

Do Business Environmental Factors Moderate the Relationship between Sustainable Technology and Performance? Insights from 4 and 5 Star-Rated Hotels in Kenya

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Abstract

Understanding the external environmental conditions under which sustainable technology (ST) contributes to organisational performance remains a key challenge in the hospitality industry. Although prior research has examined business environmental factors (BEF) as drivers of technology adoption, there is limited evidence about whether the factors affect the relationship between ST and hotel performance, particularly in developing-country hospitality contexts. Anchored in the Technology–Organisation–Environment (TOE) framework, this study evaluates whether BEF moderate the relationship between ST and performance of 4 and 5 star-rated hotels in Kenya. A census approach was used to collect data through a structured online questionnaire from 151 hotel general managers. Hayes' PROCESS Model 1 was employed to test the moderating effect. The results indicated that ST positively and significantly predicts performance ($B=0.389$, $p<0.001$) with the model explaining 46% of the variance, while BEF were not a significant direct predictor of hotel performance ($B=0.0745$, $t=1.6397$, $p=0.1032$). Importantly, BEF had a negative but non-significant moderating effect on the ST–performance relationship ($B=-0.039$, $t=-0.741$, $\Delta R^2=0.002$, $p=0.459$). The findings demonstrate that BEF do not shape the strength and direction of ST's effects on performance outcomes. The study enriches the TOE framework by demonstrating that its environmental context factors do not operate as moderators during the post-adoption phase of ST implementation. The findings inform managerial decisions and policy initiatives aimed at facilitating the complex technology and performance interplay. The study recommends that hotels place less emphasis on BEFs as determinants of performance and more as antecedents for identifying relevant ST applications. Policymakers should note that

while BEF may accelerate ST integration, they do not amplify or constrain performance returns.

Keywords: Business Environmental Factors, Sustainable Technology, Hotel Performance, 4 and 5 Star-Rated Hotels, Kenya

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Funding: The author received no financial support for the research, authorship and/or publication of this article

Data Availability Statement: The authors confirm that the data supporting the findings of this study are available within the article [and/or] its supplementary materials or upon reasonable request.

Competing interests: The authors declare no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Introduction

Hospitality establishments are increasingly operating within a business environment characterised by strict regulatory requirements, competition intensity, government interventions and policies, and evolving customer expectations (Tajeddini et al., 2020). These external conditions are particularly relevant because they shape high-rated hotels' decisions about whether and how to integrate sustainable technologies (STs) (Lucas et al., 2024). While STs are increasingly incorporated into hotel operations to support resource efficiency, service delivery, and sustainability objectives, the performance outcomes associated with such technologies may differ (Li & Hao, 2026). This possibility draws attention to the hotel business environment within which STs are implemented and utilised.

Hotel performance is a multidimensional construct that reflects the extent to which a hotel effectively achieves its aims and objectives (Sampaio et al., 2025). In this study, its conceptualisation was guided by the Balanced Scorecard (BSC) framework as

explained by Kaplan and Norton (1992). The financial perspective focuses on return on investment (ROI), revenue generation, operating expenses, and profitability metrics. The customer perspective considers room occupancy, customer retention, online ratings, complaints, and market share. The internal business process perspective examines service quality, productivity, process cycle time, safety, and operational efficiency. Finally, the learning and growth perspective captures the hotel's capacity for continuous improvement through product and service development, employee training and empowerment, and effective change management (Kaplan & Norton, 1992).

Sustainable technology refers to eco-responsible innovations that have the potential to enhance business performance (Akbari et al., 2020). In the hotel sector, STs encompass electronic key cards, occupancy sensors, HVAC systems, smart lighting, video conferencing, solar energy technologies, and eco-rated appliances designed to improve energy efficiency (Maitra, 2024).

Water conservation is supported through smart taps and showers, leak detection systems, smart meters, outdoor water controls, and greywater recycling systems (Songur et al., 2023). Likewise, waste management is advanced through digital menus, reservation systems, menu engineering and inventory control software, food digesters, composters, smart bins, and cloud-based technologies (Saura et al., 2022). In Kenya's 4 and 5 star-rated hotels, ST adoption is evident but uneven (Githenduka & Fwaya, 2024). Whereas many properties rely on conventional technologies, more advanced smart solutions such as occupancy sensors and intelligent water systems remain only moderately common.

Business environmental factors (BEF) encompass the external conditions shaping an organisation, including regulatory requirements, competitive pressures, government support, and guest expectations (Ahmad et al., 2023). Within the hospitality sector, these conditions shape the context in which hotels respond to ST developments and operational demands (Lucas et al., 2024). For instance, regulatory requirements may create expectations for compliance, and competitive pressures may encourage organisations to embrace technologies that enhance their market position (Zhang et al., 2020). Additionally, changing guest preferences may increase demand for technologically enabled and sustainable services, while government incentives and support (Etuonu, 2025) also form part of the external context within which hotels apply STs to achieve performance objectives.

Hotels in Kenya operate in a dynamic business environment shaped by regulatory requirements, competition intensity, government policies, and evolving customer expectations (Aroko et al., 2025). These conditions are especially

relevant for 4 and 5 star-rated hotels, where STs are increasingly being used for sustainability and operational efficiency. In Kenya, this issue is amplified by fluctuating utility costs, regulatory bodies' environmental expectations, reliance on eco-conscious international tourists, and broader sustainability policy frameworks.

Despite the aforementioned relevance, the role of BEF in understanding the performance implications remains insufficiently established (Yoopetch & Chareanporn, 2024). Most hospitality research exploring BEF's role in the ST and performance nexus is largely limited to direct effects (Li et al., 2022). Indeed, much of the existing empirical work has conceptualised external business conditions as antecedents or explanatory factors rather than examining whether they alter the relationship between technology and performance (Chen et al., 2023; Pizam et al., 2022; Sun & Nasrullah, 2024; Vu et al., 2023). This leaves an important question unresolved: do the external business environmental factors condition the extent to which ST is associated with hotel performance?

Further, research evidence generally suggests that ST is associated with improvements in both eco and business performance (Caprian et al., 2023). However, this does not necessarily imply that similar outcomes will be observed across all operating environments. Hotels using comparable STs may experience different outcomes, raising questions about the extent to which the external business environment is relevant to this relationship (Kotuwage et al., 2020; Li & Hao, 2026).

Moreover, literature also provides an inconsistent picture of the role of BEF in hotel performance (Suder, 2025). While some studies identify regulatory, competitive, and customer-

related conditions as important contextual considerations, others report weaker or context-dependent relationships (Giang, 2022; Sharma & Singh, 2025). Such differences reflect variations in national regulatory circles, competitive structures, customer expectations, legal policies, and levels of technological development.

This concern is particularly pertinent in developing hospitality economies, where hotels operate within institutional, regulatory, legal, and market conditions that may differ substantially from those in developed economies (Ezzaouia & Bulchand-Gidumal, 2020). Despite this context, scholarly evidence remains limited regarding whether and how BEF are associated with sustainable technology and hotel performance. Against this backdrop, this study examined the moderating effect of business environmental factors on the relationship between sustainable technology and hotel performance among 4 and 5 star-rated hotels in Kenya.

Literature Review

Hospitality researchers recognise the importance of the external factors within which hotels' business decisions are made (Etuonu, 2025; Kariuki et al., 2023; Kiplagat et al., 2024). The following selected studies highlight how BEF have been conceptualised, operationalised, and examined within the hotel industry.

Firstly, studies have investigated the direct effect of the external factors on sustainability and business performance. Sun and Nasrullah (2024) found that customer and competitive pressures significantly foster green product and process innovations, enhance sustainable firm performance, and encourage green corporate initiatives in the Chinese hospitality industry. Further, green corporate social responsibility was found

to be a critical mediator in enhancing firm performance under the influence of these pressures. Likewise, Chen et al. (2023) findings revealed that competitive pressure and regulatory support significantly influence the performance of AI adoption in China's hospitality industry. Yoopetch and Chareanporn (2024) investigation indicated that environmental factors had no significant effect on financial and non-financial performance in hospitality firms.

In a different perspective, Lucas et al. (2024) investigated the role of sustainability practices in enhancing competitive advantage among hotels in Africa and Asia. Findings suggested that environmental regulation drives sustainability in the hospitality sector. Specifically, the implementation of eco-innovative technologies and compliance with environmental standards collectively reinforce performance and competitive positioning.

Most studies, however, examine the business environmental factors that affect the initial adoption of technology. For example, Pateli et al. (2020) explored the determinant factors that affect a hospitality firm's decision to adopt social media among hospitality firms operating in Greece. Results showed that environmental factors were considered less important in terms of their predictive power. Similarly, Nikopoulou et al. (2023) also conducted a study to investigate the factors that affect hotels' decision to adopt digital technologies in Greece with a theoretical grounding in the Technology–Organisation–Environment (TOE) research framework. The results indicated that the intention to adopt digital technology was positively and significantly influenced by, among other factors, government regulations.

The results of Pizam et al. (2022) study indicated that hotels in North and South America, Europe, Asia, and the

Middle East intention to adopt robotic technologies was positively influenced by competitive pressure. The findings further demonstrated that the impacts of competitive advantage on intention to adopt were moderated by innovativeness. Ezzaouia and Bulchand-Gidumal (2020) investigated the factors influencing the adoption of information and communication technology (ICT) in the hotel industry in Morocco. The research model incorporated four constructs, namely organisational characteristics, individual characteristics, perceived benefits, and external factors. The results revealed that external factors (competitive pressure, customer pressure, supplier pressure, and government support) had the strongest effect on the adoption of IT.

Vu et al. (2023) study aimed at unravelling the factors that impact the intention of adopting social media in 2–3-star hotels in Hanoi, Vietnam. Quantitative findings affirmed that industry competition and guest expectations positively influence adoption intentions. Finally, Li et al. (2022) analysed 119 articles on the drivers and effects of green innovation in top international journals from 2006 to 2021. They explored the consistencies and contradictions of research conclusions and explored the possible research opportunities. The findings showed that the drivers of green innovation include environmental factors.

The practice of green innovation has an internal impact on both financial performance and non-financial performance (environmental and green performance). Among the major moderating factors of the drivers and effects of green innovation are external factors such as market and social factors. Notably, the few studies that researched on moderation leave out the ST aspect and focus on non-hospitality

establishments. For example, Suder (2025) investigation demonstrated a moderating role of the external environment in the relationship between dimensions of entrepreneurial orientation and hotel performance. Kiplagat et al. (2024) findings showed that the external environment significantly moderates the relationship between transformational leadership and organizational performance of Commercial State Corporations in Kenya. Additionally, Kariuki et al. (2023) study revealed that environmental turbulence had a significant moderating effect on the relationship between core competences and firm performance of star-rated hotels in Nairobi City County, Kenya. Wang (2019) also found that the relationship between radical innovation and firm performance is moderated by environmental factors, while the relationship between incremental innovation and firm performance is not moderated by environmental factors. Furthermore, Jiang et al. (2022) findings indicated that green practices improve customer evaluations of the service experience in the Chinese hotel industry. This positive impact is, however, weaker in external environments characterized by high internet penetration and market complexity, but is stronger for hotels with innovative services and for business hotels. Equally, Fu et al. (2021) results indicate a significant association between innovation and SME performance, and the external environment has a moderating impact on innovation and performance of SME operating in Pakistan. Owenga et al. (2024) results also demonstrate that government policies and regulations significantly strengthened the link between diversification strategies and hotel performance in Kenya's Coast region.

The review suggests that despite growing scholarly interest in BEF, several

areas remain insufficiently explored. First, existing research has largely positioned BEF as explanatory, predictor, or antecedent variables, with considerably less attention to their potential moderating role in the relationship between ST and hotel performance. Subsequently, the extent to which external conditions possibly alter this relationship remains unclear. Second, most studies have focused on the direct relationship between BEF and performance outcomes in hospitality, while studies examining moderating effects have largely been limited to non-hospitality sectors such as textiles and manufacturing. Third, existing literature presents divergent evidence on the relationship, indicating that their role may vary across settings and analytical approaches. Fourth, existing studies mainly examine BEF through general information, digital and smart technologies, with limited focus on sustainable technologies. Lastly, evidence from developing hospitality markets like Kenya remains limited, particularly regarding the external business conditions under which ST use translates into performance outcomes. In a nutshell, BEF as a moderating variable remains underdeveloped in hospitality research because existing studies rarely explain how external conditions may alter the effect of ST on performance. In theory, factors such as competition, regulations, customer expectations, and government support may strengthen or weaken this relationship by shaping the conditions under which ST is implemented.

As such, the following null hypothesis was proposed;

H_{01} *Business environmental factors do not have a significant moderating effect on the relationship between sustainable technology and performance in 4 and 5 star-rated hotels in Kenya.*

Theoretical Review

Technology-Organisation-Environment framework

The moderator variable choice was anchored in Tornatzky and Fleischer's TOE framework. The framework's environmental context pertains to the external business environment in which an organisation operates. (Tornatzky & Fleischer, 1990). The environmental factors represent the external pressures that influence how companies pursue technological innovation (Zhang et al., 2020). They include the structure of the industry, guests' preferences and tastes, competitive pressures, government support and incentives, legal framework and policies, and regulatory regulations and requirements (Ahmad et al., 2023). As noted by Baker (2012), Nguyen et al. (2022), Yang et al. (2026), and Zhong & Moon (2023), these factors not only influence technology adoption but also shape the implementation and utilisation of technology.

Competitive pressure is defined as the intensity of rivalry exerted by industry competitors (Ali-Abbasi et al., 2022). When firms perceive an increase in competition in an industry, they invest in technology as a response. If competitors deploy technology, then firms have to make a similar change and embrace the same to reduce costs or gain competitive advantages. When competition compels firms to enhance performance, it is strategically necessary to embrace technology to compete in the market, as these innovations directly drive the competition (Badghish & Soomro, 2024). Government incentives relate to assistance or facilitating conditions provided to an organisation to transform or implement technology diffusion (Badghish & Soomro, 2024). Governmental financial and non-financial support increases a firm's probability of

performing well through technology application (Lucas et al., 2024). For instance, green technology tax incentives, training, funding for innovation, and subsidies for investing in ST (Vu et al., 2023) enhance performance by reducing upfront costs. Indeed, hotels increasingly need additional resources and government support due to resource constraints.

Customer tastes and preferences refer to customers' expectations and behaviours that influence firms' service offerings. Changing guest preferences determine how hotels implement ST (Adeel et al., 2024). As customers increasingly expect better services, hotels face greater pressure to use ST to enhance service quality, sustainability, and competitiveness (Ray et al., 2023). Moreover, customers' access to information and alternative accommodation providers strengthens their influence on hotel technology uptake. As such, evolving customer preferences and power potentially make hotels use ST to remain responsive to market expectations and sustain performance (Memarzadeh & Anand, 2020).

Legal policies and regulatory frameworks have an impact on a firm's business and eco performance (Etuonu, 2025). The legal framework reflects laws, guidelines, and specifications that pertain to the operations that a firm must follow. Hotels are subject to policies that dictate their utilisation of ST. Certainly, organisational non-compliance with environmental regulations may produce additional transaction costs and potential legal penalties affecting financial performance (Etuonu, 2025). In summary, intense competition, favourable regulation, and supportive market conditions may strengthen the value created by sustainable technology, whereas weak demand, poor policy

support, or unstable regulatory environments may limit its performance payoffs.

The TOE framework was considered appropriate for this study for several reasons. First, it is particularly suited to examining technology application at the organisational level, in contrast to behavioural models that primarily explain individual adoption decisions (Li, 2020). Secondly, the TOE framework provides a more encompassing approach to innovation implementation. It not only assesses the technology itself but also recognises that external environmental factors are crucial in shaping technology returns (Badghish & Soomro, 2024). Third, its emphasis on organisational-level conditions aligns with the study's focus on firm-level technology use rather than individual employee behaviours (Li, 2020). Markedly, due to the TOE framework's insufficiency in explaining conditions that determine the value created from technology use and performance outcomes, the study complemented its use with the Resource-Based View (RBV) and Contingency Theory.

Resource-Based View (RBV)

It offers a useful explanation of how technology can serve as a strategic resource for improving hotel performance (Mehmood et al., 2023). From the RBV perspective, the value of sustainable technology (ST) comes from its dual role in supporting both environmental sustainability and better business outcomes. ST can help hotels use energy, water, and other resources more efficiently, reduce environmental impacts, and simultaneously improve service delivery, operational efficiency, and overall performance (Adeel et al., 2024). When these technologies are effectively adopted and generate benefits that competitors find difficult to copy or

replace, they can provide hotels with a lasting performance advantage (Mehmood et al., 2023). RBV, therefore, helps explain why similar investments in ST may produce different results across hotels and how the strategic use of ST can contribute to improved operational, customer, and financial performance.

Contingency Theory

The theory argues that there is no universally best way for organisations to achieve performance and that the effectiveness of internal capabilities depends on how well they fit external contextual conditions (Omazić et al., 2023). It postulates that organisational outcomes are contingent upon the alignment between internal arrangements and the external environment, rather than being determined by any single resource or practice in isolation (Omazić et al., 2023). It explains the conditions under which sustainable technology (ST) may translate into superior hotel performance (Kaya & Kaya, 2023).

In the hotel context, the performance effects of ST may therefore vary according to external conditions, including regulatory pressures, competitive intensity, market expectations, environmental uncertainty, and changing customer demands. Accordingly, contingency theory provides a strong theoretical justification for operationalising external environmental factors as moderators, as the nature and intensity of the external environment can strengthen or weaken the extent to which ST deployment translates into operational, customer, and financial performance. This perspective also complements the RBV by recognising that the value of strategic resources is not inherently fixed but depends on their fit with the environment in which they are deployed.

Materials and Methods

The study was informed by a post-positivist philosophy, which recognises that relationships among variables are not fixed universally but may vary across settings and circumstances (Maksimovic & Evtimov, 2023). From this perspective, the relationship between ST and hotel performance was treated as contextual rather than absolute. The study was conducted in 4 and 5 star-rated hotels in Kenya. To capture the study population more comprehensively, a joint procedure was applied by combining the Tourism Regulatory Authority's official hotel ratings with verified guest reviews from Booking.com. This made it possible to include newly established hotels that had not yet appeared in the Tourism Regulatory Authority's (TRA) 2020 classification list (TRA, 2020). The two hotel categories were selected because they possess stronger financial, managerial, and operational ability to apply STs. An explanatory research design was adopted to assess the link between ST and hotel performance within the framework of BEF, which enabled the study to examine directional associations consistent with causal analysis (Hair Jr. et al., 2023).

The target population consisted of 151 hotel general managers drawn from 4 and 5 star-rated hotels across Kenya. A census method was used so that managers from all eligible hotels could be included in the survey. To avoid duplicate responses, only one general manager represented each hotel, since the hotel was the unit of analysis. Data was collected through a Google Form questionnaire administered online, which was suitable for the geographically dispersed nature of the respondents. Where necessary, reminders were sent to encourage completion, and no incentives were offered. Before the main survey, the questionnaire was pretested virtually for

clarity checks with 12 general managers from hotels listed on Booking.com with 4 and 5 star reviews that were excluded from the final group.

Sustainable technology served as the predictor, business environmental factors as the moderator, and hotel performance as the outcome variable. The measurement items were drawn from established instruments used in previous studies. Specifically, ST items were adapted from prior hospitality green technology and sustainability studies, while the BEF and hotel performance measures were informed by Baker (2012), Tornatzky and Fleischer (1990), and Kaplan and Norton (1992), respectively. All constructs were measured using 5-point Likert scales. BEF were measured on an extent scale ranging from very low to very high, whereas ST and hotel performance were assessed using an agreement format ranging from strongly disagree to strongly agree.

The study measured BEF through competitive pressures, guest tastes and preferences, government incentives and support, legal policies and regulatory requirements (Baker, 2012; Tornatzky & Fleischer, 1990). ST covered energy management, water conservation, and waste management technologies (Songur et al., 2023; Xess et al., 2021). Hotel performance was assessed using financial, customer, internal process, and learning-and-growth dimensions metrics (Kaplan & Norton, 1992). For moderation analysis, each variable's items were combined into a single reflective composite index rather than modelled as separate subdimensions.

Several procedures were used to strengthen validity and reduce bias. Content validity was confirmed through expert review by academics and industry practitioners to ensure the items adequately reflected the constructs. Construct validity was examined using

Exploratory Factor Analysis (EFA) as an initial check of the underlying structure, given that the four-item BEF scale provides only preliminary evidence. Although combining the four BEF items that capture distinct environmental forces into a single index may mask their separate effects, the composite was necessary to test the overall contextual influence of BEF on the relationship under study. Internal consistency was assessed using Cronbach's alpha. The data were analysed using means, standard deviations, skewness, and kurtosis, while frequency tables were used for presentation.

Because all information was obtained from general managers through a single questionnaire, the study was potentially exposed to common method variance, single-source bias, and social desirability bias. These risks were reduced by separating questionnaire sections, using different response formats for the independent variable, assuring respondents of anonymity and confidentiality, and emphasising aggregate reporting only. The online tool did not require hotel identification or email sign-in, and the wording of items was neutral and non-judgmental. In addition, Harman's single-factor test using Principal Components Analysis (PCA) was performed to check for common method bias. To reduce multicollinearity, both the predictor and moderator were mean-centred before the interaction term was created. PROCESS Model 1 was selected because the study examined a moderation effect involving ST, BEF, and hotel performance as composite constructs.

Moderation analysis was carried out in SPSS version 31 using Hayes' PROCESS Macro model 1, with bootstrapped confidence intervals based on 5,000 samples. PROCESS was appropriate because the study estimated

a single moderation model using observed composite scores rather than a latent-variable framework. The model tested the moderating effect of BEF on the relationship between ST and hotel performance as follows:

$$HP = \alpha + \beta_1 ST + \beta_2 BEF + \beta_3 (ST * BEF) + \varepsilon \dots \dots \dots \text{Model 1}$$

Where:

HP = Hotel performance

α = Y-intercept (a constant term)

$\beta_1 \dots \beta_3$ = Slope parameters (partial/regression coefficients)

ST = Sustainable Technology

BEF = Business Environmental Factors

*ST*BEF* = Interaction of *ST* and Business Environmental Factors

ε = Residual (error term)

Results

The reliability of the constructs was evaluated using Cronbach's alpha. As depicted in Table 1, the business environmental factors construct achieved satisfactory internal consistency across its four items ($\alpha=.707$). Construct validity was subsequently examined using Exploratory Factor Analysis (EFA). The

Kaiser–Meyer–Olkin (KMO) statistic of .621 indicated acceptable sampling adequacy, while Bartlett's test of sphericity was statistically significant, $\chi^2(10)=125.863$, $p<.001$, demonstrating that the correlation matrix was suitable for factor analysis. All four items exhibited factor loadings of .683 or higher, indicating satisfactory convergent validity. Furthermore, the items loaded clearly onto their intended component without notable cross-loadings, providing support for discriminant validity.

Similarly, *ST* and hotel performance showed high levels of internal consistency, yielding Cronbach's alpha coefficients of .907 and .933 across 25 and 24 items, respectively. The Kaiser–Meyer–Olkin (KMO) statistics of 0.759 and 0.815 demonstrated satisfactory sampling adequacy. Furthermore, Bartlett's tests of sphericity were statistically significant for both constructs, $\chi^2(300)$, 2538.581, $p<.001$, and $\chi^2(351)$, 3151.797, $p<.001$, respectively, indicating that the correlation matrices were appropriate for factor analysis.

Table 1: Validity and Reliability

Construct	Number of items	Cronbach's α	KMO	Bartlett's χ^2 (df)	Factor loadings
Sustainable technology	25	.907	.759	2538.581 (300), $p<.001$	$\geq .596$
Business environmental factors	4	.707	.621	125.863 (10), $p<.001$	$\geq .683$
Hotel performance	24	.933	.815	3151.797 (351), $p<.001$	$\geq .551$

The factor loadings for all items exceeded the recommended threshold for performance (≥ 0.551), and for *ST* (≥ 0.596) thereby supporting convergent validity. In addition, the items exhibited clear associations with their designated factors, with no notable cross-loadings, providing further support for discriminant validity.

To assess possible existence of common method variance due to reliance on self-administered online survey responses, Harman's single-factor test was conducted. The unrotated principal component analysis indicated that the first factor explained 30.041% of the overall variance, remaining well below the commonly accepted 50% benchmark

(Table 2). These findings suggest that common method variance was not a significant concern and hence unlikely to

compromise the validity of the study results.

Table 2: Harman's Single-Factor Test Statistics

Component	Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %
1	15.922	30.041	30.041

The descriptive findings indicated that BEF were generally perceived positively by respondents, with an overall mean of 3.55 (Table 3). The overall mean suggests a moderate level of agreement regarding the influence of these external factors on hotel operations and strategic decisions. Specifically, the results showed that competitive pressures shape the hotel's strategic decisions (M=4.13, SD=0.751) and government policies influence hotel operations (M=3.91, SD=0.795). Conversely, respondents expressed moderate agreement with regulatory requirements not being challenging to implement (M=3.40, SD=1.132) and government incentives benefiting hotels (M=2.77, SD=0.948).

The standard deviation of 0.91 indicates relatively low variability in the responses, suggesting that respondents held fairly similar views regarding the business environmental aspects. The skewness value of -0.56 indicates a slight negative skew, suggesting that responses were somewhat concentrated toward the higher end of the scale, reflecting a tendency toward agreement. The kurtosis value of 0.43 indicates a slight positive excess kurtosis, suggesting that the distribution is marginally more peaked than a normal distribution. Nevertheless, the skewness and kurtosis values are sufficiently close to zero to indicate that the data are approximately normally distributed.

Table 3: Descriptive Statistics for Business Environmental Factors

	Mean	Std. Dev.	Skewness	Kurtosis
Competitive pressures shape the hotel's strategic decisions	4.13	.751	-.690	.443
The government offers incentives that benefit the hotel	2.77	.948	.005	-.352
Government policies influence the hotel's operations	3.91	.795	-.963	2.241
Regulatory requirements are not challenging to implement	3.40	1.132	-.580	-.625
	3.55	0.91	-0.56	0.43

Table 4 depicts aggregated descriptive statistics on the level of utilisation of STs in hotels, and performance measures on a scale of 1 to 5. ST had a mean score of 3.57 (SD=1.25), suggesting a moderately positive level of utilisation in the hotels. The negative

skewness value (-0.52) indicates that responses were slightly concentrated toward the higher end of the scale, while the kurtosis value (-0.61) suggests a relatively flatter distribution than a normal distribution. For hotel performance, the mean was considerably

higher at 4.18 (SD=0.66), suggesting that respondents generally perceived hotel performance positively. The skewness of -0.47 shows a slight tendency toward higher scores, while the kurtosis of 0.27 indicates that the distribution was close to normal, with only a small degree of peakedness.

Overall, the respondents reported relatively favourable levels of both sustainable technology and hotel performance, with hotel performance receiving the higher average rating and showing less variation in responses. In contrast, the ST’s large standard deviation indicates that the extent of utilisation varies considerably across hotels.

Table 4: Predictor and dependent variable descriptive statistics

	Mean	Std. Dev.	Skewness	Kurtosis
Sustainable technology	3.57	1.25	-0.52	-0.61
Hotel performance	4.18	0.66	-0.47	0.27

The bivariate correlation results indicated positive associations between ST, BEF, and hotel performance (Table 5). A strong positive correlation was observed between ST and hotel performance ($r=.669, p<.001$), suggesting that greater use of STs is related to higher levels of hotel performance. The association between ST and BEF was

positive but weak and not statistically significant ($r=.152, p=.062$). Furthermore, BEF demonstrated a weak yet statistically significant positive association with hotel performance ($r=.203, p=.013$). All correlation coefficients remained below the .80 threshold, indicating that the variables did not exhibit problematic levels of multicollinearity.

Table 5: Bivariate correlations

Variables	1	2	3
1. Sustainable technology	1.000		
2. Business environmental factors	.152	1.000	
3. Hotel performance	.669**	.203*	1.000
N	151	151	151

Note: $p < .05$ (two-tailed); $p < .01$ (two-tailed).

Importantly, the study hypothesised that business environmental factors do not have a significant moderating effect on the relationship between sustainable technology and performance in 4 and 5 star-rated hotels in Kenya. A moderation model was used with sustainable technology (ST) as the independent variable and business environmental factors (BEF) as the moderator. The interaction term ($Int_1 = ST \times BEF$) was included to assess the moderating effect.

The overall model was significant ($R=0.6780, R^2=0.4596, F(3,147)=41.6766, p<0.001$), indicating that ST, BEF, and their interaction collectively explained approximately 46.0% of the variance in hotel performance (Table 6). However, although ST was a significant positive predictor of hotel performance ($B=0.3887, p<0.001$), business environmental factors did not significantly predict hotel performance ($B=0.0745, p=0.1032$), suggesting that BEF’s direct effect on performance was not statistically significant.

Table 6: Model Summary for Business Environmental Factors Interaction Effects

R	R ²	MSE	F	df1	df2	p
.6780	.4596	.0977	41.6766	3.0000	147.0000	.0000
Model	coeff	se	t	p	LLCI	ULCI
constant	4.1776	.0256	163.0016	.0000	4.1269	4.2282
ST	.3887	.0371	10.4706	.0000	.3153	.4620
BEF	.0745	.0455	1.6397	.1032	-.0153	.1644
Int_1	-.0390	.0526	-.7414	.4596	-.1430	.0650
Test(s) of highest order unconditional interaction(s)						
	R ² -chng	F	df1	df2	p	
X*W	.0020	.5497	1.0000	147.0000	.4596	

Int_1: ST x BEF

Notably, the interaction term (Int_1) was negative and not significant ($B = -0.0390$, $t = -0.7414$, $p = 0.4596$, 95% CI [-0.1430, 0.0650]). The negative coefficient suggests that an increase in BEF is associated with a slight reduction in the relationship between ST and hotel performance. Consistent with this, the change in R^2 associated with the interaction ($\Delta R^2 = 0.0020$, $F(1,147) = 0.5497$, $p = 0.4596$) suggested that the interaction explained only 0.2% additional variance in hotel performance (HP). The high p-value of 0.4596 meant that business environmental factors do not significantly moderate the relationship between sustainable technology and hotel performance. Therefore, the hypothesis was not rejected, and the business environmental factors moderation model was formulated as follows;

$$HP = 4.1776 + 0.3887(ST) + 0.0745(BEF) + -0.0390(ST*BEF) + \epsilon \dots \dots \dots \text{Model 2}$$

Discussion

The descriptive results indicate that ST was largely utilised in the sampled hotels. This suggests that STs were present to a reasonable extent, although their level of implementation may not yet be fully established across the hotels in Kenya. This finding is consistent with

hospitality studies by Engolan et al. (2025) and Nyamogosa et al. (2025) that highlight moderate ST usage in Kenya's hospitality market. On the other hand, the hotel performance high mean score provides evidence that respondents generally perceived hotels as performing well. This finding is in line with Kariuki et al. (2023) observation that star-rated hotels' core competencies effectively result in better performance levels in Kenya.

The findings also reveal a mixed external business environment context within the hotel industry. Competitive pressures and government policy influence are important factors shaping hotel operations and strategic decisions. However, the relatively low mean score for government incentives suggests that hotels perceive limited access to government support and incentives. Similarly, the findings suggest that regulatory requirements remain a consideration for hotel management, although respondents did not strongly perceive them as difficult to implement. These findings are consistent with Aroko et al. (2025) and Ohanyere (2022), who respectively report that macro and micro level business environmental factors significantly influence hotel business operations in Kenya and Nigeria. The

findings, therefore, underscore the importance of the broader external business context in shaping hotel operations and undertakings.

Additionally, although the direct effect of ST on hotel performance was statistically significant, the direct effect of BEF on performance was not statistically significant. This demonstrates that utilising STs is associated with hotel performance benefits, whereas favourable external conditions do not independently predict performance. This non-significant direct effect of BEF on HP results aligns with Yoopetch and Chareanporn (2024) findings that environmental factors do not significantly affect hotel performance. The results, however, contradict Chen et al. (2023) findings that BEF, such as competitive pressure and regulatory support, directly predicts performance. In agreement, Demir and Demir (2025) and Lucas et al. (2024) also remark that market conditions determine how hotels' investments in technology affect their competitive performance.

Markedly, BEF were found to have no moderating effect on the relationship between ST and hotel performance. The non-meaningful interaction effect suggests that external pressures do not alter the strength or direction of the relationship. It is plausible that these factors function more as drivers of technology adoption rather than moderators of impact strength. In this regard, external pressures may influence whether hotels implement STs, but once in place, the technologies deliver performance outcomes independently of the external environment.

Several scholars support this view by evidencing that the external business environment acts more often as an antecedent than a moderator in the technology-based models. For instance, findings from Chen et al. (2023),

Nikopoulou et al. (2023), Sun and Nasrullah (2024), and Vu et al. (2023) demonstrate that the external environment's role as a determinant is more pronounced than its moderating function. Suder (2025) found that the external environment's role as a determinant is more pronounced than its moderating function in hospitality research. Ali-Abbasi et al. (2022) results similarly showed that perceived competitor pressure and perceived vendor pressure have a significant impact on social media marketing adoption.

Moreover, the findings may reflect weak, inconsistent, or limited enforcement of environmental policies and regulations (Owenga et al., 2024), limited consumer preference for sustainability, and low levels of environmental awareness in the Kenyan hospitality context. These scenarios reduce the environmental factors' ability to shape the relationship between ST use and performance. This argument corresponds with Pastor (2025) and Singh et al. (2025) observations that strong and standardized regulatory frameworks and policies play a critical role in successful environmental preservation and the realisation of economic hotel benefits.

The current study findings compare differently with other scholars' work. Literature demonstrates that different environmental factors have diverse effects on the performance of STs and reveal mixed moderation results. Lui et al. (2021) findings, for example, reveal that pressures imposed by government policies provide fewer financial benefits of energy-efficient systems, while pressures from competitors provide more financial benefits. Owenga et al. (2024) note that government policies and regulations have a significant moderating effect on the relationship between diversification strategies with performance of star-rated hotels in the

Kenyan Coast. Other scholars found that external environment factors condition performance in the context of non-technology predictor variables. In particular, these factors moderate the relationship between performance and entrepreneurial orientation (Suder, 2025), transformational leadership (Kiplagat et al., 2024), and core competences (Kariuki et al., 2023).

Conclusion and Implications

Although business environmental factors play a central strategic role in 4 and 5 star-rated hotels in Kenya, they do not moderate the relationship between sustainable technology applications and hotel performance. The study contributes to the application of the TOE framework in research by demonstrating that BEFs do not constitute a significant boundary condition in this relationship. While environmental pressures encourage or force hotels to embrace ST, they do not strengthen or weaken the relationship between those technologies and hotel performance in the post implementation stages.

Accordingly, the findings support the TOE framework's conceptualisation of the factors as pre-adoption antecedents. This suggests that once STs are in place, hotels experience relatively limited performance differences associated with the level of attention given to external forces or pressures. Contextually, the study clarifies that variations in the external business environment do not correspond with differences in the relationship between ST and hotel performance in a developing country context.

The non-significant moderation result refines contingency theory by providing evidence that context may operate earlier in the technology lifecycle than traditionally conceptualised. Because BEF did not influence post-

adoption performance outcomes, the findings imply that contextual fit may be more relevant at the point of adoption than through moderation of the ST–performance relationship. In developing-market hotels, therefore, BEF do not moderate this relationship, indicating a narrower contextual role for contingency theory in this setting.

Recommendations

Hotels should focus less on external business environmental factors as predictors and enablers for improving performance. Instead, managerial effort should consider BEF during the pre-adoption stage decision-making and place emphasis on the effective configuration and utilisation of sustainable technologies.

The relatively low mean for government incentives suggests that managers did not strongly perceive existing incentives as beneficial to the hotels. The ministries of Tourism and Wildlife, in liaison with Information, Communications and the Digital Economy, should therefore introduce targeted tax incentives, subsidies, concessional financing, and grants to encourage ST initial adoption.

Competitive pressure high ranking implies that it remains an important influence on hotel strategic decisions. Managers should therefore use competitor practices and changing market expectations as strategies for identifying relevant STs, while ensuring that application decisions remain grounded in operational and performance objectives.

Limitations and Suggestions for Further Studies

The study has several limitations. Because ST, BEF, and hotel performance were measured at one point in time,

causality cannot be inferred. In addition, the BEF construct was measured with only four items, which may raise content validity concerns. Finally, the study was limited to 4 and 5 star-rated hotels in Kenya, so the findings need to be cautiously generalised to lower-rated hotels.

Future studies could examine regulatory pressures, competition, government interventions, and guest expectations separately rather than as a composite construct, using multi-item measures to strengthen the assessment of their effects. Researchers could also test these factors as mediators to better explain how BEF influence the link between ST and hotel performance. Comparative studies across different hotel categories and geographical settings may further reveal whether their influence varies by context and identify conditions under which they become significant.

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