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RETRACTED: Social sustainable development green brand value in education impact strategic alliance investment decision evaluation

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The green brand is a consumer experience. Educational hospitality attaches importance to green brands, and consumers' preference for green brands has become the current business practice of environmental protection and sustainable development. Strategic alliances drive competitiveness and exert multiplier effects. Commodity diversification is an important key factor in enhancing competitiveness and sustainable development. This study uses the real options approach to construct a dynamic strategy model, which explains the optimal occupancy pricing threshold and optimal green brand value investment strategy threshold on different influence variables and evaluates the difference between hospitality alliances with green brand restaurants and hospitality providers that create their own brand specialty restaurants. This study provides corresponding strategies for the development of a larger consumer market and market share for hospitality and the feasibility of sustainable development. The results show that the threshold of hospitality alliances with green brand restaurants is lower and will gain higher returns. However, if the economy is booming, it is more advantageous for hospitality alliances to adopt their own innovative brand specialty restaurants. It is recommended that managers consider developing innovative catering services and quality when hospitality faces strong competition. The choice is to form an alliance with a green brand restaurant or create its own brand specialty restaurant to enhance the popularity of hospitality to attract more customers. This will contribute to the sustainable development of hospitality. The results of the analysis provide a reference for managers to make appropriate investment decisions for restaurant management at an appropriate time.

KEYWORDS

sustainable development, strategic alliance, green brand value, innovation strategy, real options

1 Introduction

While travel and tourism are gradually becoming important economic activities in many countries, the environmental change and COVID-19 pandemic outbreak has had a huge impact on the global tourism industry. Viana-Lora and Nel·Lo Andreu (2022) pointed to the knowledge transfer to tourism that helps overcome the consequences of the COVID-19 pandemic. Turning a crisis into a new impetus can create opportunities for sustainable tourism. Most countries have proposed travel bans, and consumer demand in the global tourism industry has also changed. Regional tourism investment has become a development goal under the COVID-19 pandemic. Due to the impact of the epidemic, hospitality catering that was quarantined has become one of the most important services for customers to choose. In addition to providing accommodation commodity services, service diversification is an important factor for hospitality to enhance its competitiveness and sustainable development. This study aims to improve the service quality of hospitality, improve the catering business, increase consumer loyalty, and enhance the popularity of hospitality. Kim et al. (2019) found that sustainability is one of the most commonly discussed trends in the hotel industry. Huang and Liu (2019) pointed out that when creativity increases, service innovation is further strengthened. Lee et al. (2022) pointed out that competitive advantage, core competitiveness, and strategic alliance partner selection have significant effects on alliance performance. This study attempts to explore hospitality options and green brand restaurant alliances or self-created brand specialty restaurants. Hospitality can create a competitive advantage in uncertain environments.

Brand value and nostalgia are the factors those influence consumers' perception of restaurant authenticity. Consumers' perceived authenticity and service quality have a positive impact on the perceived value of their dining experience (Chen et al., 2020). Yang et al. (2022) mentioned that in the Internet era, consumers prefer products with socially responsible attributes. Products with social responsibility attributes also create the brand values of products. Brand value is the consumer's recognition of a brand. Brand value is mainly to attract consumers to continue consuming. Managing hospitality brands effectively brings many benefits to managers, such as access to high prices, increased market share, increased consumer loyalty, and stimulating positive word-of-mouth sponsorship recommendations (Kayaman and Arasli, 2007). A strong brand helps simplify consumer decision-making by reducing perceived risks and increasing expectations (Keller, 2008). Cavaliere and Crea (2021) have indicated that brand premium is driven by real quality improvement. Chen et al. (2020) proposed that historical and cultural value, brand value, and nostalgia affect consumers' perception of restaurant authenticity.

Strategic alliances drive competitiveness, cooperation, and sharing of resources, which are important trends for the future sustainable development of hospitality. Strategic alliances can have a multiplier effect. Donbesuur et al. (2021) pointed out that post formation alliance capabilities, interorganizational coordination, and communication have a positive interactive effect on environmental innovation. Yu et al. (2019) studied the main and relative impacts of different types of strategic alliances and corporate performance and found that vertical symmetric alliances have gained more benefits than other alliances. This study evaluates the feasibility of strategic alliances between hospitality and green brand restaurants with brand value. The general financial strategy assessment uses the net present value method, which does not consider the dynamic investment environment and ignores the management elasticity value, so it is more suitable for the static investment environment. The real options approach incorporates management elasticity value into investment decision-making, which is more in line with the evaluation of economic investment projects under uncertainty (Myers, 1977; Dixit and Pindyck, 1994). Méndez-Suárez and Crespo-Tejero (2021) applied a real options approach to determine the customer lifetime value and evaluate the threshold. Gao and Driouchi (2018) studied the role of ambiguity and trust in some outsourcing decisions from the perspective of the real options approach (ROA). Guo et al. (2020) used a real option valuation method with a jump process, constructing a natural tourist attraction investment valuation model under uncertainty considering multiple unexpected events. The study found that the higher the incidence of multiple unexpected events, the greater the value of the investment opportunity and the longer the wait for the best investment opportunity. Lee (2018) adopted the real options approach to study corporate social responsibility (CSR), which is conducive to the long-term development of a company and can improve corporate reputation. The study clarifies the value of CSR and the decision to invest in CSR. Niu et al. (2021) used the real options approach to study the impact of market incompleteness on investment decisions.

The study uses the real options approach with management elasticity value to construct a dynamic investment decision-making model, analyses the impact of the hotel prices and brand value on returns in addition to the equity value of the project, and then conducts a feasibility evaluation of the investment strategy.

2 Model

This model provides the optimal lodging pricing threshold and brand value investment decision threshold and analyses project equity value. It also conducts a feasibility assessment of investment projects and provides a reference for hospitality to make investment decisions on brand value, strategic alliances, or innovation in brand specialty restaurants.

2.1 The assumption

To increase brand recognition, attract people, and increase the occupancy rate, hospitality requires innovative catering service projects. There are two investment projects to choose from: strategic alliances with green brand restaurants and the establishment of own brand specialty restaurants. Considerations include customer needs, optimal investment timing, investment costs, and revenue. This study assumes that $I_i, i = W, S$ is the input fixed cost. Among them, paying for fixed cost I_W when choosing to enter into a strategic alliance with a green brand restaurant, the input fixed cost of the innovation's own brand specialty restaurant is I_S. That is, I_W is the premium to be paid for a hospitality alliance with a green brand restaurant. $B_i, i = W, S$ is the brand value. Then, B_W is the brand value of the green brand restaurant, and B_S is the value of the innovating brand specialty restaurant. The number of lodging customers affected by innovative catering services is $Q_i, i = W, S$. Q_W, Q_S are the number of customers affected by alliances with green brand restaurants or the establishment of proprietary specialty restaurants. The number of lodging customers is $Q_i = q_i(B_i), i = W, S$. The brand value B_W, B_S will affect the number of hospitality lodging customers, and the brand value is positively correlated with the number of lodging customers. That is, when the brand value is increased, the number of lodging customers increases. Hospitality's inverse lodging demand function is shown in Eq. 1:

$$P_i = X_i(B_i, t) \times D_i(Q_i), i = W, S \tag{1}$$

where $P_i, i = W, S$ is the unit change in the price of lodgings. $X_i(B_i, t), i = W, S$ is the lowest unit change in lodging prices. Generally, the price of hospitality lodging is divided into low season and high season. The lodging price increases as the number of tourists and guests increases. Lodging prices increase with demand. Suppose the price of lodging shift variable $X_i(B_i, t), i = W, S$ of the demand function follows geometric Brownian motion, we have Eqn. 2:

$$dX_i(B_i, t) = \alpha_i X_i(B_i, t)dt + \sigma_i X_i(B_i, t)dZ_i(t), i = W, S \tag{2}$$

where $\alpha_i, i = W, S$ is the expected growth rate of $X_i(B_i, t), i = W, S$. It is influenced by economic and environmental factors that change the expected rate of change in lodging demand. $\sigma_i, i = W, S$ is the standard deviation of $X_i(B_i, t), i = W, S$. It is the risk of changing the expected growth in lodging demand due to economic and environmental factors. $dZ_i(t), i = W, S$ is the increment of the standard Wiener process. Here, $E[dZ_i(t)] = 0, i = W, S$, $E[dZ_i(t)^2] = dt, i = W, S$.

Under the assumption of sustainable operations, the expected revenue of hospitality $TR_i, i = W, S$ is as given in Eqn. 3:

$$TR_i = P_i \times Q_i = X_i(B_i, t) \times D_i(Q_i) \times Q_i = X_i(B_i, t) \times M_i(B_i), i = W, S \tag{3}$$

where the expected revenue $TR_i = P_i \times Q_i, i = W, S$ is the unit change in lodging price multiplied by the number of lodging customers. By arranging Eqn. 3, the assumption is $M_i(B_i) = D_i(Q_i) \times Q_i, i = W, S$.

2.2 Decision model

The following is an investment strategy for hospitality providers to choose strategic alliances with green brand restaurants or to create their own brand specialty restaurants and construct an investment strategy model to describe the optimal lodging pricing, the optimal brand value investment decision threshold, investment opportunities, and hospitality revenue.

Let us suppose $V_i(X_i(B_i, t)), i = W, S$ is the managing elastic value when hospitality chooses a strategic alliance with a green brand restaurant or chooses to create its own brand specialty restaurant. Then the choice of the green brand restaurant strategic alliance management elasticity value is $V_W(X_W(B_W, t))$. $V_S(X_S(B_S, t))$ is the management flexibility value of hospitality choosing to innovate its own brand specialty restaurant. Its value is affected by the variation of the shift variable $X_i(B_i, t), i = W, S$ of the uncertain demand curve. The change in $X_i(B_i, t), i = W, S$ follows geometric Brownian motion. Using Itô's (1951) Lemma theorem, its management elasticity value is shown in Eqn. 4:

$$dV_i(X_i(B_i, t)) = V_{iX_i}(X_i(B_i, t))dX_i(B_i, t) + \frac{1}{2}V_{iX_iX_i}(X_i(B_i, t))(dX_i(B_i, t))^2, \quad i = W, S \tag{4}$$

where $V_{iX_i}(X_i(B_i, t)), i = W, S$ and $V_{iX_iX_i}(X_i(B_i, t)), i = W, S$ are the first- and second-order differential equations derived from $V_i(X_i(B_i, t)), i = W, S$ for $X_i(B_i, t), i = W, S$. The risk discount rate is assumed to be $r_i, i = W, S$. It is the required rate of return required to take risks when investing. r_W is the risk discount rate for selecting a strategic alliance with a green brand restaurant. r_S is the risk discount rate for choosing to create one's own brand specialty restaurant. Different investment projects generate different risks. Because restaurants with their own brand specialty are required to bear the risk of customer acceptance, it is assumed that $r_W \le r_S$. The expected value over an interval time dt, $r_i V_i(X_i(B_i, t))dt, i = W, S$ is equal to its expected potential value based on the conditions of risk discount rate $r_i, i = W, S$. The Bellman equation (Dixit & Pindyck, 1994) is shown in Eqn. 5.

$$r_i V_{iX_i}(X_i(B_i, t))dt = E[dV_{iX_i}(X_i(B_i, t))], \quad i = W, S \tag{5}$$

Replacing Eqs. 2 and 4 with Eqn. 5, the value of management flexibility is shown in Eqn. 6:

$$\frac{1}{2}\sigma_i^2 X_i(B_i,t)^2 V_{iXX}(X_i(B_i,t)) + \alpha_i X_i(B_i,t) V_{iX}(X_i(B_i,t)) - r_i V_i(X_i(B_i,t)) = 0, \quad i = W,S \tag{6}$$

The general solution of Eqn. 6 should be familiar (Dixit and Pindyck, 1994):

$$V_i(X_i(B_i,t)) = A_{1i} X_i(B_i,t)^{\beta_{1i}}, i = W,S \tag{7}$$

Equation 7 is the management flexibility value of hospitality. This study solves the optimal lodging pricing threshold $X_i(B_i,t)^*, i = W,S$ of the shift variable using value matching condition and smooth pasting condition (Dixit and Pindyck, 1994).

$X_i(B_i,t)^*, i = W,S$ is the optimal lodging pricing threshold of the shift variable; then, the value function is as given in Eqn. 13:

$$V_i(X_i(B_i,t)) = \begin{cases} A_{1i} X_i(B_i,t)^{\beta_{1i}}, X_i(B_i,t) < X_i(B_i,t)^* \\ \dfrac{X_i(B_i,t) \times M(B_i)}{(r_i - \alpha_i)} - I_i, X_i(B_i,t) \geq X_i(B_i,t)^* \end{cases}, i = W,S \tag{8}$$

This will provide the expected revenue $TR_i, i = W,S$. From Eqn. 8, the solution for $X_i(B_i,t)^*, i = W,S$ and $A_i, i = W,S$ using the value matching condition and smooth pasting condition is as shown in Eqn. 9 (Dixit and Pindyck, 1994):

$$\begin{cases} A_{1i} X_i(B_i,t)^{\beta_{1i}} = \dfrac{X_i(B_i,t) \times M(B_i)}{(r_i - \alpha_i)} - I_i \\ \beta_{1i} A_{1i} X_i(B_i,t)^{\beta_{1i}-1} = \dfrac{M(B_i)}{(r_i - \alpha_i)} \end{cases}, i = W,S \tag{9}$$

Arranging Eqn. 9, the optimal lodging pricing threshold of shift variable is $X_i(B_i,t)^*, i = W,S$, as shown in Eqn. 10:

$$X_i(B_i,t)^* = \frac{\beta_{1i}}{(\beta_{1i} - 1)} \times \frac{I_i(r_i - \alpha_i)}{M_i(B_i)}, i = W,S \tag{10}$$

The parameter value $A_{1i}, i = W,S$ to be determined is shown in Eqn. 11:

$$A_{1i} = \left[\frac{\beta_{1i} - 1}{I_i}\right]^{\beta_{1i}-1} \left[\frac{M_i(B_i)}{\beta_{1i}(r_i - \alpha_i)}\right]^{\beta_{1i}}, i = W,S \tag{11}$$

The optimal lodging pricing threshold of the shift variable for a hospitality alliance with a green brand restaurant is $X_W(B_W,t)^* = \frac{\beta_{1W}}{(\beta_{1W}-1)} \times \frac{I_W(r_W - \alpha_W)}{M_W(B_W)}$. Additionally, the optimal lodging pricing threshold of the shift variable for innovating one's own brand specialty restaurant is $X_S(B_S,t)^* = \frac{\beta_{1S}}{(\beta_{1S}-1)} \times \frac{I_S(r_S - \alpha_S)}{M_S(B_S)}$. The optimal lodging pricing threshold of the shift variable provides reference data on investment strategies for hospitality firms choosing strategic alliances with green brand restaurants or innovating their own brand specialty restaurants.

To raise the popularity of hospitality, hospitality companies choose strategic alliances with green brand restaurants or innovate their own brand specialty restaurants. Assuming that the number of lodging customers is $Q_i = q_i(B_i), i = W,S$, the average unit lodging consumption price $P_i = X_i(B_i,t) \times D_i(Q_i), i = W,S$ and the hospitality expected revenues function $TR_i = P_i \times Q_i, i = W,S$ will be influenced by the brand value B_W, B_S. The following explores the impact of the overall decision assessment:

The number of lodging customers is hypothesized as shown in Eqn. 12:

$$Q_i = q_i(B_i) = g_i \times B_i^{\theta_i}, g_i > 0, \theta_i > 0, i = W,S \tag{12}$$

where observed by the market, the products with a high brand value attract customers to consume. g_W is the correlation coefficient between the number of lodgings and the green brand value. g_S is the correlation coefficient between the number of lodgings and the brand value of own brand. Assuming $0 < g_i < 1, 0 < \theta_i < 1, i = W,S$ indicates that the number of hospitality lodgings is positively correlated with the brand value. When the brand value is higher, the customer is more interested. Assuming $g_W > g_S$ indicates that the brand value of a green brand restaurant affects customer consumption more than the value of innovating one's own brand specialty restaurant brand.

Then, hospitality's inverse lodging demand function is shown in Eqn. 13:

$$\begin{aligned} P_i &= X_i(B_i,t) \times D_i(Q_i) \\ &= B_i^{\omega_i} \times \left(\bar{P} + c_i \times P_R\right) \times \left(g_i \times B_i^{\theta_i}\right)^{\lambda}, \omega_i > 0, \lambda > 0, i = W,S \end{aligned} \tag{13}$$

Equation 13 is the average unit lodging price. The shift variable $X_i(B_i,t) = B_i^{\omega_i}, i = W,S$ is also affected by brand value. In $D_i(Q_i) = (\bar{P} + c_i \times P_R) \times (g_i \times B_i^{\theta_i})^{\lambda}, i = W,S$, we assume that the average lodging price per consumer is $\bar{P}$, while the average unit consumer food and beverage price is P_R, and $c_i, i = W,S$ is the price distribution ratio for the food and beverage portion. If hospitality chooses to enter into a strategic alliance with a green brand restaurant, then after paying the brand value cost I_W, the price distribution ratio for food and beverage will be $c_W < 1$. Then $c_S = 1$, and the average per-consumer food and beverage consumption P_R of a brand specialty restaurant is completely owned by the hospitality company. θ_W is the green brand value elasticity $0 < \theta_W < 1$. It means that the increase in the number of lodging is less than the increase in the green brand value. θ_S is the own brand value elasticity $0 < \theta_S < 1$. It means that the increase in the number of lodging is less than the increase in the value of the own brand. λ is the elasticity of demand for lodging $\lambda > 0$.

Using the functional forms of Eqn. 12 and $D_i(Q_i) = (\bar{P} + c_i \times P_R) \times (g_i \times B_i^{\theta_i})^{\lambda}, \lambda > 0, i = W,S$, $M_i(B_i), i = W,S$ is shown in Eqn. 14:

$$M_i(B_i) = \left(\bar{P} + c_i \times P_R\right) \times \left(g_i \times B_i^{\theta_i}\right)^{\lambda} \times g_i \times B_i^{\theta_i}, \lambda > 0, i = W,S \tag{14}$$

Replacing Eqn. 14 with Eqn. 10 and under the assumption of the shift variable $X_i(B_i,t) = B_i^{\omega_i}, \omega_i > 0, i = W,S$, the optimal threshold of shift variable $X_i(B_i,t)^*, i = W,S$, $X_i(B_i,t)^*, i = W,S$ is calculated to solve the optimal brand value threshold of the green brand restaurant B_W^* and the optimal brand value threshold of innovating one's own brand specialty restaurant B_S^*. We find that

$$B_W{}^* = \left[\frac{\beta_{1W}}{(\beta_{1W}-1)} \times \frac{I_W(r_W-\alpha_W)}{g_W{}^{(1+\lambda)} \times (\bar{P}+c_W \times P_R)}\right]^{\frac{1}{\theta_W(1+\lambda)+\omega_W}} \quad (15)$$

In Eqn. 15, if the optimal brand value threshold of a green brand restaurant is B_W^*, when $B_W = B_W^*$, hospitality should consider the choice of a strategic alliance.
where,

$$B_S{}^* = \left[\frac{\beta_{1S}}{(\beta_{1S}-1)} \times \frac{I_S(r_S-\alpha_S)}{g_S{}^{(1+\lambda)} \times (\bar{P}+P_R)}\right]^{\frac{1}{\theta_S(1+\lambda)+\omega_S}} \quad (16)$$

In Eqn. 16, when the optimal brand value threshold of innovating its own brand specialty restaurant is B_S^*, and $B_S = B_S^*$, hospitality considers the choice of innovating its own brand specialty restaurant.

During the choice of investment strategies, in addition to considering the timing of the investment, which is choosing to lower the optimal brand value threshold, through which we can reach the investment threshold and gain the investment revenues of the first move earlier, we also need to consider the investment revenues. If the economy is in a growth stage, hospitality is also at the high growth stage. Hospitality can obtain high investment revenues, whether choosing strategic alliances with green brand restaurants or creating its own brand specialty restaurants. Then, the investment decision rule is as shown in Eqn. 17:

$$\left[\frac{TR_W}{(r_W-\alpha_W)} - I_W\right] - \left[\frac{TR_S}{(r_S-\alpha_S)} - I_S\right] = K \quad (17)$$

The first item of Eqn. 17 is the discounted value of the investment profit after hospitality alliances with green brand restaurant revenues minus the alliance's fixed cost. The second item is the discounted value of the operating profit of creating a proprietary brand specialty restaurant minus the input fixed cost. When $K > 0$, the investment strategy chosen by the hospitality firm is to enter into an alliance with the green brand restaurant. If $K < 0$, the investment strategy chosen by the hospitality firm is to create its own brand specialty restaurant.

3 Numerical example and sensitivity analysis

This section will conduct a numerical example and sensitivity analysis for the decision model constructed in Section 2.

3.1 Numerical example

This section will explore hospitality, considering the impact of brand value on customer spending choices and lodging demand function shift variables. The following model is used to make decision-making evaluations for hospitality selection and investment projects between alliances with green brand restaurants or proprietary brand specialty restaurants. The assumptions of exogenous variables mainly refer to the data released by the World Tourism Cities Federation and the Tourism Research Centre, Chinese Academy of Social Sciences in the "World Tourism Economic Trends Report (2022)." The model's assumptions for model-related exogenous variables are shown in Table 1:

Substituting the exogenous variables of Table 1 into the investment decision models of Eqs. 15, 16, and Eq. 17, the optimal brand value threshold of the green brand restaurant becomes $B_W^* = 30.76$ thousand dollars. Then, when the optimal brand value threshold of the green brand restaurant has reached $B_W^* = 30.76$ thousand dollars, hospitality should choose to sign an alliance contract with the green brand restaurant. The net revenue is $TR_W \div (r_W - \alpha_W) - I_W = 40,850.44$ thousand dollars. Simultaneously, the optimal lodging pricing threshold of the shift variable is $X_W(B_W,t)^* = 7.90$.

Concurrently, the optimal brand value threshold of the proprietary brand specialty restaurant is $B_S^* = 56.04$ thousand dollars. Then, when the optimal brand value threshold of hospitality's own brand specialty restaurant has reached $B_S^* = 56.04$ thousand dollars, hospitality can consider creating its own brand specialty restaurant. The net revenue is $TR_S \div (r_S - \alpha_S) - I_S = 28,989.18$ thousand dollars. Then, the optimal lodging pricing threshold of the shift variable is $X_S(B_S,t)^* = 8.91$.

From the numerical example results $B_W^* < B_S^*$, meaning that the optimal brand value threshold of the alliance with a green brand restaurant is less than the optimal brand value threshold of creating its own brand specialty restaurant. The optimal brand value threshold of a green brand restaurant can be reached earlier. Therefore, with the other conditions unchanged, hospitality prioritizes the investment strategy of entering into an alliance with green brand restaurants to enhance the quality of its food and beverage service. Hospitality net revenue is $TR_W \div (r_W - \alpha_W) - I_W = 40,850.44$ thousand dollars. At this time, if hospitality invests in the development of an innovative brand specialty restaurant, its net revenue will be $TR_S \div (r_S - \alpha_S) - I_S = 28,989.18$ thousand dollars. The hospitality investment decision rule calculation results are $K = 11,861.26$ thousand dollars.

The numerical results $K > 0$ show that the net revenue of hospitality alliances with green brand restaurants is greater than the investment revenue of innovating its own brand specialty restaurants. $B_W^* < B_S^*$, thus hospitality can develop an early strategic alliance with green brand restaurants. Then, the optimal lodging pricing threshold of the shift variable is

TABLE 1 Exogenous variables.

Exogenous variables	Significance	Value
α_W	Shift variable average growth rate (hospitality alliance with green brand restaurant). α_W is influenced by economic and environmental factors that change the expected rate of change in lodging demand.	0.04
α_S	Shift variable average growth rate (hospitality innovates its own brand specialty restaurant). α_S is influenced by economic and environmental factors that change the expected rate of change in lodging demand.	0.04
σ_W	Shift variable standard deviation (hospitality alliance with green brand restaurant). σ_W is the risk of changing the expected growth in lodging demand due to economic and environmental factors.	0.20
σ_S	Shift variable standard deviation (hospitality innovates its own brand specialty restaurant). σ_S is the risk of changing the expected growth in lodging demand due to economic and environmental factors.	0.20
r_W	Risk discount rate (hospitality alliance with green brand restaurant). r_W is the required rate of return required to take risks when investing.	0.06
r_S	Risk discount rate (hospitality innovates its own brand specialty restaurant). r_S is the required rate of return required to take risks when investing.	0.08
g_W	The number of lodging customers' parameters (hospitality alliance with green brand restaurant). g_W is the correlation coefficient between the number of lodging and the green brand value $0 < g_W < 1$.	0.50
g_S	The number of lodging customers' parameters (hospitality innovates its own brand specialty restaurant). g_S is the correlation coefficient between the number of lodging and the brand value of own brand $0 < g_S < 1$.	0.50
θ_W	The number of lodging customers' parameters (hospitality alliance with green brand restaurant). θ_W is the green brand value elasticity $0 < \theta_W < 1$. It means that the increase in the number of lodging is less than the increase in the green brand value.	0.40
θ_S	The number of lodging customers' parameters (hospitality innovates its own brand specialty restaurant). θ_S is own brand value elasticity $0 < \theta_S < 1$. It means that the increase in the number of lodging is less than the increase in the value of the own brand.	0.20
ω_W	Shift variable parameter (hospitality alliance with green brand restaurant).	0.20
ω_S	Shift variable parameter (hospitality innovates its own brand specialty restaurant).	0.20
$\bar{P}$	The average lodging price per consumer (unit: dollar).	1,000.00
P_R	The average unit consumer food and beverage price (unit: dollar).	500.00
c_W	The price distribution ratio for the food and beverage (hospitality alliance with green brand restaurant).	0.50
c_S	The price distribution ratio for the food and beverage (hospitality innovates its own brand specialty restaurant).	1.00
I_W	The fixed cost (unit: 10 million). I_W is the premium to be paid for hospitality alliance with green brand restaurant.	2.00
I_S	The fixed cost (hospitality innovates its own brand specialty restaurant cost) (unit: 10 million). I_S is the investment cost that hospitality innovates its own brand specialty restaurant.	3.00
λ	Hospitality's inverse lodging demand function of the parameters. λ is the elasticity of demand for lodging $\lambda > 0$.	0.50

$X_W(B_W, t)^* < X_S(B_S, t)^*$. Therefore, under the hypothesis of this study, the optimal investment strategy for hospitality should be an alliance with a green brand restaurant.

3.2 Sensitivity analysis

Sensitivity analysis was applied to the effects of exogenous variables on the optimal brand value threshold of the alliance with green brand restaurants and innovative brand specialty restaurants. First, the study analyses the changes in the risk discount rate $r_i, i = W, S$ that affect the optimal brand value threshold B_W^*, B_S^*, lodging pricing threshold of shift variable X_W^*, X_S^*, and the difference between the net revenue of the two strategies K. These changes are shown in Table 2:

As shown in Table 2, when the risk discount rate $r_i, i = W, S$ rises, the optimal brand value threshold B_W^*, B_S^* also rises. High brand value will be required. The optimal lodging pricing threshold of shift variable X_W^*, X_S^* also increases. However, when the risk discount rate increases, the net revenue gradually decreases. The main reason is that the risk discount rate will increase, which will increase the cost of investment. The net revenue of the alliance strategy decreases more than the net revenue of creating its own brand specialty restaurants. At $r_W < 0.10, r_S < 0.12$, the optimal brand value threshold of the alliance with a green brand restaurant is less than the optimal brand value of creating its own brand specialty restaurants. The

TABLE 2 The influence of the risk discounted rate $r_i, i = W, S$ on B_W^*, B_S^*, X_W^*, X_S^*, and K

r_W	r_S	B_W^* unit: thousand	B_S^* unit: thousand	X_W^*	X_S^*	K unit: thousand
0.06	0.08	30.76	56.40	7.90	8.91	11,861.26
0.07	0.09	36.53	63.93	8.18	9.14	4,107.32
0.08	0.10	42.40	71.94	8.42	9.36	1,304.46
0.09	0.11	48.38	80.06	8.65	9.56	118.11
0.10	0.12	54.43	88.28	8.85	9.75	−411.97
0.11	0.13	60.57	96.61	9.05	9.93	−639.63

TABLE 3 The influence of the $\alpha_i, i = W, S$ of shift variable on B_W^*, B_S^*, X_W^*, X_S^*, and K

α_W	α_S	B_W^* unit: thousand	B_S^* unit: thousand	X_W^*	X_S^*	K unit: thousand
0.030	0.030	32.54	58.62	7.99	8.99	3,503.97
0.035	0.035	31.61	57.28	7.94	8.95	6,386.84
0.040	0.040	30.76	56.04	7.90	8.91	11,861.26
0.045	0.045	29.99	54.89	7.86	8.87	23,193.50
0.050	0.050	29.29	53.84	7.82	8.84	50,855.46

TABLE 4 The influence of the $\sigma_i, i = W, S$ of shift variable on B_W^*, B_S^*, X_W^*, X_S^*, and K

σ_W	σ_S	B_W^* unit: thousand	B_S^* unit: thousand	X_W^*	X_S^*	K unit: thousand
0.10	0.10	22.55	42.45	7.42	8.43	10,223.18
0.15	0.15	26.04	48.38	7.64	8.65	10,812.49
0.20	0.20	30.76	56.04	7.90	8.91	11,861.26
0.25	0.25	36.72	65.37	8.18	9.18	13,383.29
0.30	0.30	43.97	76.42	8.48	9.48	15,379.37

net revenue of an alliance with a green brand restaurant is greater than that of an alliance with an innovative specialty restaurant. Therefore, the best investment plan for hospitality should be to choose alliances with green brand restaurants. However, when $r_W \geq 0.10, r_S \geq 0.12$, the net revenue of an alliance with a green brand restaurant alliance is less than the net revenue of innovating a brand specialty restaurant. Therefore, the difference between the net returns of the two strategies is less than 0, $K < 0$. Therefore, when the investment cost increases to a certain level, hospitality should choose to delay the investment. If a strategic alliance is carried out, the net revenue will be distributed according to the contract ratio. As a result, when the investment risk is high, the net revenue of creating one's own brand specialty restaurant is higher, so innovating one's own brand specialty restaurant should be selected.

Second, the study analyses the change in the average growth rate $\alpha_i, i = W, S$ of the shift variable, which affects the optimal brand value threshold B_W^*, B_S^*, lodging pricing threshold of the shift variable X_W^*, X_S^*, and the difference between the net revenue of the two strategies K. The changes are shown in Table 3:

As shown in Table 3, when the average growth rate $\alpha_i, i = W, S$ of the shift variable increases, both the optimal brand value threshold B_W^*, B_S^* and the lodging pricing threshold of shift variable X_W^*, X_S^* decrease. In addition, the net revenue of hospitality gradually rises. Mainly, when the average growth rate $\alpha_i, i = W, S$ rises, it means that the economy is in a booming stage and the global GDP is growing; thus, hospitality decision-makers should move quickly to invest. This decision will produce an increase in net revenue. From the data in Table 3, as the average growth rate increases, the net revenue also increases. The net revenue of the investment method of the strategic alliance is greater than that of the proprietary brand specialty restaurant. When the average growth rate $\alpha_i, i = W, S$ of the shift variable is higher, the lower is the optimal brand value threshold B_W^*, B_S^* which indicates that the hospitality can reach the investment threshold sooner. Therefore, the investment activities should be carried out immediately. The net revenue of hospitality will increase. This shows that when the average growth rate is on the rise, decision-makers who adopt strategic alliances are better off than when they create their own specialty restaurant.

TABLE 5 The influence of the $I_i, i = W, S$ of shift variable on B_W^*, B_S^*, X_W^*, X_S^*, and K

I_W	I_S	B_W^* unit: thousand	B_S^* unit: thousand	X_W^*	X_S^*	K unit: thousand
18,000	28,000	26.97	51.41	7.69	8.75	9,708.83
19,000	29,000	28.85	53.72	7.80	8.83	10,785.05
20,000	30,000	30.76	56.04	7.90	8.91	11,861.26
21,000	31,000	32.70	58.39	8.00	8.98	12,937.48
22,000	32,000	34.66	60.75	8.09	9.05	14,013.69

Third, the study analyses the change in the standard deviation $\sigma_i, i = W, S$ of the shift variable, which affects the optimal brand value threshold B_W^*, B_S^*, lodging pricing threshold of the shift variable X_W^*, X_S^*, and the difference between the net revenue of the two strategies K. The changes are shown in Table 4:

When the standard deviation $\sigma_i, i = W, S$ of the shift variable increases, the optimal brand value threshold B_W^*, B_S^*, the lodging pricing threshold of shift variable X_W^*, X_S^*, and the net revenue all increase, as shown in Table 4. When the standard deviation $\sigma_i, i = W, S$ of the shift variable rises, it means that uncertainty and risk will increase, so investments should be more cautious. However, the increase in the optimal brand value threshold B_W^*, B_S^* and the lodging pricing threshold of shift variable X_W^*, X_S^* means delaying investments and waiting for a better investment opportunity. Because of the high investment risk, decision-makers will require a higher return on their investments before they choose to implement the investment project. Furthermore, the optimal threshold of the brand value of the alliance strategy is smaller than that of the proprietary brand specialty restaurant, while its net revenue is greater. Therefore, the best investment strategy should be to choose alliances with green brand restaurants.

Finally, the study analyses the change in the fixed cost $I_i, i = W, S$ of the shift variable, which affects the optimal brand value threshold B_W^*, B_S^*, lodging pricing threshold of the shift variable X_W^*, X_S^*, and the difference between the net revenue of the two strategies K. The changes are shown in Table 5:

When the fixed cost $I_i, i = W, S$ of the shift variable increases, the optimal brand value threshold B_W^*, B_S^*, the lodging pricing threshold of shift variable X_W^*, X_S^*, and the net revenue all increase, as shown in Table 5. When the fixed cost $I_i, i = W, S$ of the shift variable rises, it means that more investment funds need to be prepared. However, the increase in the optimal brand value threshold B_W^*, B_S^* and the lodging pricing threshold of shift variable X_W^*, X_S^* means delaying investments and waiting for a better investment opportunity. Because of the higher capital required to invest, the investment risk increases, and decision-makers will require a higher return on their investments before they choose to implement the investment project. Policymakers will be more cautious in evaluating investment projects, so the investment threshold will be raised. At the same time, decision-makers will be more cautious in evaluating investment projects, so the investment threshold will be raised. Furthermore, the optimal threshold of the brand value of the alliance strategy is smaller than that of the proprietary brand specialty restaurant, while its net revenue is greater. Therefore, the best investment strategy should be to choose alliances with green brand restaurants

4 Conclusion

Under the education of environmental protection and emphasis on green brands, this study aims to increase the quality of food service to attract more consumers and ultimately achieve improved revenue to enhance the hospitality sector. It considers the investment plans of alliances with green brand restaurants or development of proprietary brand specialty restaurants using an investment strategy model using the real options approach. The results of the numerical analysis show that the optimal green brand value threshold and the lodging pricing threshold of hospitality alliances with green brand restaurants are smaller, so hospitality should give priority to alliances with green brand restaurants to improve the quality of food service. Moreover, the net revenue of hospitality alliances with green brand restaurants is greater than that of alliances with new restaurants. Therefore, the best investment strategy for hospitality is to collaborate with green brand restaurants. By choosing an alliance with green brand restaurants, hospitality can reduce development costs and quickly increase visibility and market share, creating a mutually beneficial win–win situation.

In addition, the sensitivity analysis shows that when the risk discount rate $r_i, i = W, S$ rises, the optimal brand value threshold B_W^*, B_S^* and the optimal lodging pricing threshold of shift variable X_W^*, X_S^* also rise, but the net revenue decreases. This is mainly because an increased risk discount rate leads to an increased investment cost. At $r_W < 0.10$, $r_S < 0.12$, the net revenue of hospitality alliances with green brand restaurants is greater than the net revenue of creating one's own brand specialty restaurants. A hospitality investment strategy should choose an alliance with a green brand restaurant. However, when $r_W \geq 0.10$, $r_S \geq 0.12$, the net revenue of an alliance with a green brand restaurant is less than the net revenue of innovating one's own brand specialty restaurant. When the risk discount rate rises to a certain level $r_W \geq 0.10$, $r_S \geq 0.12$, that is, the investment cost is too high, the investment risks of innovating one's own brand specialty restaurant are relatively small. In such cases, hospitality should choose to innovate its own specialty restaurant. Additionally, when the average growth rate $\alpha_i, i = W, S$ of the shift variable rises, both the optimal brand value threshold B_W^*, B_S^* and the lodging pricing threshold of shift variable X_W^*, X_S^* decrease. The net revenue gradually increases. The average growth rate $\alpha_i, i = W, S$ of the shift variable rises, indicating that the economy is in a booming phase and investments should be made immediately. The net revenue of hospitality alliances with green brand restaurants is greater than that of innovating one's own brand specialty restaurants. A hospitality investment strategy should choose an alliance with a green brand restaurant. Moreover, when the uncertainty risk standard deviation $\sigma_i, i = W, S$ and the change in the fixed cost $I_i, i = W, S$ of the shift variable rises, the optimal brand value threshold B_W^*, B_S^*, lodging pricing threshold of shift variable X_W^*, X_S^*, and net revenue all increase. The net revenue of hospitality alliances with green brand restaurants is greater than that of innovating one's own brand specialty restaurants. Therefore, selecting an alliance with a green brand restaurant will be the best investment strategy.

The continuous expansion of hospitality is one of the most important strategies for sustainable growth. Strategic alliances drive competitiveness, play a multiplier effect, and share resources. This study mainly considers the uncertainty of the market from the perspective of flexible management, avoiding investment risks, and using the real options approach to construct the best investment timing model for hospitality to choose strategic alliances with green brand restaurants. A numerical analysis was carried out. The study provides more flexible decision-making thinking than other trend prediction criteria.

5 Importance of education for green brand

The social environment requires hospitality to implement green brands. Green brand development and education have become one of the important issues for sustainable economic development. Faced with severe climate change and serious air pollution, governments around the world are actively protecting the environment and developing green products. And for hospitality to formulate relevant low-carbon policies to solve the problem of global warming. Now, green brands have become one of the important factors for the sustainable development of hospitality. Creating a green brand can enhance the corporate image and increase business profits. It is an important way for green brands to connect with consumers and differentiate

themselves from competitors. It is also beneficial for hospitality to fulfill their social responsibilities. In the hospitality strategic alliance model constructed in this study, hospitality and green brand restaurant alliance can obtain higher net revenue. Therefore, promoting green brand education and raising the awareness of environmental protection will help hospitality to develop sustainably and solve social and environmental problems.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material; further inquiries can be directed to the corresponding authors.

Author contributions

Conceptualization: C-CK, C-YL, and CL; funding acquisition: C-CK; methodology: C-CK and C-YL; writing—original draft: C-CK and C-YL; writing—review and editing: C-CK, C-YL, and CL.

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