Symmetrical and asymmetrical analyses of hotel guests' pro-environmental behaviours

Abstract

Purpose - This study examines the influence of pro-environmental awareness and social media advertising on hotel customers' pro-environmental behaviours. The theory of planned behaviour (TPB) and social impact theory (SIT) are applied to investigate how environmental and advertising-related factors interact to shape customers' behavioural outcomes.

Design/Methodology/Approach – The study employed an online survey in this study, with a focus on customers who recently stayed at a hotel and engaged in pro-environmental behaviours. Both symmetrical (partial least squares–structural equation modelling [PLS–SEM]) and asymmetrical (fuzzy set qualitative comparative analysis [fsQCA]) methods were used to analyse the roles of subjective norms, pro-environmental attitudes and perceived behavioural control in driving pro-environmental accommodation behaviours.

Findings - The results highlight the mediating role of subjective norms and attitudes in translating environmental and advertising influences into pro-environmental behaviours. The findings underscore the synergistic effects between environmental awareness and advertising characteristics, highlighting their combined impact on customer behaviour.

Originality - By integrating the TPB and SIT, this study advances the theoretical understanding of the interplay between environmental awareness and advertising strategies. Further, the use of both PLS–SEM and fsQCA offers a comprehensive perspective, bridging the gap between statistical and configurational analyses.

Practical implications – This study provide guidelines for hotel managers and policy makers to promote customer incentives, differentiated social media communication strategies and a green certification system with cross-sectoral collaboration to promote customer eco-behaviour effectively and to facilitate the sustainable transformation of the hospitality industry.

Keywords: subject norms, social media advertising, pro-environmental behaviour, hotels, PLS–SEM, fsQCA

1. Introduction

The hospitality industry is facing increasing pressure to engage in sustainable development (Omar *et al*., 2024), as excessive energy consumption, water usage and waste management cause harm to ecosystems (Wang *et al*., 2024). To achieve sustainable development in the hospitality industry, active customer engagement and the adoption of green practices by businesses are necessary (Seo *et al*., 2024). According to the literature, increasing environmental awareness among consumers has accelerated the implementation of eco-friendly measures in hotels, which have received positive feedback (Yildiz *et al*., 2024). In addition, social media advertising has become a powerful tool for raising public awareness (Fan *et al*., 2024); however, despite its

growing use in hotel marketing, its impact on pro-environmental behaviours remains underexplored (Li *et al*., 2024). While some studies have examined customers' willingness to choose green hotels, few have considered the influence of social factors on pro-environmental intentions (Wang *et al*., 2024). In addition, environmentally conscious consumers are more likely than others to choose hotels that offer eco-certifications or sustainable services (Wang *et al*., 2024).

Despite significant research exploring customers' environmental behaviours in the hospitality industry, few studies have delineated how social media advertising interacts with customers' pro-environmental awareness to explain their behaviours, according to the theory of planned behaviour (TPB) and social impact theory (SIT; Xiao *et al*., 2023). Most studies overlook the critical role of perceived behavioural control and social impact, which not only shape customers' ability to adopt eco-friendly behaviours but also influence their decisions when faced with external constraints (Liu and Madni, 2024).

Drawing on SIT and the TPB, this study examines the relationships among pro-environmental awareness, social media advertising, subjective norms, pro-environmental attitudes, perceived behavioural control and customers' pro-environmental behaviours in hotel accommodations. Specifically, the study aims to examine 1) the effects of pro-environmental awareness and social media advertising on subjective norms and pro-environmental attitudes; 2) the relationships among subjective norms, pro-environmental attitudes, perceived behavioural control and customers' pro-environmental behaviours in hotel accommodations; and 3) the mediating role of subjective norms and pro-environmental attitudes among pro-environmental awareness, social media advertising and customers' environmental behaviours.

2. Literature review and hypothesis development

2.1 Theoretical foundations

2.1.1 Social impact theory and the theory of planned behaviour

This study integrates the TPB and SIT to understand the mechanisms of pro-environmental behavioural intentions by building bridges between rational decision-making and psychosocial mechanisms. The TPB, proposed by Ajzen (2020), is a central framework for understanding individual behavioural intentions and the determinants of action, and it extends the theory of reasoned action (TPB) to include perceived behavioural control. In this study, the introduction of SIT as complementary to the TPB is intended to reveal how individuals form environmental attitudes towards and perceptions of social norms through group influences.

Social influence is considered an important antecedent for reinforcing subjective norms and pro-environmental attitudes. For instance, Latané (1981) suggests that SIT explains how social factors, such as power, proximity and the number of sources, influence individual behaviour; today's wide spread of social media has significantly increased the 'social visibility' of sustainable consumption practices, and group identity is becoming a central mechanism for influencing subjective norms and behavioural attitudes (Murtaza *et al*., 2024). Research suggests that when consumers see influencers

or peers supporting environmentally friendly behaviours (e.g. choosing sustainable hotels), they may feel compelled to follow suit, resulting in a 'follow-the-leader effect' (Jose and Narayanan, 2024). In turn, this internalises group norms and shapes more positive environmental attitudes (Carlson *et al*., 2022). Thus, SIT not only complements the TPB's explanation of the social influence mechanism, but it also provides theoretical support for the process of the social construction of attitudes and subjective norms.

Pro-environmental awareness plays a dual role in this study, both in terms of individuals' rational knowledge and of decision-making on environmental issues from the TPB perspective. Simultaneously, it reflects the degree of internalisation of the values of pro-environmental groups among individuals from the SIT perspective. Social media advertising not only serves as a channel for information dissemination, but it is also an important medium for social norm and identity construction. As such, environmental advertisements that include user interaction elements can enhance users' sense of belonging to the environmental community, thus enhancing their behavioural intentions.

Therefore, by linking SIT with the core path of the TPB, this study constructs an integrative theoretical framework for this research (Figure 1), providing a more comprehensive explanatory perspective of the mechanism of the formation of pro-environmental behaviours in digital contexts from the dual perspectives of individual decision-making and social influence.

**** Figure 1 near here ****

2.2 Hypothesis development

2.2.1 Pro-environmental awareness perspective

Environmental concerns capture people's worries about environmental impacts, affecting both individual and societal dimensions (Lin *et al*., 2022). At the individual level, concerns surround personal perceptions of environmental degradation and the willingness to reduce negative impacts (Lim *et al*., 2023), whereas the societal level is concerned with the broader impact of human activity, highlighting perceptions of collective environmental harm (Xiao *et al*., 2023). As individuals gain environmental knowledge, their pro-environmental awareness grows, making them more susceptible to social norms and encouraging positive attitudes towards eco-friendly behaviours that are grounded in environmental knowledge, beliefs and responsibility (Kumar *et al*., 2017). Studies indicate that personal environmental concerns significantly shape attitudes and values, reinforcing environmental behavioural intentions through social group expectations (Batool *et al*., 2024). In addition, environmental knowledge, beliefs and responsibility are strongly aligned with subjective norms regarding green products (Kumar *et al*., 2017). Consequently, individuals who are aware of the importance of environmental protection are likely to consider group norms regarding green behaviours and attempt to meet these expectations, particularly regarding eco-friendly hotel choices. The following hypothesis is therefore proposed:

H1: Environmental (a) knowledge, (b) beliefs and (c) responsibility are positively

related to subjective norms.

Some studies indicate that individuals with increased environmental awareness, beliefs and responsibility tend to develop strong pro-environmental attitudes (Hidalgo-Crespo *et al*., 2022), which, according to the TPB, are crucial in shaping behavioural intentions (Ajzen, 2020). For instance, pro-environmental awareness not only deepens individuals' understanding of environmental issues, but it also fosters support for environmental responsibility and beliefs (Mansoor *et al*., 2025). Recent studies indicate positive relationships between pro-environmental attitudes and environmental knowledge, beliefs and responsibilities (Yu *et al*., 2024), suggesting that those with high awareness are inclined towards eco-friendly behaviours, such as choosing green hotels, believing these behaviours benefit both the environment and society (Van Huy *et al*., 2023). Accordingly, the following hypothesis is proposed:

H2: Environmental (a) knowledge, (b) beliefs and (c) responsibility are positively related to pro-environmental attitudes.

2.2.2 Social media advertising perspective

Today, advertising extends beyond traditional media, increasingly relying on social media platforms (Ren *et al*., 2024), and the key elements of this type of advertising include appeal, effect and frequency. Advertising appeal motivates consumers to take action and shapes attitudes towards a product/service by conveying interest, identity and relevance (Zhu *et al*., 2022), while effective pro-environmental advertising, for example, uses emotional resonance or social responsibility themes to enhance environmental concern (Pittman *et al*., 2024). Based on SIT, advertising's effect serves as a measure of success, as reflected in changes in customers' cognition, attitudes and behaviours. It reinforces subjective norms, aligning closely with social expectations (Sharma *et al*., 2022). Finally, advertising frequency—the amount of ad exposure in a set period—also plays a key role, with high-frequency ads enhancing message retention and familiarity with pro-environmental social norms. Frequent exposure to advertising fosters an awareness of eco-friendly expectations, thereby boosting individuals' willingness to adhere to these norms (Srisathan *et al*., 2024). Accordingly, the following hypothesis is proposed:

H3: Advertising's (a) appeal, (b) effect and (c) frequency are positively related to subjective norms.

Advertising appeal not only evokes positive emotions and value recognition but also strengthens attitudes towards eco-friendly behaviours (Zhu *et al*., 2022). According to the TPB and SIT, appealing advertisements foster pro-environmental attitudes by enhancing favourable perceptions of sustainable actions (Polisetty *et al*., 2024). In addition, effective advertising boosts awareness and understanding of environmental messages, further reinforcing positive attitudes (Chang *et al*., 2023). Frequent exposure to environmental ads also contributes by consistently reinforcing these messages, allowing individuals to identify more strongly with the importance of green behaviours

and thus creating more positive attitudes (Kim and Kim, 2021). Accordingly, the below hypothesis is proposed:

H4: Advertising's (a) appeal, (b) effect and (c) frequency are positively related to pro-environmental attitudes.

2.2.3 Subjective norms, attitudes and pro-environmental behaviours

According to the TPB, subjective norms, pro-environmental attitudes and perceived behavioural control are key factors influencing pro-environmental behaviours regarding hotel accommodations. Subjective norms reflect societal or group expectations regarding eco-friendly behaviour, and social support or the expectations of others often play a crucial role in customers' decisions to choose green accommodations (Ahmad *et al*., 2020). When individuals perceive that their actions are aligned with societal expectations, such as reducing their carbon footprint or opting for eco-friendly hotels, this sense of social approval motivates them to adopt these behaviours (Balaji *et al*., 2019). In the context of hotel accommodations, subjective norms serve as a bridge, connecting customers to environmentally conscious options when they feel the need to meet social and cultural standards.

Pro-environmental attitudes and perceived behavioural control are critical in determining whether individuals will translate their intentions into actual behaviour. Pro-environmental attitudes, which are shaped by environmental knowledge and social influences, reflect an individual's intrinsic belief in the importance of environmental protection, and customers with a positive pro-environmental attitude are likely to select sustainable accommodation options, especially when these align with their environmental values (Ateş, 2020). However, simply having a positive attitude does not guarantee action, as perceived behavioural control plays a decisive role in whether customers can overcome barriers, such as cost or a lack of information. When customers feel confident in their ability to navigate these challenges, they are more likely to act on their pro-environmental intentions (Ajzen, 2020). In the hotel industry, providing clear information; reducing the cost of green accommodations; and offering convenient, sustainable options can enhance perceived behavioural control, thereby increasing the likelihood of customers choosing eco-friendly accommodations. These three factors—subjective norms, pro-environmental attitudes and perceived behavioural control—work together to promote pro-environmental decision-making regarding hotel accommodations, fostering the implementation of sustainable tourism practices. Based on this, we propose the following hypotheses:

H5: Subjective norms positively influence pro-environmental behaviour regarding hotel accommodations.
H6: Pro-environmental attitudes positively influence pro-environmental behaviour regarding hotel accommodations.
H7: Perceived behavioural control positively influences pro-environmental behaviour regarding hotel accommodations.

2.2.4 The mediating role of subjective norms

Subjective norms, which reflect the perceived social pressure that individuals face in adopting specific behaviours, significantly influence pro-environmental intentions (Gansser and Reich, 2023). These norms act as a socio-cognitive mediator, translating environmental knowledge into behaviours through social expectations (Ajzen, 2020; Kumar *et al*., 2017). In hotel accommodations, strong subjective norms amplify the likelihood of customers adopting eco-friendly practices (Peng *et al*., 2024), and advertising appeal, while effective in capturing attention and fostering eco-friendly identification, relies on subjective norms to reinforce its impact (Zhang *et al*., 2024). Meanwhile, social expectations enhance the influence of advertisements, aligning individual behaviours with perceived environmental demands (Sharma *et al*., 2022). The frequent dissemination of eco-focused content establishes these actions as societal standards, with subjective norms mediating the integration of social expectations into actionable behaviours, guiding customers towards environmentally responsible lodging choices. Therefore, we propose the following hypothesis:

H8: Subjective norms mediate the relationships between customers' pro-environmental behaviour regarding hotel accommodations and (a) environmental knowledge, (b) environmental beliefs, (c) environmental responsibility, (d) advertising attractiveness, (e) advertising effectiveness and (f) advertising frequency.

2.2.5 The mediating role of pro-environmental attitudes

Attitudes reflect an individual's enduring feelings towards specific behaviours, and they influence preferences and outlooks (Cologna *et al*., 2024). Positive attitudes, which are shaped by environmental knowledge, beliefs and responsibility, are key drivers of pro-environmental intentions, particularly in consumer and environmental psychology (Kumar *et al*., 2017). For example, environmental knowledge enhances the understanding of sustainable practices, beliefs emphasise their intrinsic value and responsibility motivates action (Hidalgo-Crespo *et al*., 2022). Based on SIT, social media advertising further strengthens pro-environmental attitudes through engaging, frequent and effective messaging (Sharma *et al*., 2022), such that emotional appeals and repeated exposure to eco-focused content increase awareness and foster positive attitudes, driving sustainable behaviours regarding hotel accommodations (Zhang *et al*., 2024). Consequently, pro-environmental attitudes function as critical mediators, linking social media advertising to behavioural outcomes. Thus, we propose the following hypothesis:

H9: Pro-environmental attitudes mediate the relationships between customers' pro-environmental behaviours regarding hotel accommodation and (a) environmental knowledge, (b) environmental beliefs, (c) environmental responsibility, (d) advertising attractiveness, (e) advertising effectiveness and (f) advertising frequency.

3. Method

3.1 Sample and data collection

The study was undertaken with adult hotel guests (aged 18 years and above) who had stayed in at least one green hotel in the past 12 months. To ensure clarity, we provided respondents with a brief explanation of the study aims and the relevant constructs involved. An online survey link was distributed using several well-known Chinese social media platforms, including WeChat, bilibili.com and Kuaishou. The data were collected from May to October 2024. Although this study focuses on Chinese social media users, this group is highly representative in terms of green consumption awareness and social media usage frequency (Xie *et al*., 2024), effectively reflecting the characteristics of pro-environmental behaviours in the digital environment. To reduce any potential interference of cultural differences when measuring variables, this study opted conduct empirical tests in a single cultural context (China) to enhance internal validity. The sample size for this study was determined using G*Power, a statistical tool commonly used to calculate sample sizes for various tests, ensuring the study has sufficient statistical power to detect meaningful relationships among the variables under investigation. Herein, G*Power indicated that the minimum sample size required to detect significant effects was 172 participants.

All items intended to measure the study variables were rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). Environmental knowledge was measured by adapting the scale created by Bohlen *et al*. (1993), whereas environmental responsibility and beliefs were evaluated using a scale adapted from Huang (2016). Advertising appeal and effectiveness were measured using scales derived from Wang *et al*. (2013), while advertising frequency was assessed based on the work of Burton *et al*. (2019). Finally, subjective norms, pro-environmental attitudes and perceived behavioural control were measured using a scale derived from Lou *et al*. (2022), and pro-environmental behaviour regarding hotel accommodations was measured based on a scale created by Agag and Colmekcioglu (2020).

3.2 Data collection procedure

Before conducting the survey, respondents were informed of the study's aims and their right to refuse participation or withdraw from the study at any time. The authors confirm that this study adheres to the ethical guidelines for human subjects and that the anonymity and confidentiality of the respondents were ensured throughout the study. In addition, this study's procedures were reviewed and approved by the university's Ethics Review Board. Because the measurement of pro-environmental behaviours in hotel accommodations was self-reported, there may be a social desirability bias. To mitigate this problem, this study used anonymity in the questionnaire design and randomised the order of items to reduce response tendencies (Zhu *et al*., 2024). In addition, to ensure correct targeting of potential respondents, screening questions were included, such as 'Are you 18 years old or over'?, 'Have you used social media'? and 'Have you stayed at a green hotel'?. Each respondent who provided positive answers to the filtered questions and successfully completed the questionnaire received a 10-RMB red envelope—a monetary gift—as a reward. All questionnaires were also thoroughly

screened for careless and invalid responses, which were then discarded.

A pilot test was conducted with 18 consumers who use social media regularly and who have stayed at a green hotel to assess the readability, clarity and response format of the questionnaire. To validate the scale items, correlations and Cronbach's alpha were calculated for each construct. In addition, two professors specialising in hotel management and two hotel marketing managers reviewed the questionnaire. Because the respondents were Chinese and the scale was written in English, the direct translation method was used to ensure the consistency and accuracy of the scale (Mellinger and Hanson, 2020).

Most the respondents were female (52.2%), with the largest age group being 25–44 years (54.6%). Regarding education level, the respondents were mainly holders of associate and bachelor's degrees (33.5% and 38.5%, respectively). In addition, 38.4% of respondents had a monthly income of 6,001–9,000 CNY, 22.4% used social media for less than one hour per day and 21.3% used social media for three to four hours per day on average.

4. Results

4.1 Results of assessment of model using partial least squares–structural equation modelling

4.1.1 Measurement model evaluation

The measurement model was evaluated for reliability, convergent validity and discriminant validity, where Cronbach's alpha, factor loadings, composite reliability (CR) and average variance extracted (AVE) exceeded the recommended thresholds, confirming construct reliability (Hair Jr. *et al*., 2020). Variance inflation factor (VIF) values ranged from 1.998 to 2.746, which are well below the threshold of 5, indicating no multicollinearity, and discriminant validity was confirmed using Heterotrait-monotrait ratio of correlation (HTMT), with all values below 0.85 (Hair Jr. *et al*., 2021). These findings validate the measurement model for hypothesis testing (see Tables 1 and 2). A Harman single-factor test ruled out common method bias (CMB), with the cumulative variance being 42.697%, which is below the 50% threshold (Hair Jr. *et al*., 2021). Thus, CMB was not a concern in this study.

**** Table 1 near here ****
**** Table 2 near here ****

4.1.2 Structural model evaluation

The results in Table 3 show that environmental knowledge positively influenced subjective norms ($\beta = 0.178$, $p < 0.001$) and pro-environmental attitudes ($\beta = 0.15$, $p < 0.01$), confirming H1a and H2a. In addition, environmental beliefs significantly affected pro-environmental attitudes ($\beta = 0.1$, $p < 0.01$), supporting H2b, but it had no effect on subjective norms ($\beta = 0.06$, n.s.), rejecting H1b. Further, environmental responsibility positively impacted both subjective norms ($\beta = 0.227$, $p < 0.001$) and pro-environmental attitudes ($\beta = 0.169$, $p < 0.001$), supporting H1c and H2c, while advertising appeal positively influenced subjective norms ($\beta = 0.09$, $p < 0.01$),

supporting H3a, but did not affect pro-environmental attitudes (β = 0.039, n.s.), rejecting H4a. Meanwhile, both advertising effect and advertising frequency positively affected subjective norms and pro-environmental attitudes, supporting H3b, H4b, H3c and H4c, while subjective norms, pro-environmental attitudes and perceived behavioural control significantly influenced pro-environmental behaviour regarding hotel accommodations, supporting H5, H6 and H7. Further, the mediating effects showed that subjective norms and pro-environmental attitudes mediated several pathways, supporting H8a, H8c–f, H9a–c, H9e and H9f; however, subjective norms did not mediate the relationship between environmental beliefs and pro-environmental behaviours (β = 0.015, n.s.), rejecting H8b. Similarly, pro-environmental attitudes did not mediate the relationship between advertising appeal and behaviour (β = 0.01, n.s.); therefore, H9d was rejected.

The coefficient of determination (R^2) showed that the model explained 39.5% of the variance in environmental behaviours regarding hotel accommodations, exceeding the 0.30 threshold and indicating good explanatory power (Hair Jr. *et al*., 2020). The model also demonstrated an acceptable fit, with a standardised root mean square residual (SRMR) value of 0.034, which is well below the 0.08 cut-off. In addition, the positive Q^2 value ($Q^2 = 0.417$) confirmed the model's predictive validity for pro-environmental hotel behaviours (Hair Jr. *et al*., 2021).

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4.2 Results of fuzzy set qualitative comparative analysis

To provide a holistic view of the hotel guests' pro-environmental behaviours, fuzzy set qualitative comparative analysis (fsQCA) was employed to analyse the data and identify the configurations of antecedents that explain the behaviours. This method is case-based, grounded in set theory and Boolean algebra, enabling the exploration of asymmetrical and combinational relationships between variables while identifying necessary and sufficient conditions for outcomes (Kang and Shao, 2023). By calibrating raw data into set membership scores, fsQCA reveals how multiple antecedents interact to shape behavioural outcomes (Wang *et al*., 2024). This approach offers a configurational perspective, as well as optimal solutions for enhancing pro-environmental behaviours, providing a novel pathway through which the complexity and nonlinearity inherent in environmental behaviour analysis can be addressed.

4.2.1 Data calibration

To perform fsQCA, the data must be calibrated prior to the truth table analysis. Calibration transforms data into fuzzy sets by determining membership scores based on three anchors, allowing for the analysis of complex causal relationships and partial membership in various sets. The key step in fsQCA is data calibration, which transforms raw data into fuzzy sets with affiliation scores ranging from 0.000 to 1.000, rounded to three decimal places. A score of 0.000 indicates non-membership, and 1.000 indicates full membership, whereas 0.500 represents ambiguity and was adjusted to 0.499 based on previous studies (Wang *et al*., 2024). Therefore, based on the principles

validated by Kang and Shao (2023), data calibration was performed using the fsQCA 3.0 software, with the 95th, mean and 5th percentiles of each structure being set to full membership, intersection and non-membership, respectively, using the direct calibration method, in accordance with Wang *et al.*'s (2024) approach to ensure the transformed variables have both explanatory power and comparability. Simultaneously, we also conducted sensitivity analyses of several variables to verify the robustness of the findings under different threshold settings.

4.2.2 Necessary conditions analysis

After the fuzzy sets were calibrated, a necessity analysis was conducted to determine whether the explanatory variables are necessary conditions for the outcome variable. The consistency values for these conditions ranged from 0.500 to 0.788, all below the 0.90 threshold (Kang and Shao, 2023), indicating none of the necessary conditions for pro-environmental behaviour in hotel accommodations (PEBHA). These conditions can now be combined in the next step to analyse the effect of factor combinations on PEBHA (Table 4).

**** Table 4 near here ****

4.2.3 Sufficient conditions analysis

Following the necessity analysis, a sufficiency analysis was performed to identify condition combinations that predict managers' sustainability practices. A truth table with 2k logical combinations (k = number of conditions) was constructed using Pappas and Woodside's (2021) approach, where configurations with consistency values below 0.55 were excluded. Three solutions—complex, economical and intermediate—emerged, the latter of which was chosen due to its completeness and interpretability (Kang and Shao, 2023), and the results are shown in Table 5.

Table 5 identifies six configurations associated with high PEBHA, with an overall solution coverage of 0.667 and a consistency of 0.866, reflecting robust explanatory and predictive power. In the first configuration—PEBHA1—, despite the lack of environmental beliefs, those who reflect environmental knowledge, responsibility, advertising effect and frequency, subjective norms, pro-environmental attitudes and perceived behavioural control (consistency = 0.926; raw coverage = 0.183) tend to engage more often in pro-environmental behaviours. This result challenges the traditional assumption of the linear path of 'belief–attitude–behaviour' in the TPB, and it suggests that environmental beliefs are not necessary for pro-environmental behaviours. The addition of advertising appeal to PEBHA2 resulted in a significant increase in consistency and coverage (consistency = 0.953; raw coverage = 0.465), emphasising the marginal reinforcing role of advertising perceptions in eliciting behaviour. These pathways suggest the existence of multiple configurational mechanisms for the generation of pro-environmental behaviour, strengthening the theoretical necessity of integrating the individual rational decision-making logic of the TPB with the socio-contextual influences of SIT.

In configuration PEBHA3, greater environmental knowledge significantly predicted

pro-environmental hotel accommodation behaviour despite the lack of typical internal drivers, such as environmental beliefs, responsibility and perceived behavioural control (consistency = 0.867; raw coverage = 0.176). This result deviates from the dominant path of attitudinal and perceived control emphasised by the TPB, suggesting that under specific conditions, cognitive-level environmental knowledge may function as a key driver of the independent promotion of behavioural intentions. PEBHA4 showed that a strong advertising effect significantly promotes pro-environmental behaviour, even in the absence of other traditional drivers (consistency = 0.894; raw coverage = 0.174), challenging the TPB's emphasis on internal cognition-centred explanations of behaviour. Meanwhile, in social media environments, strong advertising effects may directly trigger behavioural intentions through emotional arousal or social influence mechanisms, reflecting the dominant role of external motivators in a given context.

Further, PEBHA5 showed that pro-environmental behaviour remained significantly high, even in the presence of only advertising frequency (consistency = 0.874; raw coverage = 0.178), suggesting that continued exposure to advertisements may gradually enhance individuals' behavioural tendencies through potential social influences or cognitive habituation effects, reflecting an irrational incentive mechanism that relies on repeated stimuli. Finally, PEBHA6 showed that pro-environmental attitudes still significantly promoted pro-environmental behaviours (consistency = 0.868; raw coverage = 0.176), suggesting that an individual's intrinsic environmental attitudes are independently and strongly driven to compensate for the absence of external factors in a given situation, which highlights the critical role of attitudes in promoting green behaviour.

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5. Discussion and implications

5.1 Discussion

This study, which is based on SIT and the TPB, explores how pro-environmental awareness (knowledge, beliefs and responsibility), social media advertising (appeal, effect and frequency) and perceived behavioural control influence customers' pro-environmental behaviours regarding hotel accommodations, including the mediation of subjective norms and attitudes. First, the PLS–SEM results show that environmental knowledge, responsibility and social media advertising positively impact subjective norms (H1a, H1c, H3a, H3b and H3c), implying that pro-environmental awareness and social media information shape subjective norms, which motivates individuals to align their behaviours with societal expectations. This aligns with SIT, which posits that individuals imitate group behaviours to ensure social belonging, reinforcing pro-environmental behaviours through external stimuli, such as social media.

Second, environmental knowledge, beliefs, responsibility, advertising effects and advertising frequency positively influence pro-environmental attitudes (H2a, H2b, H2c H4b and H4c). For instance, customers with high environmental awareness are likely to adopt positive attitudes towards sustainability, and social media platforms play a key role in enhancing this awareness by promoting eco-friendly attitudes through

continuous exposure to relevant information and advocacy.

Third, subjective norms, pro-environmental attitudes and perceived behavioural control positively impact pro-environmental behaviours regarding hotel accommodations (H5, H6 and H7), where subjective norms and pro-environmental attitudes significantly mediate the relationship among pro-environmental awareness, social media advertising and pro-environmental behaviours regarding hotel accommodations (H8a, H8c-H8f, H9a-H9c, H9e and H9f). Customers' behaviours are also influenced by external social norms and internal attitudes, leading them to choose sustainable accommodations, while strong pro-environmental attitudes and perceived behavioural control further drive these eco-friendly decisions. Perceived behavioural control **(**PBC) may amplify the effects of attitudes and subjective norms (i.e. attitudes and social pressures have a strong influence on behaviour when individuals perceive elevated levels of control).

Fourth, H1b shows that environmental beliefs do not significantly affect subjective norms, indicating that individuals' internalised ecological values do not necessarily translate into their perceived social pressures. This may reflect the difficulty of individuals' beliefs to stimulate the perception of social norms when environmental issues are not yet widely included in the mainstream social discourse on tourism or hotel consumption. The lack of a significant effect of advertising appeal on pro-environmental attitudes (H4a) suggests that even if adverts are visually or emotionally appealing, they are insufficient to induce attitudinal change, especially if not supported by credible or practical content. This echoes recent discussions of the phenomenon of 'green advertising fatigue' or 'greenwashing', which increases consumers' sensitivity to the authenticity and credibility of environmental advertising. Consumers are becoming more attuned to the truthfulness of environmental advertisements, and information that is vague, exaggerated or distorted may lead to aversion or resistance. H8b and H9d were not supported, which further highlights the complexity of environmental behaviour paths in the current digital context, and which suggests that the driving mechanism of pro-environmental behaviours is not only limited by individual cognitive and emotional responses, but it also relies on the reinforcement of external social cues and the safeguarding of information quality.

The fsQCA analysis identified six distinct configurations that contribute to pro-environmental behaviours, with a particular emphasis on the role of environmental beliefs in amplifying these behaviours (Solution 1). PLS–SEM is primarily used to evaluate linear and symmetric relationships between variables, emphasising the independent net effect of each predictor variable on the dependent variable. FsQCA is based on complexity theory and reveals multiple equivalent causal pathways, emphasising how combinations of different antecedent conditions can work together to lead to the same outcome in a given context. Pro-environmental behavioural intentions (e.g. PEBHA) are not always driven by a single key factor but may stem from synergies and complementarities among multiple conditions. For example, PLS–SEM validated the significant role of variables, such as environmental attitudes and perceived behavioural control, in predicting PEBHA, while fsQCA further identified that stronger behavioural intentions can be formed when responsibility or knowledge levels are low,

as long as external stimuli, such as high frequency of advertisements or strong subjective norms, are present. This configural perspective reveals the non-linear and asymmetric causal mechanisms behind behaviour that are difficult to capture by PLS–SEM. As such, the integration of the two methods not only enhances the explanatory power and robustness of the results, but also expands our theoretical understanding of the formation mechanisms of sustainable behaviours in the hotel context, providing strong support for the study of the multiple pathways of complex psychosocial behaviours.

5.2 Theoretical implications

This study makes three major theoretical contributions. First, by integrating the TPB and SIT, this study proposes a 'social impact–planned behaviour model' and constructs an environmental behavioural decision-making framework for digital contexts, expanding the boundaries of the two theories to include the influential mechanisms of social media advertising. Specifically, the study reveals how social influence cues, such as ad attractiveness, frequency and utility, indirectly affect customers' PEBHA through subjective norms, environmental attitudes and behavioural control, enriching SIT's understanding of normative and informational social influences. In addition, this study introduces the perspective of individual pro-environmental awareness, which interacts with social influences to promote jointly the formation of environmental behavioural intentions, providing a new perspective on pro-environmental behavioural research within the cross-cutting framework of the TPB and SIT and filling the research gap of theoretical integration in the application of virtual environments.

Second, this study deepens the theoretical understanding of the factors influencing PEBHA by combining both the PLS–SEM and fsQCA approaches, overcoming the limitations of traditional linear models. The empirical results show that individuals' environmental knowledge and environmental responsibility significantly shape pro-environmental attitudes and subjective norms, validating the important role of knowledge and responsibility in driving behaviour in social psychological theory (Rousta and Allaf Jafari, 2024). It is particularly noteworthy that environmental responsibility not only acts as an intrinsic independent variable within individuals, but also as a key hub connecting social norms and attitudes, highlighting its centrality as a behavioural driver. Conversely, advertising frequency and advertising effectiveness have a significant impact on pro-environmental behaviours, while the role of advertising appeal is relatively limited. Enhancing the visual or emotional appeal of advertisements alone is insufficient to change behaviours, as practical information and high-frequency exposure are necessary complements to achieve behavioural change. Through the configurational lens of fsQCA, this study reveals multiple causal pathways, suggesting that the variables of environmental responsibility, advertising attractiveness and perceived behavioural control can compensate for or reinforce each other in different combinations to achieve increased pro-environmental behaviours. This multifaceted and complex causal mechanism expands the explanatory scope of the TPB and social influence theories, reflects the multifaceted and context-dependent nature of pro-environmental behaviours and infuses theoretical models with linear and non-linear

perspectives. The research results not only enrich the theoretical framework of pro-environmental behaviour, but also provide a new theoretical basis and empirical support for how social media advertising can effectively promote customers' environmental behaviours.

By integrating advertising frequency and advertising effectiveness into the theoretical model, this study systematically explains how social media promotion can effectively promote sustainable consumer behaviours by strengthening subjective norms and shaping individual attitudes. This innovative integration not only deepens the understanding of the interaction mechanism between environmental psychology theories and marketing strategies, but it also overcomes the limitations of traditional theories of a single perspective and linear causality, revealing the complex dynamic process and multi-level influence pathways involved in the formation of pro-environmental behaviours. The research results provide a solid foundation for the theoretical construction of an environmental behaviour intervention on digital platforms, and simultaneously, it provides important theoretical support and practical guidance for enterprises in designing accurate marketing strategies based on scientific evidence.

5.3 Practical implications

This study offers practical suggestions for hotel managers and policymakers who want to promote pro-environmental behaviours among customers. First, to enhance the environmental behaviours of customers, hotels can guide customers towards sustainable options and provide practical rewards (such as discounts on room rates or free services) by setting up environmental knowledge cards, holding themed activities and adopting green point reward mechanisms. Concurrently, they should cooperate with eco-certification organisations to establish standardised environmental service processes, conduct regular first-hand training for staff and set up 'Green Pioneer Awards' to motivate staff to practice and spread the concept of environmental protection. In addition, hotels can use social media to launch green interactive topics and encourage customers to share their eco-friendly behaviours to enhance the brand's sustainable image and customer engagement.

Second, the results of the configuration analysis suggest that hotels should develop differentiated communication strategies for customers with various levels of environmental awareness. For customers with weak environmental beliefs, hotels can push high-frequency, emotionally resonant visual short-video advertisements (e.g. 15-second Xiaohongshu note/ Tik Tok) through social media and their own hotel apps to reinforce the environmental theme and brand image. In addition, it is recommended to embed real environmental promises into the content of ads, such as, 'For every night of stay, the hotel will plant a tree for the local community,' and to combine this with user-generated content (UGC), such as reposting short videos of residents participating in the 'Green Room Challenge', to enhance the credibility and social impact of the adverts. To enhance the sense of inclusion, hotels can also regularly launch the 'Green Punch Card Challenge' or 'Plastic Free Experience' activities on social media platforms and set up redeemable rewards (such as green card membership points), and they can

display the results of customer participation through a visual list to arouse their sense of responsibility further and encourage a positive cycle of environmental protection.

Finally, hotels should cooperate with local tourism bureaus, hotel associations and third-party environmental certification organisations (e.g. China Green Hotel Standard), to establish a detailed certification system for environmentally friendly hotels, covering core indicators, such as energy consumption control, carbon emissions, waste classification and water resource management. The certification results can be displayed on official publicity and OTA platforms (e.g. Fliggy, Airbnb) and be attached to the hotel's homepage and physical front desk with a green logo, to enhance consumers' perceptions of its environmental credibility. The government can also set up a 'Green Hotel Development Fund' to provide tax breaks, preferential interest rates on green loans and brand promotion support for hotels that have passed high-level environmental certification. Industry organisations can also select the 'Environmental Pioneer Hotel of the Year' every year, and through media coverage, award ceremonies and logo usage rights, they can increase hotels' motivation to participate in the green transition and promote environmental protection behaviours, from individual behaviours to industry norms.

5.4 Limitations and future research

Some limitations warrant further attention. First, the study utilised a cross-sectional design, which limits our ability to make causal inferences, as relationships between variables may change over time. Therefore, future research could verify the stability of these findings through longitudinal studies. Second, this study focused on a specific cultural and geographical context, which may limit the generalisability of the results to other regions or customer groups. The use of a more targeted sample (e.g. actual guests of green hotels) would help ensure the findings accurately reflect real-world behaviours; thus, future research could conduct comparative empirical studies in different cultural contexts to validate the external validity and generalisability of the theoretical model further. Third, this study focused on customers' pro-environmental behaviours under existing social media conditions and did not fully explore the potential impacts of technological advances (e.g. artificial intelligence and the Internet of Things), individual personality traits (e.g. hedonism) and societal changes (e.g. changes in travel patterns in the post-pandemic era) on these behaviours; as such, future research should investigate the incorporation of technological, hedonic and social trends into the research framework for a better prediction of the impacts of customers' intrinsic personality motivations and social changes on environmental behaviours. Future research could also incorporate actual behavioural data (e.g. platform comments and booking data), use experimental or longitudinal designs and introduce theoretical frameworks beyond the TPB to reveal in full the causal mechanisms and complexities of sustainable decision-making in the hospitality industry.

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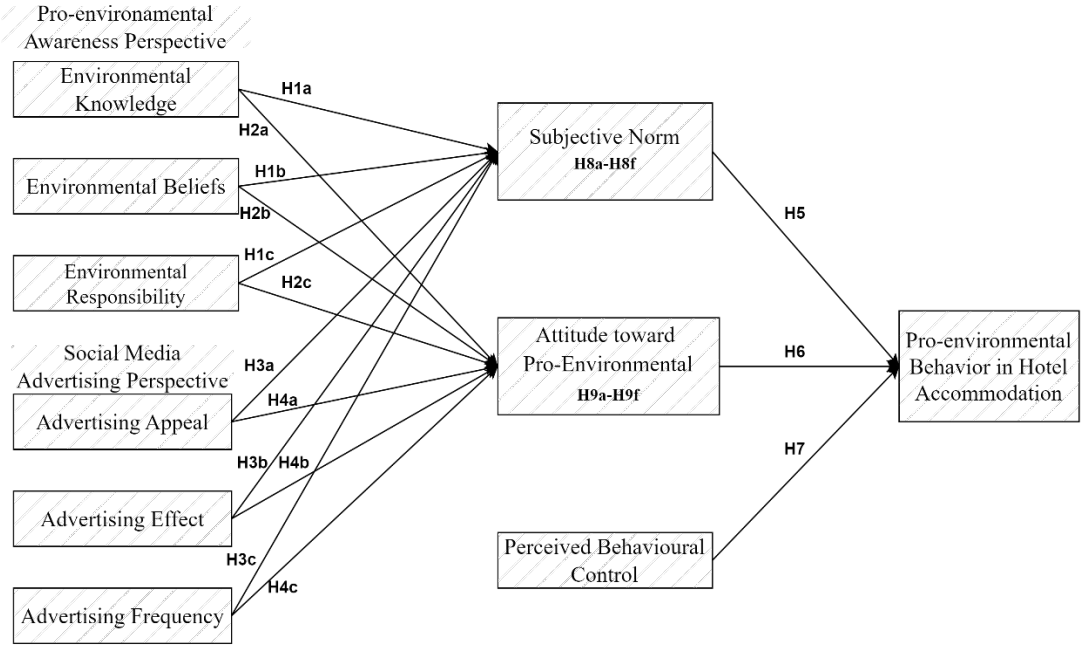

Figure 1 Conceptual framework (Source: Developed by authors)

Table 1 Measurement model evaluation results (Source: Developed by authors)

Construct	Factor loading	Cronbach's α	CR	AVE	VIF
Environmental Knowledge (EK)		0.921	0.94	0.76	
EK1	0.863				2.475
EK2	0.874				2.493
EK3	0.879				2.615
EK4	0.87				2.461
EK5	0.871				2.51
Environmental Beliefs (EB)		0.847	0.907	0.766	
EB1	0.88				2.196
EB2	0.877				2.248
EB3	0.868				2.036
Environmental Responsibility (ER)		0.881	0.918	0.738	
ER1	0.86				2.234
ER2	0.851				2.176
ER3	0.856				2.215
ER4	0.868				2.341
Advertising Appeal (ADA)		0.915	0.936	0.747	
ADA1	0.86				2.416
ADA2	0.869				2.411
ADA3	0.857				2.391
ADA4	0.869				2.56
ADA5	0.866				2.317
Advertising Effect (ADE)		0.89	0.924	0.752	
ADE1	0.873				2.409
ADE2	0.851				2.203
ADE3	0.881				2.55
ADE4	0.863				2.304
Advertising Frequency (ADF)		0.906	0.93	0.727	
ADF1	0.874				2.746
ADF2	0.853				2.44
ADF3	0.851				2.342

ADF4	0.838				2.382
ADF5	0.846				2.351
Subjective Norm (SN)		0.89	0.924	0.751	
SN1	0.866				2.311
SN2	0.86				2.275
SN3	0.86				2.283
SN4	0.881				2.564
Attitude Toward Pro-environmental (APE)		0.907	0.931	0.729	
APE1	0.862				2.546
APE2	0.839				2.264
APE3	0.854				2.453
APE4	0.857				2.492
APE5	0.856				2.479
Perceived Behavioral Control (PBC)		0.887	0.922	0.747	
PBC1	0.872				2.297
PBC2	0.86				2.346
PBC3	0.862				2.351
PBC4	0.863				2.27
Pro-Environmental Behaviour in Hotel Accommodation (PEBHA)		0.846	0.907	0.764	
PEBHA1	0.878				2.071
PEBHA2	0.862				1.998
PEBHA3	0.883				2.031

Notes: EK=Environmental knowledge; EB=Environmental beliefs; ER=Environmental responsibility; ADA=Advertising appeal; ADE=Advertising effect; ADF=Advertising frequency; SN=Subjective norm; APE=Attitude toward pro-environmental; PBC=Perceived behaviour control; PEBHA= Pro-environmental behaviour in hotel accommodation.

Table 2 Heterotrait-monotrait ratio (HTMT) (Source: Developed by authors)

	ADA	**ADE**	**ADF**	**APE**	**EB**	**EK**	**ER**	**PEBHA**	**PBC**	**SN**
ADA	-									
ADE	0.493	-								
ADF	0.528	0.599	-							
APE	0.482	0.632	0.632	-						
EB	0.585	0.543	0.54	0.524	-					
EK	0.529	0.562	0.596	0.575	0.456	-				
ER	0.533	0.655	0.668	0.634	0.541	0.613	-			
PEBHA	0.496	0.637	0.645	0.625	0.519	0.573	0.616	-		
PBC	0.489	0.612	0.627	0.637	0.542	0.556	0.655	0.589	-	
SN	0.527	0.635	0.628	0.692	0.515	0.611	0.68	0.621	0.632	-

Notes: EK=Environmental knowledge; EB=Environmental beliefs; ER=Environmental responsibility; ADA=Advertising appeal; ADE=Advertising effect; ADF=Advertising frequency; SN=Subjective norm; APE=Attitude toward pro-environmental; PBC=Perceived behaviour control; PEBHA= Pro-environmental behaviour in hotel accommodation.

Table 3 Structural model results (Source: Developed by authors)

Paths specified	Standardized coefficient	Finding
EK -> SN	0.178***	H1a supported
EK -> APE	0.15**	H2a supported
EB -> SN	0.06	H1b unsupported
EB -> APE	0.1**	H2b supported
ER -> SN	0.227***	H1c supported
ER -> APE	0.169***	H2c supported
ADA -> SN	0.09**	H3a supported
ADA -> APE	0.039	H4a unsupported
ADE -> SN	0.19***	H3b supported
ADE -> APE	0.219***	H4b supported
ADF -> SN	0.16***	H3c supported
ADF -> APE	0.206***	H4c supported
SN -> PEBHA	0.252***	H5 supported
APE -> PEBHA	0.267***	H6 supported
PBC -> PEBHA	0.219***	H7 supported
EK -> SN -> PEBHA	0.045**	H8a supported
EB -> SN -> PEBHA	0.015	H8b unsupported
ER -> SN -> PEBHA	0.057**	H8c supported
ADA -> SN -> PEBHA	0.023*	H8d supported
ADE -> SN -> PEBHA	0.048**	H8e supported
ADF -> SN -> PEBHA	0.04**	H8f supported
EK -> APE -> PEBHA	0.04**	H9a supported
EB -> APE -> PEBHA	0.027*	H9b supported
ER -> APE -> PEBHA	0.045**	H9c supported
ADA -> APE -> PEBHA	0.01	H9d unsupported
ADE -> APE -> PEBHA	0.058**	H9e supported
ADF -> APE -> PEBHA	0.055**	H9f supported
SRMR composite model = 0.034		
R^2PEBHA = 0.395	Q^2PEBHA = 0.417	

Notes: *p<0.05, **p<0.01, ***p<0.001; EK=Environmental knowledge; EB=Environmental beliefs; ER=Environmental responsibility; ADA=Advertising appeal; ADE=Advertising effect; ADF=Advertising frequency; SN=Subjective norm; APE=Attitude toward pro-environmental; PBC=Perceived behaviour control; PEBHA= Pro-environmental behaviour in hotel accommodation.

Table 4 Analysis of necessary conditions for predicting Pro-Environmental Behaviour in Hotel Accommodation (PEBHA) (Source: Developed by authors)

Conditions	High PEBHA		Low PEBHA	
	Consistency	Coverage	Consistency	Coverage
EK	0.761	0.742	0.544	0.533
~EK	0.520	0.532	0.736	0.756
EB	0.701	0.742	0.500	0.532
~EB	0.558	0.526	0.758	0.718
ER	0.762	0.741	0.558	0.545
~ER	0.533	0.545	0.735	0.756
ADA	0.756	0.721	0.579	0.555
~ADA	0.533	0.558	0.708	0.745
ADE	0.741	0.751	0.508	0.518
~ADE	0.525	0.515	0.756	0.745
ADF	0.781	0.740	0.568	0.541
~ADF	0.515	0.543	0.727	0.769
SN	0.732	0.751	0.508	0.524
~SN	0.536	0.520	0.759	0.740
APE	0.788	0.745	0.571	0.542
~APE	0.516	0.545	0.731	0.776
PBC	0.752	0.728	0.558	0.542
~PBC	0.527	0.543	0.720	0.744

Notes: "~" means logical operator NOT; EK=Environmental knowledge; EB=Environmental beliefs; ER=Environmental responsibility; ADA=Advertising appeal; ADE=Advertising effect; ADF=Advertising frequency; SN=Subjective norm; APE=Attitude toward pro-environmental; PBC=Perceived behaviour control; PEBHA= Pro-environmental behaviour in hotel accommodation.

Table 5 Main configurations for high PEBHA (Source: Developed by authors)

Configuration	Solutions					
	PEBHA1	PEBHA2	PEBHA3	PEBHA4	PEBHA5	PEBHA6
EK	●	●	•	⊗	⊗	⊗
EB	⊗		⊗	⊗	⊗	⊗
ER	●	●	⊗	⊗	⊗	⊗
ADA		•	⊗	⊗	⊗	⊗
ADE	●	●	⊗	•	⊗	⊗
ADF	●	●	⊗	⊗	•	⊗
SN	●	●	⊗	⊗	⊗	⊗
APE	●	●	⊗	⊗	⊗	•
PBC	●	●	⊗	⊗	⊗	⊗
Raw coverage	0.183	0.465	0.176	0.174	0.178	0.176
Unique coverage	0.023	0.308	0.029	0.029	0.030	0.027
Consistency	0.926	0.953	0.867	0.894	0.874	0.868
Solution coverage	0.667					
Solution consistency	0.866					

Notes: ● indicate the core condition exist, • indicate the peripheral condition exist, ⊗ indicate the core condition does not exist, and ⊗ indicate the peripheral condition does not exist. The presence or absence of a condition is indicated by blank spaces; EK=Environmental knowledge; EB=Environmental beliefs; ER=Environmental responsibility; ADA=Advertising appeal; ADE=Advertising effect; ADF=Advertising frequency; SN=Subjective norm; APE=Attitude toward pro-environmental; PBC=Perceived behaviour control; PEBHA= Pro-environmental behaviour in hotel accommodation.