., Qiu, R., Lin, C.Y., Batbayar, B., 2022. Predictors of green purchase intention toward eco-innovation and green products: evidence from Taiwan. Economic Research-Ekonomska Istraživanja 1–22.

Mostafa, M.M., 2006. Antecedents of Egyptian consumers' green purchase intentions: a hierarchical multivariate regression model. J. Int. Consum. Market. 19 (2), 97–126. https://doi.org/10.1300/J046v19n02_06.

Ng, P.F., Butt, M.M., Khong, K.W., Ong, F.S., 2014. Antecedents of green brand equity: an integrated approach. J. Bus. Ethics 121 (2), 203–215.

Nyilasy, G., Gangadharbatla, H., Paladino, A., 2014. Perceived greenwashing: the interactive effects of green advertising and corporate environmental performance on consumer reactions. J. Bus. Ethics 125 (4), 693e707.

Papadas, K.K., Avlonitis, G.J., Carrigan, M., 2017. Green marketing orientation: Conceptualization, scale development and validation. J. Bus. Res. 80, 236–246.

Poria, S., Cambria, E., Gelbukh, A., Bisio, F., Hussain, A., 2015. Sentiment data flow analysis by means of dynamic linguistic patterns. IEEE Comput. Intell. Mag. 10 (4), 26–36. https://doi.org/10.1109/MCI.2015.2471215.

Ranaweera, C., Prabhu, J., 2003. The infuence of satisfaction, trust and switching barriers on customer retention in a continuous purchasing setting. Int. J. Serv. Ind. Manag. 14 (4), 374–395.

Rathore, B., 2018. Emergent perspectives on green marketing: the intertwining of sustainability, artificial intelligence, and the metaverse. Int. J. New Media Stud. Int. Peer Rev. Scholar. Index. J 5 (2), 22–30.

Rathore, B., 2019. From trendy to green: exploring AI's role in sustainable fashion marketing. International Journal of New Media Studies: International Peer Reviewed Scholarly Indexed Journal 6 (2), 12–22.

Richter, N.F., Schubring, S., Hauff, S., Ringle, C.M., Sarstedt, M., 2020. When predictors of outcomes are necessary: guidelines for the combined use of PLS-SEM and NCA. Ind. Manag. Data Syst. 120 (12), 2243–2267.

Sarstedt, M., Hair, J.F., Ringle, C.M., Thiele, K.O., Gudergan, S.P., 2016. Estimation issues with PLS and CBSEM: where the bias lies. J. Bus. Res. 69 (10), 3998–4010. https://doi.org/10.1016/j.jbusres.2016.06.007.

Sharma, R., Yetton, P., Crawford, J., 2009. Estimating the effect fo common method vairance: the method–method pair technique with an illustration TAM research. MIS Q. 33 (3), 473-A413.

Slevitch, L., Mathe, K., Karpova, E., Scott-Halsell, S., 2013. Green attributes and customer satisfaction: optimization of resource allocation and performance. Int. J. Contemp. Hospit. Manag. 25 (6), 802–822.

Spence, M., 2002. Signaling in retrospect and the informational structure of markets. Am. Econ. Rev. 92 (3), 434e459.

Tan, Z., Sadiq, B., Bashir, T., Mahmood, H., Rasool, Y., 2022. Investigating the impact of green marketing components on purchase intention: the mediating role of brand image and brand trust. Sustainability 14 (10), 5939.

Tarabieh, S.M.Z.A., 2020. The impact of greenwash practices over green purchase intention: the mediating effects of green confusion, green perceived risk, and green trust. Manag. Sci. Lett. 11, 451–464. https://doi.org/10.5267/j.msl.2020.9.022.

Verma, S., Yadav, N., 2021. Past, present, and future of electronic word of mouth (EWOM). J. Interact. Market. 53, 111–128. https://doi.org/10.1016/j.intmar.2020.07.001.

Vlačić, B., Corbo, L., Silva, S.C., Dabić, M., 2021. The evolving role of artificial intelligence in marketing: a review and research agenda. Journal of business research 128, 187–203.

Wiedmann, T., Lenzen, M., Keyßer, L.T., Steinberger, J.K., 2020. Scientists' warning on affluence. Nat. Commun. 11 (3107), 1–10. https://doi.org/10.1038/s41467-020-16941-y.

Wu, L., Liu, Z., 2022. The influence of green marketing on brand trust: the mediation role of brand image and the moderation effect of greenwash. Discrete Dynam Nat. Soc. 1–10. https://doi.org/10.1155/2022/6392172, 2022.

Xi, Y., Siau, K., 2020. Values of artificial intelligence in marketing. Proceedings of the Fifteenth Midwest Association for Information Systems Conference 27. Retrieved from. https://aisel.aisnet.org/cgi/viewcontent.cgi?article=1172&context=ecis2020_rp.

Yadav, A., Sondhi, H., 2023. Systematic literature review on sustainable marketing and artificial intelligence. In: 2023 10th International Conference on Computing for Sustainable Global Development (INDIACom). IEEE, pp. 583–588.

Zhuang, W., Luo, X., Riaz, M.U., 2021. On the factors influencing green purchase intention: a meta-analysis approach. Front. Psychol. 12, 644020.