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Tech-Driven Green Entrepreneurship in Emerging Markets: A Structural Equation Modeling Approach to AI's Moderating Role in the Relationship Between Green Innovation, Green Creativity, and Purchase Intentions

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Abstract

This research examines the impact of Green Innovation (GI) and Green Creativity (GC) on Consumer Purchase Intentions (PI), moderated by Artificial Intelligence (AI). Using a quantitative approach, data from 312 eco-conscious consumers were analyzed through Structural Equation Modeling (SEM) to assess the relationships between the constructs. The study validates that Green Innovation and Green Creativity significantly enhance Purchase Intention, demonstrating the critical role of integrating environmental innovation and creative marketing in influencing purchase intention.

Furthermore, Artificial Intelligence was found to strengthen the impact of both Green Innovation and Green Creativity on Purchase Intention, suggesting that AI can significantly enhance the appeal and effectiveness of green marketing strategies. These findings highlight the potential of AI in bridging the gap between green product innovation and consumer engagement, offering substantial implications for businesses aiming to respond to the growing market for sustainable goods. This paper contributes to the literature on sustainable business practices by delineating the synergistic effects of creativity, innovation, and technology in promoting environmental products.

Keywords: Sustainable Consumption, Environmental Behavior, Technology Adoption, Theory of Planned Behavior, Eco-conscious Consumers

1. Introduction

Growing environmental concerns and rising consumer awareness of sustainability have prompted businesses across industries to adopt greener practices. This shift is driven not only by regulatory requirements but also by the strategic need to align with the preferences of environmentally conscious consumers (Bansal & Roth, 2000). At the same time, technological advancements, particularly Artificial Intelligence (AI), are transforming how organizations approach sustainability by enabling smarter, more efficient, and more impactful green initiatives (Porter & Heppelmann, 2015). Within this context, tech-driven green entrepreneurship has emerged as a critical framework that integrates digital technologies, such as AI, machine learning,

and data analytics into environmentally responsible business models. This approach is especially relevant in emerging markets such as Malaysia, Indonesia, India, Vietnam, and the Philippines, where rapid digitalisation, economic development, and increasing resource pressures create fertile ground for technology-enabled sustainability efforts.

Two concepts central to tech-driven green entrepreneurship are Green Innovation and Green Creativity. Green Innovation refers to the development of products or processes that reduce environmental impact through the use of biodegradable materials, recyclable components, low-carbon technologies, and circular production methods (Khan, 2021; Nidumolu et al., 2009). Green Creativity, in contrast, encompasses the generation of novel, environmentally focused ideas reflected in creative eco-friendly designs, unique sustainability campaigns, and innovative solutions that minimise waste and enhance resource efficiency (Zhang, 2024). Although these constructs have been widely explored in the context of firm performance and environmental outcomes (Schaltegger & Wagner, 2011), their combined influence on consumer purchase intention particularly when supported by emerging technologies remains insufficiently examined.

Despite extensive scholarship on green innovation and creativity, comparatively little attention has been given to technological enablers such as AI that can amplify the effectiveness of sustainable practices. AI offers capabilities including predictive analytics, automated personalisation, intelligent eco-labelling, and data-driven sustainability insights that enhance

how businesses design, develop, and communicate green products (Zong, 2024; Suljic, 2025; Kiron et al., 2015). These capabilities are especially influential in emerging markets where digital adoption is accelerating and consumers increasingly rely on technology to guide purchasing decisions. Recognising this gap, the present study investigates how AI moderates the relationships between Green Innovation, Green Creativity, and Consumer Purchase Intentions. Prior research has demonstrated the positive influence of green innovation on consumer attitudes (Schaltegger & Wagner, 2011), but the moderating role of AI remains underexplored, particularly in relation to how it enhances consumers' understanding and appreciation of sustainable product attributes.

This study therefore contributes a deeper theoretical and empirical understanding of how digital transformation strengthens sustainable marketing strategies. By synthesising insights from environmental science, marketing, and digital technology, the research offers a holistic perspective on how AI-enabled sustainability practices can enhance both environmental and economic performance (Kumar & Christodouloupoulou, 2014). Conducted in Malaysia, one of Southeast Asia's key emerging markets, the study empirically validates the proposed model and provides evidence-based recommendations for organisations seeking to leverage AI in their green innovation and creativity strategies (Bocken et al., 2014).

Furthermore, the study aligns with global sustainability efforts, particularly the United Nations Sustainable Development Goals (SDGs). It contributes to SDG

9 by promoting sustainable innovation and technology-driven infrastructure, to SDG 12 by encouraging responsible consumption patterns, and to SDG 13 by supporting climate action through AI-enhanced green business practices. Overall, this research advances theory and practice by offering empirical insights into how AI can strengthen sustainable business innovations and increase the adoption of green products in emerging markets, thereby benefiting businesses, policymakers, and consumers alike.

2. Literature review

Green innovation has been widely examined as a strategic response to rising ecological pressures, yet scholarship increasingly emphasizes that innovation outcomes depend not only on technical improvements but also on how effectively such innovations create perceived value for consumers and stakeholders. While early work linked green innovation to environmental performance, recent studies highlight that firms adopt green innovation when it enhances competitiveness, differentiation, and long-term strategic positioning (Khan et al., 2021; Schaltegger & Wagner, 2011). This perspective moves beyond a descriptive understanding of green innovation as the creation of environmentally friendly products and instead situates it within organizational capability, competitive advantage, and value creation frameworks. However, the extent to which green innovations translate into consumer behavior remains context-dependent, suggesting the need to better

understand the mechanisms through which innovation attributes influence consumer purchase decisions in sustainability-focused markets.

Green creativity has likewise evolved from being understood as merely the generation of environmentally oriented ideas to being recognized as a dynamic capability that shapes how firms conceptualize and deliver sustainability value. Rather than treating creativity as an isolated activity, contemporary literature positions green creativity as a catalyst that transforms sustainability into marketable and differentiating offerings (Chen & Chang, 2013; Boons, 2009). Creative sustainability solutions help firms respond to complex ecological challenges by reframing traditional consumption models and introducing novel, appealing product designs that resonate with consumers' moral and aesthetic expectations. Despite its growing relevance, empirical work still underexplores how such creative outputs influence consumer decision-making, particularly when consumers are increasingly sensitive to authenticity, transparency, and measurable environmental benefits.

Recent discussions recognize Artificial Intelligence (AI) as a transformative enabler of sustainability, but its actual contribution to green innovation and creativity requires more critical scrutiny. Much of the popular discourse positions AI as inherently beneficial, yet academic research stresses that its value emerges only when firms integrate AI into specific processes such as predictive modeling, eco-design optimization, or personalized sustainability communication (Porter & Heppelmann, 2015; Kiron et al., 2015). When applied

strategically, AI can reveal hidden inefficiencies, support lifecycle-based decision making, and enhance firms' ability to communicate sustainability claims credibly to consumers. Nevertheless, technological integration does not guarantee positive outcomes; the effectiveness of AI depends on organizational readiness, data capabilities, and ethical governance. This indicates that the moderating effects of AI on green innovation and creativity may vary significantly across contexts, requiring empirical validation.

The influence of green innovation, creativity, and AI on consumer purchase intention must be interpreted through the lens of evolving consumer psychology. Modern consumers increasingly expect firms to demonstrate genuine environmental responsibility, but they also require clarity, credibility, and relevance in sustainability claims (Kumar & Christodouloupoulou, 2014). Innovation alone is insufficient if consumers cannot perceive its benefits or if firms fail to articulate environmental value meaningfully. Creative sustainability communication, when supported by AI-driven personalization can strengthen perceived value by tailoring messages to consumers' environmental attitudes and decision heuristics. This aligns with the broader view that consumer responses to sustainability are shaped by a combination of cognitive evaluation, emotional engagement, and perceived moral congruence.

Taken together, the literature suggests that green innovation and creativity are important drivers of consumer engagement, yet their impact is contingent on firms' ability to communicate value effectively and credibly, an area where

AI has growing but uneven influence. Existing studies offer fragmented insights, often examining these constructs in isolation rather than as interdependent drivers of purchase intention. This creates a pressing need for empirical models that integrate innovation, creativity, and AI to understand their combined effects on sustainable purchase intention. The present study aims to address this gap by examining how AI strengthens or potentially reshapes the relationship between green strategies and consumer purchase intentions within emerging markets.

Consumer responses to Green Innovation can be better understood by drawing on established innovation-adoption principles. As Rogers (2014) explains in the Diffusion of Innovations theory, individuals tend to adopt new products when they perceive clear functional advantages and compatibility with their needs. Applied to sustainability contexts, consumers are more likely to show interest in green products when these innovations demonstrate meaningful improvements such as reduced environmental harm, enhanced safety, or resource efficiency, relative to conventional options. Rather than focusing solely on ecological benefits, consumers evaluate whether such innovations provide tangible value in everyday use. Prior studies also support the notion that clearly communicated environmental and user benefits increase the likelihood of adopting green technologies (Ozaki, 2011). Hence, the following hypothesis is proposed:

H1: Green Innovation positively influences Consumer Purchase Intentions.

The concept of Green Creativity, which encompasses the development of novel, environmentally friendly solutions, is pivotal in shaping consumer perceptions and behaviors. Creative marketing and product design not only attract attention but can significantly influence consumer preferences and decisions. In the context of sustainability, creatively designed green products meet both aesthetic and ethical consumer needs, which is essential in today's environmentally conscious market (Wilson, M., 2016). Enhanced creativity in presenting green products can lead to greater consumer engagement and higher purchase intentions. Furthermore, Wilson, M. (2016) suggest that the unique value provided by creatively marketed green products increases their attractiveness, making them more desirable than less creatively marketed alternatives. Therefore, it is hypothesized:

H2: Green Creativity positively influences Consumer Purchase Intentions.

Artificial Intelligence is revolutionizing the way businesses interact with consumers, particularly in enhancing personalized experiences and optimizing product recommendations. AI technologies can significantly amplify the effectiveness of green creativity and innovation in reaching and influencing consumer markets (Bashynska, 2023). For example, AI-driven analytics can help businesses better understand consumer preferences for green products, tailoring marketing strategies accordingly. AI can also enhance the visibility and perceived value of green innovations by providing consumers with personalized information on how such products meet their specific needs or values. Thus, AI is expected to strengthen the impact of Green Creativity and

Green Innovation on Consumer Purchase Intentions by ensuring that sustainable products are not only visible but also aligned with consumer expectations and preferences. This leads to the moderated hypotheses:

H3: Artificial Intelligence moderates the relationship between Green Innovation and Consumer Purchase Intentions.

H4: Artificial Intelligence moderates the relationship between Green Creativity and Consumer Purchase Intentions.

Based on the proposed relationships among Green Innovation, Green Creativity, Artificial Intelligence, and Consumer Purchase Intentions, the conceptual framework of the study is presented in Figure 1.

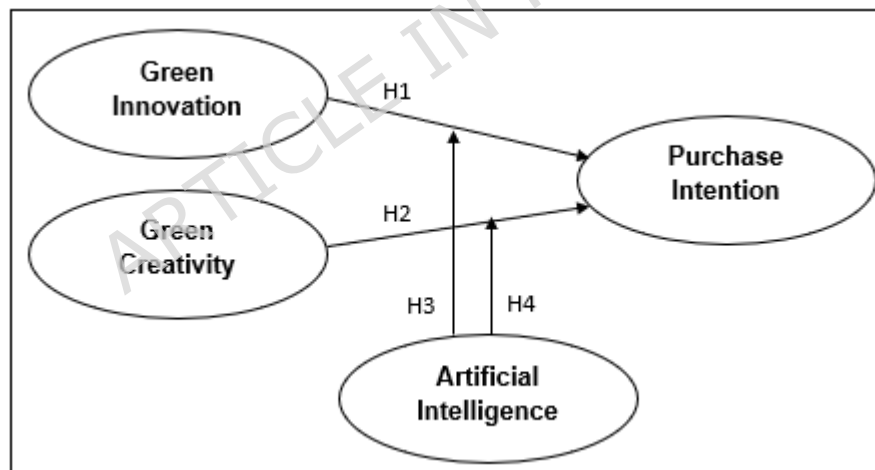


Figure 1: Conceptual Framework

3. Methodology

This study employed a quantitative research design to examine the relationships between Green Innovation, Green Creativity, Artificial

Intelligence (AI), and Consumer Purchase Intentions in the context of sustainable products. A structured questionnaire was used as the primary research instrument for data collection. The questionnaire consisted of four sections: demographic information, measurement items for Green Innovation, Green Creativity, and AI, and items assessing Consumer Purchase Intentions. All constructs were measured using previously validated scales from reputable studies to ensure reliability and content validity.

3.1 Research Respondents

Data were collected from consumers residing in several states across Malaysia, including Selangor, Johor, Sabah, Sarawak, Penang, Kuala Lumpur, and Putrajaya. A non-probability convenience sampling technique was employed, as this approach is commonly used in consumer-behaviour research and is suitable for targeting digitally active individuals, an important consideration given the study's focus on AI-enabled green products. Participation in the study was voluntary, and respondents were required to be at least 18 years of age and have prior experience purchasing or considering green products. A total of 312 valid responses were retained for analysis.

The final sample size of 312 exceeded the minimum requirements for Partial Least Squares Structural Equation Modelling (PLS-SEM). A G*Power analysis (effect size = 0.15, α = 0.05, power = 0.80, four predictors) indicated that at least 129 respondents were required. Additionally, the sample surpassed the recommended minimum of 200 cases for models involving moderation effects

(Hair et al., 2021), confirming the adequacy and robustness of the data for structural modelling.

3.2 Data Gathering Procedures

Data collection was conducted using an online survey administered via a secure web-based platform designed to be both mobile- and desktop-friendly. The survey remained open for a period of four weeks. Respondents were recruited through multiple channels, including social media platforms (Facebook and Instagram), announcements shared through university and professional mailing lists, online community groups.

Before accessing the questionnaire, respondents were presented with an informed-consent statement outlining the purpose of the study, the voluntary nature of participation, confidentiality assurances, and data-handling procedures. A screening question was included to ensure that only individuals aged 18 or above with experience purchasing or considering green products could proceed.

To enhance data quality, the survey incorporated attention-check items to detect careless responding. Throughout the data-collection period, two reminder messages were issued at one-week intervals to improve response rates. Upon closing the survey, all responses were screened for completeness, straight-lining behaviour, unrealistic completion times, and failed attention checks. Only valid and complete responses were retained, resulting in a final dataset of 312 usable cases.

All data were stored securely and handled in accordance with standard ethical guidelines for social science research.

3.3. Operationalising the constructs

Clear operational definitions were adopted to ensure accurate measurement of the study constructs. Artificial Intelligence (AI) was defined as consumers' perception of AI-enabled features that enhance environmental sustainability, such as personalised eco-recommendations, AI-driven information processing, and intelligent digital assistance. AI was measured using a scale adapted from Ho and Chow (2023), with items rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Green Innovation was operationalised as consumer perceptions of environmentally improved products and processes, including the use of recyclable materials, environmentally friendly packaging, and cleaner production technologies. Items for Green Innovation were adopted from Wong (2013) and assessed using a five-point Likert scale.

Green Creativity referred to the presence of novel, practical, and environmentally oriented ideas embedded in green products, such as unique eco-designs, creative Tech-driven features, and innovative green solutions. These items were adapted from Chen and Chang (2013) and Chang (2011), and likewise measured on a five-point Likert scale (Kline, 2015).

Consumer Purchase Intentions were defined as consumers' likelihood and willingness to purchase eco-friendly products. Measurement items were

adapted from Shafiq et al. (2011) and included statements such as “I plan to purchase green products in the future.” These were rated on the same five-point Likert scale for consistency across constructs.

The use of validated scales strengthens both the reliability and validity of the research instrument. Cronbach’s alpha, Composite Reliability (CR), and Average Variance Extracted (AVE) were subsequently assessed through the measurement model to confirm internal consistency and construct validity. Together, these operational definitions and measurement approaches ensure the constructs are clearly defined, measurable, and suitable for the empirical analysis in this study. The operational definitions, measurement scales, and sources of all study constructs are summarized in Table 1.

Table 1: Construct Measures

Construct	Definition	Scale	Source
Artificial Intelligence (AI)	The use of machine learning and robotics to enhance the sustainability features of products.	1 (Strongly Disagree) to 5 (Strongly Agree)	Ho & Chow, (2023)
Green Innovation	Development of products/processes that reduce environmental impact.	1 (Strongly Disagree) to 5 (Strongly Agree)	Wong, S. K. S. (2013)
Green Creativity	The ability to generate sustainable and innovate creative solutions.	1 (Strongly Disagree) to 5 (Strongly Agree)	Chen, Y. S., & Chang, C. H. (2013), Chang, C. H. (2011).
Purchase Intentions	Likelihood of purchasing green products.	1 (Strongly Disagree) to 5 (Strongly Agree)	(Shafiq, R., Raza et.al., 2011)

In Table 2, the demographic characteristics of the respondents reflected a diverse consumer population. Females comprised 54.5% of the sample and males 45.5%. The age distribution was broad, with the majority falling within the 26–45 age group, followed by younger consumers aged 16–25 and older adults aged 46 and above. Educational attainment varied, with 40.1% holding postgraduate degrees, 23.1% holding bachelor's degrees, 24.4% having partial college education, and 12.2% completing high school. This distribution reflects the profile of emerging-market consumers who demonstrate increasing environmental awareness and engagement with digital technologies.

Table 2: Sample Characteristics

Characteristic	Category	Description	Percentage (%)
Gender	Male	Respondents identifying as male.	45.5%
	Female	Respondents identifying as female.	54.5%
Age Group	16 - 25 years	Young adults.	16.0%
	26 - 35 years	Early to mid-career individuals.	22.8%
	36 - 45 years	Mid-career individuals.	27.9%
	46 - 55 years	Mature adults approaching retirement.	23.7%
	≥ 56 years	Seniors and retirees.	8.7%
Education Level	High School	Basic education.	12.2%
	Some College	Partial college or associate's degree.	24.4%
	Bachelor's Degree	Completed undergraduate studies.	23.1%

Geographic Location	Postgraduate Degree	Advanced degree (Master's, Doctorate).	40.1%
	Johor	Respondents from Johor.	19.9%
	Penang	Respondents from Penang.	17.3%
	Kuala Lumpur	Respondents from Kuala Lumpur.	15.7%
	Sabah	Respondents from Sabah.	15.1%
	Selangor	Respondents from Selangor.	13.5%
	Sarawak	Respondents from Sarawak.	10.6%
	Putrajaya	Respondents from Putrajaya.	7.1%

4. Data analysis

The data analysis began with evaluating the measurement model through Confirmatory Factor Analysis (CFA) to assess the reliability and validity of each construct. Reliability was examined using Cronbach's alpha and Composite Reliability (CR), where values above 0.70 indicate acceptable internal consistency (Nunnally, 1978). Convergent validity was confirmed as all Average Variance Extracted (AVE) values exceeded the recommended threshold of 0.50 (Fornell & Larcker, 1981). Discriminant validity was assessed using the Fornell-Larcker criterion, ensuring that the square root of each construct's AVE was greater than its inter-construct correlations.

Although PLS-SEM provides an SRMR estimate, global goodness-of-fit indices such as SRMR, RMSEA, and CFI are not considered primary evaluation criteria in PLS-SEM because the method is prediction-oriented and does not aim to

reproduce the empirical covariance matrix (Hair et al., 2021). Accordingly, this study followed recommended PLS-SEM evaluation procedures, focusing on construct reliability, validity, path significance, and predictive accuracy.

PLS-SEM was chosen over CB-SEM for several methodological reasons. First, the purpose of the study is primarily prediction-oriented, aiming to explain variance in Consumer Purchase Intention rather than confirm a well-established theoretical model. PLS-SEM is recommended for prediction-focused studies (Hair et al., 2021). Second, the conceptual model includes a moderating effect and multiple reflective constructs, increasing model complexity. PLS-SEM offers higher statistical power for detecting interaction effects and is more suitable for complex structural models. Third, assessment of data distribution revealed deviations from multivariate normality, which poses limitations for CB-SEM but is acceptable for PLS-SEM, which does not require strict normality assumptions. Finally, the study incorporates AI as a moderating variable, an emerging area where exploratory theoretical development is still evolving. PLS-SEM provides greater flexibility for examining such emerging relationships.

The sample size of 312 respondents meets the recommended criteria for PLS-SEM. It exceeds both (i) the “10-times rule” for the maximum number of arrows pointing at any construct, and (ii) the minimum sample requirement generated through statistical power analysis (Hair et al., 2021), ensuring adequate statistical power for detecting hypothesised effects.

Robustness checks were performed through bootstrapping (5,000 resamples), examining the stability of path coefficients and moderation effects. Collinearity diagnostics (VIF values < 3.3) further confirmed the absence of multicollinearity issues. Together, these steps strengthen the reliability of the reported results.

Artificial Intelligence (AI) was hypothesized to moderate the direct effects of Green Innovation and Green Creativity on Consumer Purchase Intentions. The study employed the bootstrapping method recommended by Preacher and Hayes (2008) to test this moderation, which provides a robust non-parametric approach to analyzing the influence of AI. This method allows for a powerful assessment of the interaction effects without the stringent assumptions of normality that other statistical tests require. By focusing on the moderation by AI, the analysis directly examines how varying levels of AI implementation might influence the strength of the relationship between Green Innovation and Green Creativity as an independent variables and Consumer Purchase Intentions.

5. Results

The path coefficient analysis provided strong support for the hypothesized relationships. The findings confirmed that Green Innovation (GI) significantly impacts Consumer Purchase Intentions (PI) ($\beta = 0.413$, $p < 0.001$). This indicates that companies investing in sustainable innovations, such as eco-friendly materials or cleaner production processes, are more likely to influence

consumers' willingness to purchase green products. By adopting environmentally responsible practices, organizations create a competitive advantage, as consumers increasingly prefer brands demonstrating genuine sustainability. These results align with prior studies highlighting that Green Innovation enhances perceived product value and consumer trust (Chen et al., 2021).

Similarly, Green Creativity (GC) had a significant positive effect on Consumer Purchase Intentions ($\beta = 0.313$, $p < 0.001$). Firms employing creative strategies, such as innovative product designs, engaging eco-campaigns, or unique green branding, attract greater consumer interest. This confirms that Green Creativity fosters differentiation in the market, making eco-friendly products more appealing, consistent with previous research (Im et al., 2015).

Beyond these direct effects, the study explored the moderating role of Artificial Intelligence (AI), which refers to how AI changes the strength of the relationships between green initiatives and purchase intentions. The GI $\rightarrow$ PI relationship was significantly moderated by AI ($\beta = -0.186$, $p < 0.001$), suggesting that AI enhances consumers' ability to understand and evaluate innovative green features, for instance through personalized sustainability information or predictive analytics. Likewise, AI significantly strengthened the GC $\rightarrow$ PI relationship ($\beta = 0.309$, $p < 0.001$), showing that AI-powered tools, such as interactive eco-labels, AI-driven storytelling, and dynamic green advertising amplify the effectiveness of creative sustainability initiatives.

Overall, these findings confirm that Green Innovation and Green Creativity are key drivers of consumer purchase behavior, and AI acts as an enabler that strengthens these effects, providing practical insights for businesses aiming to optimize their sustainability strategies.

The measurement model assessment demonstrated satisfactory reliability and validity across all constructs. The graphical output of the measurement model is presented in Figure 2.

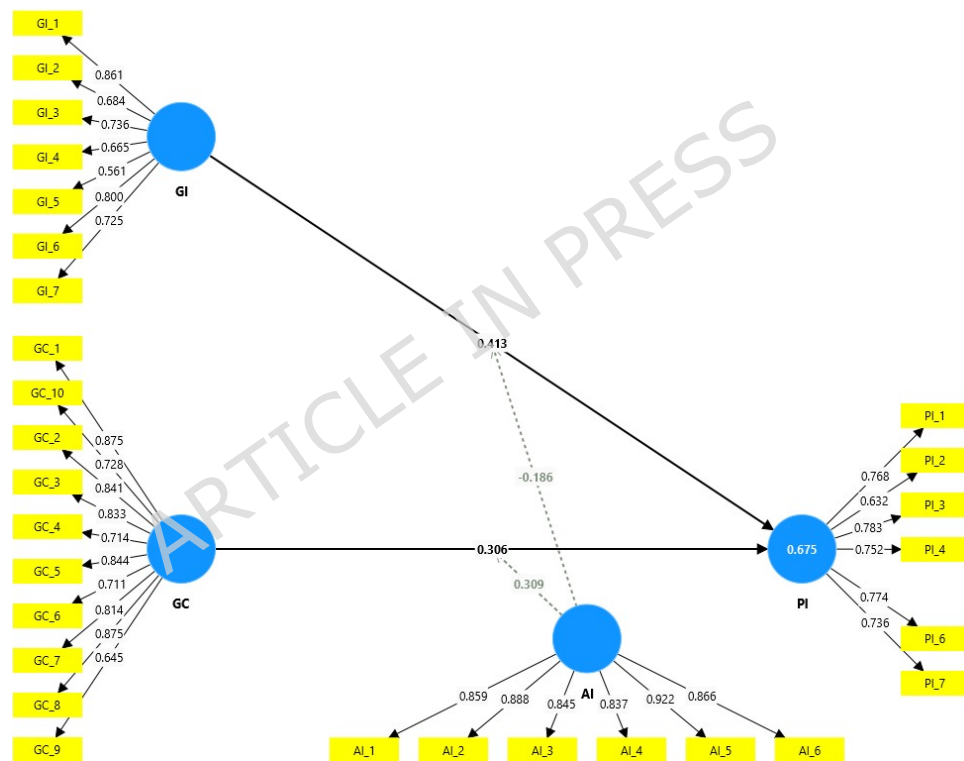


Figure 2: Output of measurement model

As shown in Table 3, all constructs demonstrated satisfactory reliability and convergent validity, with factor loadings, Cronbach's alpha, composite reliability (CR), and AVE values exceeding the recommended thresholds.

Table 3: Measurement model

Construct	Item	Loading	Cronbach's Alpha	CR	AVE
Artificial Intelligence (AI)	AI1 - AI helps to understand events happening in the green practices	0.859	0.938	0.949	0.757
	AI2 - AI provides recommendations on the green products	0.888			
	AI3 - AI provides information that helps my purchasing decision	0.845			
	AI4 - AI can deliver efficient digital assistance or information	0.837			
	AI5 - AI-based tools make it easier for me to find green products.	0.922			
	AI6 - AI enhances my knowledge about the environmental benefits of green products.	0.866			
Green Innovation	GI1 - I like products which use less or non-polluting materials.	0.861	0.852	0.884	0.525
	GI2 - I like products which use environmentally friendly packing.	0.684			
	GI3 - I like products, which take	0.736			

	recycling and disposal at the end of life into account.				
	GI4 - I like new products which use recyclable materials.	0.665			
	GI5 - I like production processes which recycle materials.	0.561			
	GI6 - I like production processes which use cleaner technology to make savings.	0.800			
	GI7 - I like production which redesign its operation processes to improve environmental efficiency.	0.725			
Green Creativity	GC1- I like green products which are developed using innovative and sustainable methods.	0.875	0.933	0.943	0.627
	GC2- I like green products which often showcase unique solutions to environmental challenges.	0.841			
	GC3- Green products in the market often reflect creative approaches to solving environmental issues.	0.833			
	GC4- I find that green products I use are designed	0.714			

	with originality and usefulness in mind.				
	GC5- I like green products which are developed with innovative eco-friendly features.	0.844			
	GC6- I like green products which show evidence of creative thinking in their design.	0.711			
	GC7- Green products available in the market often stand out for their creative environmental features.	0.814			
	GC8- I feel that green products available for purchase incorporate innovative technologies to protect the environment.	0.875			
	GC9- I like eco-friendly products which often feature new and creative solutions to minimize waste and pollution.	0.645			
	GC10- Green products in the market are creatively designed to meet both environmental and consumer needs.	0.728			
Purchase Intention	PI1- I would intend to buy those products have green packaging	0.768	0.836	0.880	0.551

PI2- I would actively seek out those green products have higher perceived value	0.632
PI3- I plan to purchase green products in the future	0.783
PI4- From now on, I plan to purchase green products	0.752
PI6- In the future, I will buy green products with less environmental pollution	0.774
PI7- I would advise others to buy and use green products.	0.736

As presented in Table 4, the discriminant validity assessment confirmed that the square root of each construct's AVE exceeded its inter-construct correlations.

Table 4: Discriminant validity

Construct	Artificial Intelligence (AI)	Green Creativity	Green Innovation	Purchase Intention
Artificial Intelligence (AI)	0.870			
Green Creativity	0.452	0.792		
Green Innovation	0.415	0.845	0.724	

Purchase Intention	0.464	0.715	0.773	0.742
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The findings relating to the direct effects among the study constructs are presented in Table 5.

Table 5: Structural model testing for direct effects

Path	Sample Mean (M)	Standard Deviation (STDEV)	T statistics (O/STDEV)	P-value	Hypothesis Test Result
GI -> PI	0.413	0.072	5.721	<0.001	H1 Confirmed
GC -> PI	0.313	0.084	3.631	<0.001	H2 Confirmed

As presented in Table 6, Artificial Intelligence significantly moderated the relationships between Green Innovation, Green Creativity, and Consumer Purchase Intentions, supporting H3 and H4.

Table 6: Structural model testing of moderator

	Coefficient	Sample Mean (M)	Standard Deviation (STDEV)	T statistics (O/STDEV)	P-value	Hypothesis Test Result
AI x GI -> PI	-0.186	-0.194	0.052	3.563	<0.001	H3 Confirmed
AI x GC -> PI	0.309	0.312	0.038	8.206	<0.001	H4 Confirmed

6. Discussion

The results provide clear empirical support for the proposed model, showing that both Green Innovation and Green Creativity significantly influence Consumer Purchase Intentions.

Green Innovation exhibited a strong positive effect ($\beta = 0.413$, $p < 0.001$), suggesting that visible eco-friendly product features, such as recyclable materials or cleaner production processes, increase consumers' willingness to purchase green products. This finding aligns with prior studies emphasizing that credible and noticeable sustainability innovations enhance consumer trust and perceived product value (Rawat, 2024).

Green Creativity also had a significant positive influence ($\beta = 0.313$, $p < 0.001$). Creatively designed green products including unique eco-packaging, engaging sustainability messages, and distinctive design elements heighten consumer interest and help products stand out in competitive markets. These findings are consistent with previous research highlighting the role of creativity in shaping positive perceptions of environmental value (Im, 2015).

A key contribution of this study lies in the moderating role of AI. In this context, "moderating" means that AI changes the strength of the relationships between green strategies and purchase intentions. AI significantly affected the GI $\rightarrow$ PI path ($\beta = -0.186$, $p < 0.001$), indicating that AI tools help consumers better interpret innovative green features, for instance through personalized sustainability insights or simplified product comparisons. Similarly, AI

strengthened the GC → PI relationship ($\beta = 0.309$, $p < 0.001$), demonstrating that AI enhances the impact of creative green strategies by improving engagement, personalization, and communication of sustainability efforts.

Collectively, these findings highlight that integrating AI into green marketing strategies enhances both functional and experiential aspects of sustainability initiatives, making them more persuasive and impactful. This study contributes to both theory and practice by showing that Tech-driven innovation and creativity, supported by AI, can effectively shape consumer purchase behavior. For businesses, this implies that leveraging AI alongside eco-friendly innovations and creative marketing initiatives can maximize consumer engagement while promoting sustainable consumption.

7. Conclusion

This study demonstrates that Green Innovation (GI) and Green Creativity (GC) significantly influence Consumer Purchase Intentions (PI), highlighting the value of both functional and creative sustainability efforts in shaping consumer behavior. Green Innovation refers to environmentally responsible product features or processes, such as recyclable materials or cleaner production methods, whereas Green Creativity involves unique eco-designs, engaging sustainability campaigns, or innovative branding that differentiates products in the market.

Importantly, the study shows that Artificial Intelligence (AI) serves as a moderator, meaning it changes the strength of the relationship between green

initiatives and purchase intentions. Specifically, AI enhances the impact of Green Innovation ($\beta = -0.186$, $p < 0.001$) and Green Creativity ($\beta = 0.309$, $p < 0.001$) by improving personalization, communication, and consumers' understanding of sustainability benefits. Tools such as predictive analytics, interactive eco-labels, and AI-driven storytelling help companies present their green strategies more effectively, increasing consumer engagement and purchase likelihood.

These findings contribute to the literature by providing empirical evidence that integrating AI into Tech-driven strategies strengthens both functional and creative green initiatives. Practically, businesses can leverage AI to maximize the market potential of eco-friendly products through personalized recommendations, dynamic green advertising, and interactive product information.

Future research could explore industry-specific variations, long-term behavioral effects, and cultural influences on AI-enhanced green marketing. Overall, the study underscores the importance of combining sustainability, creativity, and advanced technology to effectively promote green purchase intentions in modern markets.

Funding Declaration

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Clinical Trial Declaration

This study does not involve any clinical trial.

Clinical trial declaration: Not applicable.

Ethics Declaration

Ethics declaration: Not applicable.

Data Availability Declaration

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Consent to Participate Declaration

Consent to Participate declaration: Not applicable.

Consent to Publish Declaration

Consent to Publish declaration: Not applicable.

Competing Interests Declaration

The authors declare that they have no competing interests.

Authors' contributions

All authors contributed to the study in meaningful and specific ways. Areej Ahmed led the conceptualization of the research, developed the methodology, conducted data collection and formal analysis, and prepared the original draft of the manuscript. Dr. Asmaul Husna bin Haris Fadzilah provided overall

supervision, validated the research design. Prof. Dr. Rukhsar Ahmed contributed through conceptual support, critical review of the manuscript, and provided substantial input during the revision process. Dr. Urooj Ahmed assisted in validation of the research framework, provided technical review, and contributed to the review and editing of the manuscript. All authors have read and approved the final version of the manuscript.

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References

- Bansal, P., & Roth, K. (2000). Why companies go green: A model of ecological responsiveness. *Academy of Management Journal*, 43(4), 717-736.
- Bashynska, I. (2023). AI-Driven Personalization in Advertising: Transforming Consumer Engagement through Sustainability and Circular Economy. *Scientific Journal of Bielsko-Biala School of Finance and Law*, 27(4), 106-112.
- Bocken, N. M., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, 65, 42-56.
- Boons, F. (2009). *Creating ecological value: An evolutionary approach to business strategies and the natural environment*. Edward Elgar Publishing.

Chen, L., Qie, K., Memon, H., & Yesuf, H. M. (2021). The empirical analysis of green innovation for fashion brands, perceived value and green purchase intention—mediating and moderating effects. *Sustainability, 13*(8), 4238.

Chen, Y. S., & Chang, C. H. (2013). The determinants of green product development performance: Green dynamic capabilities, green transformational leadership, and green creativity. *Journal of Business Ethics, 116*(1), 107-119.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39-50.

Im, S., Bhat, S., & Lee, Y. (2015). Consumer perceptions of product creativity, coolness, value and attitude. *Journal of Business Research, 68*(1), 166-172.

Khan, S. J., Dhir, A., Parida, V., & Papa, A. (2021). Past, present, and future of green product innovation. *Business Strategy and the Environment, 30*(8), 4081-4106.

Kiron, D., Unruh, G., Kruschwitz, N., Reeves, M., Rubel, H., & Meyer Zum Felde, A. (2015). Joining forces: Collaboration and leadership for sustainability. *MIT Sloan Management Review, 56*(3), 1-35.

Kline, P. (2015). *A handbook of test construction (psychology revivals): Introduction to psychometric design*. Routledge.

Kumar, V., & Christodouloupoulou, A. (2014). Sustainability and branding: An integrated perspective. *Industrial Marketing Management*, 43(1), 6-15.

Nidumolu, R., Prahalad, C. K., & Rangaswami, M. R. (2009). Why sustainability is now the key driver of innovation. *Harvard Business Review*, 87(9), 56-64.

Nunnally, J. (1978). Psychometric theory. McGraw-Hill.

Ozaki, R. (2011). Adopting sustainable innovation: what makes consumers sign up to green electricity?. *Business strategy and the environment*, 20(1), 1-17.

Porter, M. E., & Heppelmann, J. E. (2015). How smart, connected products are transforming companies. *Harvard Business Review*, 93(10), 96-114.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavior Research Methods*, 40(3), 879-891.

Rawat, G., & Pande, M. (2024). Adoption of green marketing strategies and challenges in sustainable business practices: Insights from Indian companies. *Journal of Corporate Governance, Insurance, and Risk Management*, 11(2), 98-112.

Rogers, E.M. (2014). *Diffusion of Innovations*. Free Press.

Schaltegger, S., & Wagner, M. (2011). Sustainable entrepreneurship and sustainability innovation: Categories and interactions. *Business Strategy and the Environment*, 20(4), 222-237.

Suljic, V. (2025). Strategic Leadership in AI-Driven Digital Transformation: Ethical Governance, Innovation Management, and Sustainable Practices for Global Enterprises and SMEs. *SBS Journal of Applied Business Research*, 13(1), 17-35.

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, 51(1), 40-49.

Wilson, M. (2016). When creative consumers go green: Understanding consumer upcycling. *Journal of Product & Brand Management*, 25(4), 394-399.

Xiong, B., Skitmore, M., & Xia, B. (2015). A critical review of structural equation modeling applications in construction research. *Automation in construction*, 49, 59-70.

Zhang, Z. (2024). Exploring the green edge: the role of market orientation and knowledge management in achieving competitive advantage through creativity. *Humanities and Social Sciences Communications*, 11(1), 1-16.

Zong, Z., & Guan, Y. (2024). AI-driven intelligent data analytics and predictive analysis in Industry 4.0: Transforming knowledge, innovation, and efficiency. *Journal of the Knowledge Economy*, 1-40.