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ADVANCING GREEN INNOVATION TO IMPROVE ENVIRONMENTAL SUSTAINABILITY IN MALAYSIAN HOTELS

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Abstract

This study investigates the influence of various factors on green innovation and its impact on environmental performance in hotels located in Kuala Lumpur, Malaysia. Adopting a quantitative, cross-sectional design, data were collected through structured questionnaires and analysed using AMOS. The analysis incorporated exploratory factor analysis (EFA), confirmatory factor analysis (CFA) and structural equation modeling (SEM). Results reveal that green organisational culture, innovation strategy, energy conservation and environmental regulations significantly affect green innovation, which positively influences environmental performance. These findings contribute to the limited literature on green innovation in the hotel sector and highlight implications for environmental stewardship in hospitality contexts.

Keywords: green innovation, environmental performance, sustainability, malaysia hotel industry

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Introduction

The growing global population and economic activities are straining natural resources and the environment. Balancing development and sustainability is necessary (Hamid et al., 2020). In the technological advancement era, integrating green practices into operations is essential (Hussain & Haley, 2022). Green innovation means creating eco-friendly products and processes that reduce environmental harm and sustain productivity (Dang & Wang, 2022). It includes improving management, systems, and technologies that benefit financial, environmental, and social outcomes (Ahmed et al., 2021). These innovations combine efficiency with ecological responsibility. Businesses face more pressure from regulations, customers, and society to adopt green initiatives. Malaysia is shifting to green practices, especially in tourism, a key economic sector. Still, tourism contributes significantly to global warming, accounting for 5% of total CO_2 emissions (WTTC, 2021). The Malaysian government has initiated ecological construction and regulations. Tourism continues to cause environmental impacts, including waste and ecosystem damage. Many hospitality firms adopt green initiatives for branding and customer satisfaction, however, regulatory enforcement remains weak (Wan Norhidayah et al., 2022). Despite growing global concern, the hotel industry in Malaysia has not fully leveraged green innovation to drive environmental performance. This study aims to bridge research gaps by identifying strategic enablers and empirically evaluating their impact, emphasising that robust green innovation strategies are crucial for genuine sustainability. This study has presented a practical model to explain how hotel green innovation influences environmental performance through four essential green strategies which includes environmental regulations, green innovation strategies, green conservation and green organisational culture, offering empirical evidence from Malaysian hotels to guide the practice of sustainable tourism.

Green hotels aim to be ecologically responsible by minimising energy, water, and material use while

maintaining high-quality service standards (Sahoo et al., 2023). Green techniques in the hotel industry offer benefits such as enhanced brand value, improved guest perception, reduced costs and liabilities, and greater profitability. Kamarudin et al. (2023) note that many hotels have adopted corporate social responsibility (CSR) as an ethical response to reduce environmental impact. The InterContinental Hotels Group is a key example, having launched the world's first environmentally friendly hotel in 2008, featuring solar panels, wind-generated power, rainwater harvesting, and recycled materials (Hamid et al., 2020). This study uses Transaction-Cost Theory, which holds that organisations structure themselves to lower transaction costs. Environmental collaborations and green intellectual capital reduce these costs, spurring innovation (Gu, 2022). Lowering coordination and monitoring expenses helps organisations structure themselves for better environmental efficiency. Transaction-cost theory builds on agency theory, which posits that companies innovate to cut costs and boost performance. This connection clarifies green innovation, which both cuts coordination and governance costs and also improves environmental outcomes (Sahoo et al., 2023). This framework serves as the basis for examining the impact of green innovation on hotel environmental performance in Malaysia. The research model describing the study hypotheses is displayed in *Figure 1.*

Environmental regulations

Empirical studies indicate that environmental regulations drive firms to adopt green technologies. However, evidence remains inconclusive, with some studies suggesting that such regulations do not directly impact company's green behaviour (Sahoo et al., 2023; Patwary et al., 2022). Sahoo et al. (2023) confirmed that company's green development depends on environmental guidelines. Based on the differences between researchers regarding the effect of environmental regulations on corporate green innovation concerns, the first hypothesis is established:

H1: Environmental regulations positively influence green innovation.

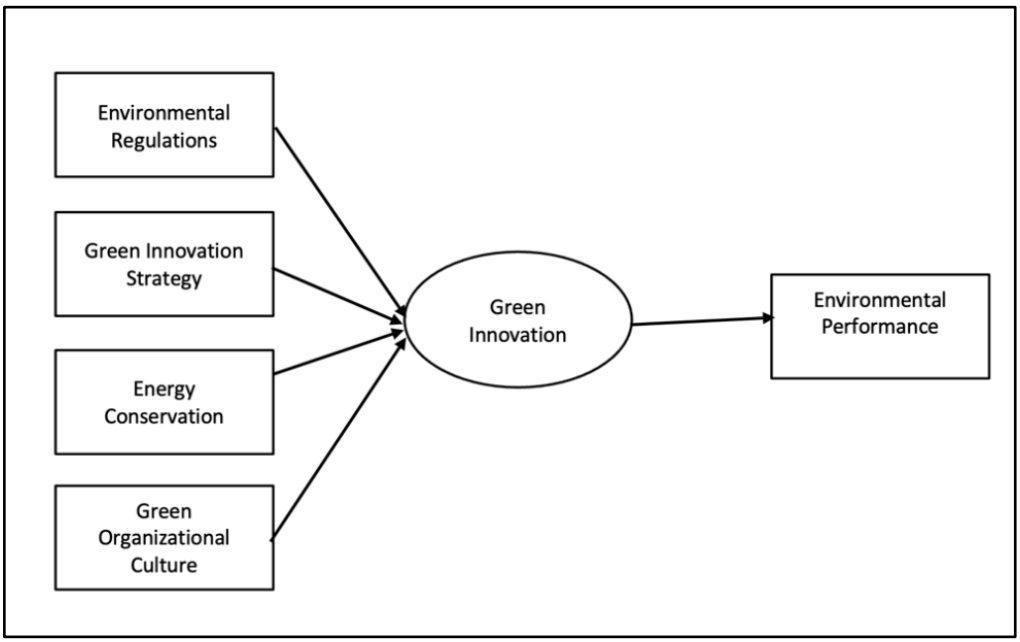


Figure 1. Research model

Green innovation strategy

Innovation strategies emphasising eco-friendly processes, recycling, and waste prevention are essential (Quintana-García et al., 2022). Green innovation strategies effectively align internal resources with sustainability objectives (Aftab et al., 2023). Green innovation strategies are crucial for driving green product innovation by fulfilling the demands of customers willing to pay a higher price for sustainable products and services (Mahasuweerachai and Suttikun, 2022). Environmental systems help companies to bring innovation in products and processes that contribute to green creation (Sahoo et al., 2023). The second hypothesis for this study is as follows:

H2: Green innovation strategy positively influences green innovation.

Green organisational culture

Organisational culture can either facilitate or impede innovation. An environmentally conscious culture fosters green values and promotes employee engagement (Thabet et al., 2023). However, there is a lack of literature that studies the relationship in the service industry. Some studies found that various organisational structures were positively related to innovation. Aftab et al. (2023) and Skordoulis et al. (2022) found that long-term orientation and individualism, organisational culture dimensions, positively impacted innovative behaviours. The following hypothesis is developed:

H3: Green organisational culture positively affects green innovation.

Energy conservation

Energy consumption is closely associated with pollution. Green innovation enhances efficiency, decreases emissions, and supports alignment with national energy priorities (Fonseca et al., 2020). Green innovation is vital to energy efficiency because it can help reduce carbon mitigation costs by enabling clean, renewable energy. Fulzele et al. (2022) studied factors affecting energy efficiency, concluded that energy efficiency is promoted by green innovation and institutional quality. Hence, it can be hypothesised that:

H4: Energy conservation positively relates to green innovation.

Green innovation and performance

Green innovation generates both tangible outcomes, such as profits and cost savings, and intangible outcomes, such as enhanced reputation. Empirical evidence indicates a positive correlation between green innovation and environmental performance (Quintana-García et al., 2022; Asadi et al., 2020). Green innovations also create new competitive regions through "win-win" situations by improving environmental conditions in the hotel industry while reducing costs and waste (Rasidah et al., 2018). The fifth hypothesis is developed:

H5: Green innovation positively affects environmental performance.

Methods

Research design and instrument

The study adopted a quantitative, cross sectional explanatory design to test theoretically derived causal relationships at a single point in time among latent constructs based on established theory. Although longitudinal designs are more suitable for capturing temporal dynamics, they are often restrict by time and resource limitations particularly in hospitality organisation settings.The structured 23-items questionnaire covering six constructs: environmental regulation, green innovation strategy, energy conservation, organisational culture, green innovation, and environmental performance. Items were adapted from prior established studies and measured on a 5-point Likert scale.The adaptation process followed a structured approach through literature-based review, panel experts (5 academicians and 2 practitioners) and pilot study with 35 hotel managers. No items required translation due to target respondents' English proficiency. The internal consistency of the pilot Cronbach's alpha values exceeding the 0.7 threshold across constructs with item total correlations were reviewed to ensure discriminant clarity, semantic adjustments and contextual appropriateness. Hair et al. (2021) noted that Structural Equation Modeling (SEM) remains widely accepted which valid testing for causal hypotheses in cross-sectional study grounded in robust theory and measurement validity. The current model built on Transaction Cost Theory which describes the directional relationship between variables justify an explanatory SEM approach.The issues related to endogeneity or simultaneity maybe a concern but are minimised by having strong theoretical justification, validated measurement instruments and robust model fit designate excellent convergence and discriminant validity.

Sampling and data collection

Targeting managers from optimal location of 4 to 5-star hotels in Kuala Lumpur, the study employed convenience sampling due to practical constraints such as accessibility and time limitations. Kuala Lumpur was chosen due to Malaysia's leading tourism and hospitality hub, hosting the highest number

of 4-5 star hotels density while receiving 30% of inbound tourists annually (Tourism Malaysia, 2023). The convenience sampling was required by access restrictions and respondent validity. The representation was balanced by ensuring diversity across hotel size, types of ownership and geographical clusters to minimise sampling bias. A Wave analysis was conducted by comparing early and late respondents with significant difference observed ($p > 0.05$), indicating low risk of nonresponse bias. Out of 950 distributed questionnaires, 486 were returned, and after filtering, only 473 valid responses were analysed (44% response rate). This sample size is acceptable for measuring the causal model, as a sample of 200 or more is adequate for using Maximum Likelihood Estimation. Respondents' profiles were cross-tabulated with national hotel industry benchmarks, signifying acceptable alignment with the target population. Table 1 presents the demographic characteristics of the respondents.

Data analysis

Data analysis utilised SPSS and AMOS software. The main analysis includes Exploratory Factor Analysis (EFA) ensured item reliability, Confirmatory Factor Analysis (CFA) to validate measurement models and Structural Equation Modelling (SEM) in testing hypotheses. Prior to SEM, several tests were conducted. These includes normality via skewness and kurtosis with all items within acceptable ±2.0 range, multicollinearity checked with VIF values below 2.5, Maximum Likehood Method (MLE) with remains robust for minor violation in large samples (n=473), the missing data using listwise deletion under 5% missingness. Lastly, bias corrected 5000 samples bootstrap used to validate indirect effect to improve parameter confidence in mediation analysis. Harman's one-factor test checked for common method bias, which was not significant (<50%). In line with Hair et al. (2021), recommendations, measurement, and structural models were tested simultaneously to estimate the hypothesised construct relationships without the confounding effects of estimation error. Demographics (age, gender, education, and work experience) were considered control variables, and a one-way ANOVA was performed to test the impact of control variables. The results of one-way ANOVA indicate an insignificant impact of demographics on our outcome variable. While initial ANOVA tests showed no significant effects, the control variables were retained in the model framework for theoretical completeness and a further robustness check recommended by Becker et al. (2025). Hence, a multi-group analysis using SEM was conducted to test model consistency across gender and educational level groups. Results suggested consistency in model structure and path relationships across subgroups.

Result and Discussion

The results section presents a comprehensive analysis using various statistical tests and validation procedures to assess the impact of green innovation drivers on environmental performance in Malaysian hotels. The detail of demographic profiles is given in Table 1. The demographic profile of the 473 respondents, all hotel managers from Kuala Lumpur, revealed that 54% were male and 46% female. The majority fell within the age group of 26–33 years (48%), followed by 18–25 years (33.2%). Most participants had 5–7 years of industry experience (56.4%), and 57% held a graduate-level qualification, while 26% held postgraduate degrees and 17% were undergraduates.

Harman's one factor test

Harman's one-factor test was performed to identify common factor bias. The results (Table 1) showed a cumulative variance of 31.92%, which is below the 50% threshold. Thus, common method bias is not a concern in this study (Min et al., 2016).

Exploratory factor analysis

An Exploratory Factor Analysis (EFA) was conducted to establish construct validity and reliability (refer to Table 2). EFA showed strong item loadings (0.56–0.95). Cronbach's alpha for all constructs exceeded 0.70, ensuring reliability and demonstrating high internal consistency. Energy conservation had an AVE of 0.83 and alpha of 0.933. Green innovation strategy showed an AVE of 0.51 and alpha of 0.807. Environmental regulation showed the strongest internal consistency (alpha = 0.954, AVE = 0.84). Green organisational culture also showed good reliability (alpha = 0.812, AVE = 0.52). Green innovation and environmental performance were measured reliably with AVEs of 0.54 and 0.53, respectively. Overall, CFA confirmed model fitness ($\chi^2/df = 1.898$, RMSEA = 0.044, CFI = 0.970, TLI

= 0.964), meeting all the cut-off criteria.

Table 1. Respondents' demographic profiles

Demographic Characteristics	Frequency	(%)
Gender		
Male	255	54
Female	218	46
Age		
18–25 years	157	33.2
26–33 years	227	48
34–40 years	55	11.6
41–50 years	26	5.5
Above 50 years	8	1.7
Work experience		
Less than one year	68	14.4
2–4 years	119	25.2
5–7 years	267	56.4
Above seven years	19	4.00
Education level		
Undergraduate	80	17.00
Graduate	269	57.00
Postgraduate	124	26.00
Note: *N = 473*		

Table 2. Exploratory factor analysis

Variables	Items	Loadings	a	AVE
Energy Conservation	(1) Providing public transportation for guests	0.899	0.933	0.83
	(2) The hotel industry purchases equipment with energy-saving/water-saving marks or green-label items	0.931		
	(3) The hotel's transportation fleet uses alternatively fueled or hybrid vehicles	0.893		
Green Innovation Strategy	(1) Destruction or containment of waste	0.742	0.807	0.51
	(2) Capital and technology investment	0.721		
	(3) ISO 14000	0.735		
	(4) Changes in pollution prevention	0.660		
Environmental Regulation	(1) Regional resource-saving and conservation regulations	0.911	0.954	0.84
	(2) National resource-saving and conservation regulations	0.921		
	(3) Regional environmental regulations (such as waste emissions and cleaner production)	0.945		
	(4) Developed countries' environmental regulations	0.885		
Green Organizational Culture	(1) Our hotel industry makes a concerted effort to make every employee understand the importance of environmental preservation	0.694	0.812	0.52
	(2) Environmental preservation is a high-priority activity in our hotel industry	0.763		
	(3) Preserving the environment is a central corporate value in our hotel industry	0.742		
	(4) Our hotel industry develops products and processes that minimise environmental impact	0.686		
Green Innovation	(1) Our hotel industry uses less or non-polluting/toxic materials	0.748	0.823	0.54
	(2) Our hotel industry improves environmentally friendly packaging for existing and new products	0.755		
	(3) Our hotel industry recovers from hotel's end-of-life products and recycling	0.763		
	(4) Our hotel industry uses eco-labelling	0.666		
Environmental Performance	(1) Improved energy consumption	0.724	0.809	0.53
	(2) Improved capacity utilisation	0.782		

Variables	Items	Loadings	a	AVE
	(3) Increased waste treatment initiatives	0.806		
	(4) Increase employee awareness	0.563		

Discriminant and divergent validity

Further validity testing was performed to assess discriminant and convergent validity using Average Variance Extracted (AVE) and Composite Reliability (CR). As per guidelines by Bagozzi et al. (1991), all constructs showed CR values above 0.60 and AVE values above 0.50, satisfying the criteria for convergent validity. Additionally, Fornell and Lacker's (1981) criterion for discriminant validity was confirmed, as the square root of AVE values exceeded inter-construct correlations across all variables. All correlation values were statistically significant ($p < 0.001$), reinforcing the consistency of hypothesised relationships (refer to Table 3).

Table 3. Discriminant and divergent validity

Variables	CR	AVE	MSV	1	2	3	4	5	6
1. EC	0.93	0.83	0.29	0.908					
2. GIS	0.81	0.51	0.21	0.458***	0.715				
3. ER	0.95	0.84	0.15	0.391***	0.381***	0.916			
4. GOC	0.81	0.52	0.29	0.534***	0.370***	0.263***	0.722		
5. GI	0.82	0.54	0.26	0.467***	0.423***	0.332***	0.513***	0.734	
6. EP	0.81	0.53	0.22	0.349***	0.281***	0.233***	0.377***	0.465***	0.725

Notes: N = 473, ***P < 0.001; EC: energy conservation; GIS: green innovation strategies; ER: environmental regulations; GOC: green organizational culture; GI: green innovation; EP: environmental performance

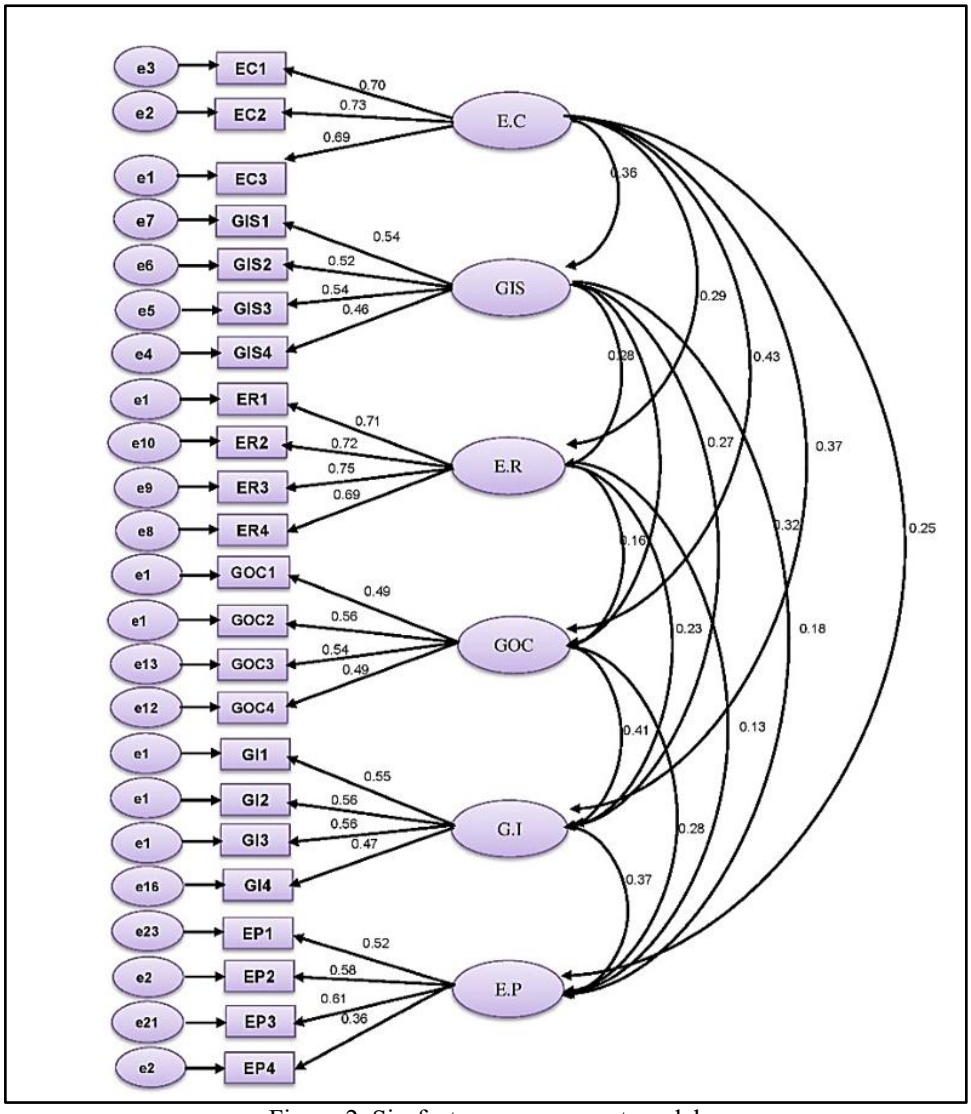


Figure 2. Six-factor measurement model

Confirmatory factor analysis

Confirmatory Factor Analysis (CFA) was conducted to assess the measurement model's fitness, as shown in Table 4. The six-factor model, as in *Figure 2,* met all standard fit indices thresholds recommended by McNeish (2022). The values included $\chi^2/df = 1.898$, RMSEA = 0.044, IFI = 0.970, TLI = 0.964, and CFI = 0.970, indicating a strong model fit. No items were removed during CFA as all standardised loadings surpassing 0.5. The model retained its original six-factor structure based on theoretical congruence. This validated the measurement model's adequacy for hypothesis testing.

Table 4. Confirmatory factor analysis

Measurement Model Fit	CMIN/DF	RMSEA	IFI	TLI	CFI
Measurement Model	1.898	0.044	0.970	0.964	0.970
The Cut-Off for Good Fit*	<3.00	<0.08	2'0.95	2'0.95	2'0.95

Note: *Cut-off criteria for fit indexes by McNeish, (2022)

Hypotheses testing

Structural Equation Modeling (SEM) was employed using AMOS-24 to test the hypothesised relationships among constructs. The SEM results supported all five hypotheses (H1–H5) as in Table 5 and Figure *3*. Environmental regulations had a significant, positive effect on green innovation ($\beta = 0.283$, $p < 0.001$), confirming H1. This aligns with a prior study suggesting that environmental regulations serve as a critical external pressure for green innovation in organisations (Hao et al., 2022).

H2, which proposed a positive impact of green innovation strategy on green innovation, was supported with a path coefficient of $\beta = 0.258$ ($p < 0.001$). This finding is consistent with Asadi et al. (2020), reinforcing the strategic role of innovation in environmental performance outcomes.H3, which predicts the influence of energy conservation on green innovation, was the strongest among all relationships, with a coefficient of $\beta = 0.371$ ($p < 0.001$). This indicates that energy efficiency practices strongly drive green innovation initiatives, supported by Sun et al. (2019) that energy conservation leads to improved resource utilisation and lower emissions. Similarly, H4 was supported with green organisational culture significantly impacting green innovation ($\beta = 0.364$, $p < 0.001$). This supports the findings of Dang and Wang (2022), who emphasised the vital role of environmental values and culture in shaping innovation behaviours within organisations. H5 tested the direct effect of green innovation on environmental performance. The results confirmed a significant and positive relationship ($\beta = 0.256$, $p < 0.001$), validating the hypothesis that green innovation enhances environmental performance in the hotel sector. While earlier studies offered mixed conclusions, this study supports a positive perspective, which aligns with Asadi et al. (2020), who observed significant improvements in firms' environmental, social, and organisational performance through green innovation.

Table 5. Test of hypotheses

Hypotheses and relationship	Estimate	SE	*P*	Result
H1: Environmental Regulations → Green Innovation	0.283	0.049	***	Accepted
H2: Green Innovation Strategy → Green Innovation	0.258	0.041	***	Accepted
H3: Energy Conservation → Green Innovation	0.371	0.050	***	Accepted
H4: Green Organisational Culture → Green Innovation	0.364	0.051	***	Accepted
H5: Green Innovation → Environmental Performance	0.256	0.040	***	Accepted

Note: ***$P < 0.001$

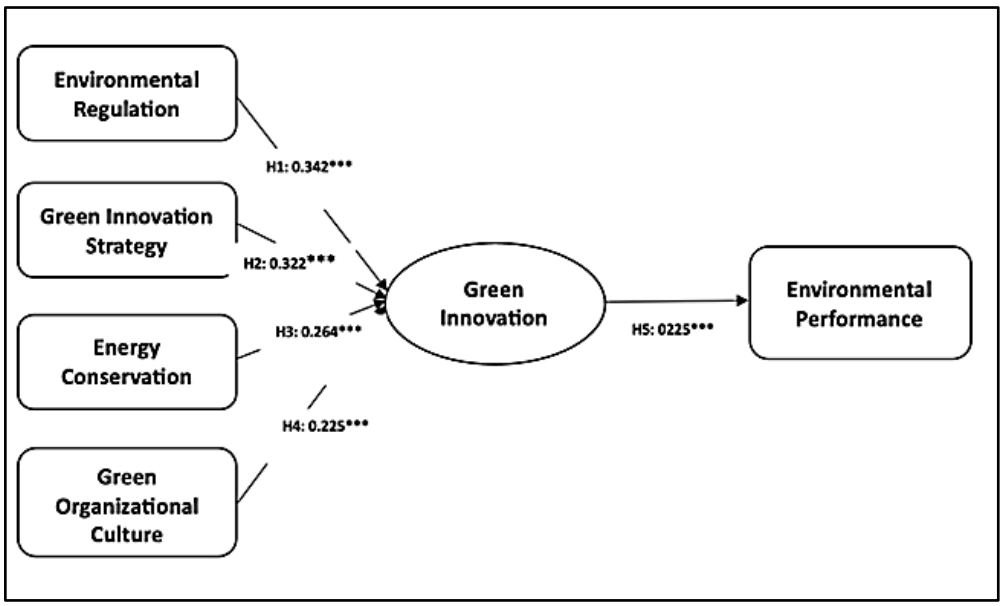


Figure 3. Results of hypothesis testing

This study demonstrates how green strategies spur green innovation and strengthens a firm's environmental performance in the context of the hotel industry in Malaysia. When hotels prioritise regulatory compliance, improve energy efficiency, and foster cultural integration, they more easily and effectively achieve impactful sustainable practices. This study explores organisational factors, such as green organisational culture, energy-saving, green innovation strategy, and environmental regulations, which significantly contribute to green innovation. Moreover, the study aims to explore the impact of green innovation on firms' environmental performance, especially in the context of the hotel industry of Malaysia. To attain the study objectives, various hypotheses were developed and tested. The discussion findings show that while innovation is long associated with improved firm performance and

competitiveness, there is limited research on the direct relationship between green innovation and environmental performance, especially in the Malaysian hotel industry. This study addresses that gap by confirming that four organisational factors, particularly environmental regulation, green innovation strategy, energy conservation, and green organisational culture, significantly and positively influence green innovation, which in turn boosts environmental performance. Notably, environmental regulations create external pressures that motivate green practices ($b = 0.283$, $p < 0.001$), and strategic alignment with green innovation encourages adoption ($b = 0.258$, $p < 0.001$). In addition, energy conservation practices make a strong contribution ($b = 0.371$, $p < 0.001$), confirming that efficient energy use supports sustainable innovation. Green organisational culture stands out as a strong internal enabler ($b = 0.364$, $p < 0.001$), consistent with previous literature on its importance for environmental sustainability. Ultimately, the study finds that green innovation directly improves hotel environmental performance ($b = 0.256$, $p < 0.001$), in line with earlier research on its positive effects on organisational sustainability. These results highlight the need for hotels to combine internal strategies and external compliance to achieve sustainable performance improvements.

Conclusion

The study concludes that green organisational culture, innovation strategies, energy conservation, and environmental regulations significantly drive the adoption of green innovation, which in turn enhances hotel environmental performance. It highlights the urgent need for Malaysian hotels to adopt sustainable practices, ensuring regulatory compliance for long-term ecological balance and business competitiveness. Green innovation enables hotels to excel, boosting performance and bold competitive advantage. To achieve this, hotels must embed environmental values within their organisational culture. They should develop comprehensive green innovation strategies aligned with business objectives and strengthen regulatory frameworks through effective enforcement and monitoring. The active promotion and adoption of advanced, energy-efficient technologies are vital for reducing carbon emissions and operational costs. Theoretically, this study provides fresh insight into green innovation in hospitality, especially across Southeast Asia. Meanwhile, practically, it equips hotel managers with evidence-backed strategies such as implementing energy-efficient technologies and reducing waste. It encourages policymakers to strengthen environmental regulations and accelerate the adoption of sustainable business models. Future research should extend beyond Kuala Lumpur to include other regions and sectors. This broader approach allows for comparative analyses and a deeper understanding of green innovation adoption across the tourism and hospitality industries. Furthermore, the research has highlighted the four major strategies that can lead to green innovation, but still, many green initiatives or strategies are ignored. The researchers aiming to explore the factors behind green innovation can extend the model by adding more strategies leading to green innovation. This paper also delivers novel empirical evidence on green innovation in the hospitality sector, emphasising the Malaysian context. It bridges a critical literature gap by establishing a validated and context-specific model that uniquely links green strategies to environmental performance. The findings offer actionable insights for academics, policymakers, and practitioners aiming to foster sustainable tourism development.

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Author Contribution

Rasidah Hamid – Conceptualisation, methodology, data curation, original draft write-ups; Mohd Hanafi Azman Ong – formal analysis; Siti Zuraini Ramley Alan – review and editing

Conflict of Interest

Authors declare no conflict of interest.

Declaration on the Use of Generative AI

Generative Artificial Intelligence (AI) tools used mainly for grammar, language enhancement and manuscript formatting guide only. The authors are fully responsible for the originality, ethical compliance and intellectual contribution of the manuscript.

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